Transformative effects of technology in learning and teaching in first year university science courses

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Declaration

I hereby declare that this thesis is my own work and has not been submitted for any other degree or professional qualification.

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Abstract

The first part of this study describes the synthesis of a research framework (known as the Transformation Framework) via the analysis of existing literature on technology-related transformation in learning and teaching. The Framework identified five Foundations that were desirable for any implementation of technology in an educational setting and also described three broad types of transformation that might be expected to occur (Institutional, Material and Behavioural). The remainder of the thesis contains a description of the application of the Framework to three science courses in the College of Science and Engineering at a large Scottish university at a point in time when they were attempting to initiate some transformation in learning and teaching, at least in part through the introduction of new technologies.

The Framework was used to construct a series of specific interview questions that were designed to illuminate each possible area of transformation. Interviews were then conducted with the Undergraduate Deans who were responsible for the overall initiative of which these courses formed a part and the organisers of each of the three courses (Courses A, B and C). The interview questions were then used to construct an online survey that was used to poll the lecturers and teaching assistants involved in the delivery of each course. Finally, anonymised course marks were obtained for the three courses covering the years before, during and after the innovations were introduced. Using the Framework as a reference, the data sources were then analysed, primarily using NVivo (qualitative data) and SPSS (quantitative data), in order to identify where there may have been transformation perceived or observed, and the evidence supporting the existence of any such transformation was evaluated. Any identified transformations were then analysed further to ascertain any specific contribution that technology may have had to such change.

The results provided broad support for the notion that the transformations that may occur are highly context-dependent, and are often influenced by the Foundations that are in place at the time. Course A could be described as

"innovation-ready" and as such there was evidence to suggest that the technologies used had several Institutional, Material and Behavioural transformative effects. Course B was more cautious and perhaps less prepared, and yet some Institutional, Material and Behavioural transformations were observed, largely in those areas that *were* well attended at the Foundation stage. The Course C implementation was done at short notice, and hence with little preparation and as such was very low-key and only limited Material and Behavioural transformations were evident as a result.

The research as described above highlights the fact that transformation is far more likely to occur if the proper Foundations have been put in place first, and the technology forms part of an implementation that is *well thought-out* by the organisers, *well supported* by the powers-that-be and *well accepted* by all those who will engage with it. The Framework itself has proved to be a useful and robust guide for this kind of study and it should have value in many different contexts in the future. Applications include not only the evaluation of existing implementations of technology in the classroom but also the planning and preparation of such implementations, informing both the design of a particular course and the choice of technology to achieve specific results.

Chapter 1. Introduction: Technology and transformation

1.1 A brief rationale for research

Having been involved in the implementation phase of many new technologies in education, I would like to take a step back and begin to look at the impact that they are having in higher education. As time goes on, a number of simple yet important things are becoming clear;

- Technology's advance into education is expanding, not diminishing
- Technology's advance into everyday life is more complete than it is in education
- Education generally plays "catch-up" with everyday life
- The technologies themselves are constantly evolving and changing
- Technology is often introduced into the classroom without any sound indication of its effectiveness in a particular area

As technology becomes more mobile and ubiquitous, and often less obtrusive, there is a general acceptance that good, forward-thinking education planning must involve increased access to and investment in digital technology. The onward march of that technology in society places pressure on educators to stay relevant and to meet the needs of today's students (Tatar, Roschelle, Vahey, & Penuel, 2003, p. 108; Weiser, 1991). Previous research seems to indicate that the thoughtful use of networked technologies can promote higher-order thinking and provide great flexibility at all education levels (Frear & Hirschbuhl, 1999; Herrington & Oliver, 1999; Jonassen, 2000; Lei & Zhao, 2007), and yet unplanned, unproven technological "innovation" can also become a costly and wasteful distraction, both financially and educationally (Cuban, 2001; Frear &

Hirschbuhl, 1999). It is therefore important to be able to identify which technologies are being used "successfully" – in this case having positive *transformative* effects - and determine the reasons for such effects so that lessons can be learned and applied in the future (Garrison & Kanuka, 2004; Jordan & Follman, 1993; Motteram, 2006). The tangled threads of practice and theory need to be constantly separated and sorted if we are to reap the very definite benefits of the technological revolution in education while avoiding the very real pitfalls. They highlight the importance of, and ongoing need for, questions to be asked and detailed answers to be sought about what technology is actually accomplishing in higher education. Furthermore, I believe that the answers to these questions will continue to be of national significance as only they can paint an accurate picture of how institutions are placed in implementing such technologies and achieving the desired results.

1.2 In search of transformative effects

In his seminal paper on the effects of educational technology, along with other novel teaching innovations, on teaching and learning, Richard Clark made the stark, bold and often, though inconclusively, contested declaration that all educational media are "mere vehicles" (2001). He stated that these vehicles have no impact on the learning that may (or may not) take place in the classroom. Going further, he suggested that any learning improvements that do occur in such situations are inevitably a result of "rival hypotheses" such as the changes in instruction that may occur simultaneously with a particular implementation. Hence, Clark implies that the introduction of technology may well transform teaching and learning, but it may not be the technology itself that directly causes the transformation. Make the same changes without the use of technology and the results will be the same. It is striking, therefore, that since Clark's original paper was first published, the demand for educational transformation in our institutions, particularly in third level education, has steadily gained momentum, and in many cases the application of new technologies is seen as a fundamental part of bringing teaching and learning into the twenty-first century. Colleges and universities invest huge amounts of money in technological infrastructure specifically to engage students and support interactive and collaborative methods in the classroom and lecture hall. The incidences of attempted transformations that have been initiated in the absence of some form of technology playing a pivotal role are few and far between. The implication, in the eyes of the educational community at least, is clear – technology is assumed to play a key role in achieving educational transformation. What is not so clear is the kind of transformations that are expected to take place and what may really lie at the heart of such transformations.

Indeed, there is a wealth of literature to support the notion that technology can be linked to transformation in teaching and learning (see Chapter 2). A major affordance of digital content is its ability to bridge both distance and time, and for its reach to extend beyond the reach of a single face-to-face meeting and become more entwined with the lives of the learners (Chris Dede, 2004). Hence the use of this kind of technology may well have an impact on how courses are structured and delivered, as well as on the nature of the target audience. McCormick and Scrimshaw (2001) and Norton and Wiburg (2003) highlight the fact that technology may impact teaching and learning in a number of different ways. Often, the first line of influence is to make existing practice more efficient. McCormick and Scrimshaw (2001) suggest the existence of a progression to using new technologies to *extend* or *transform* existing practices. Cuban writes "*computers offer ways of motivating students to learn about subjects they would seldom engage otherwise and to come to grips with real-world issues*" (2001, p. 15). Research also suggests that appropriate use of technology can foster the honing of higher order thinking skills in the classroom (Roschelle, Pea, Hoadley, Gordin, & Means, 2001, p. 76), but has the increased use of technology translated into a deepening of the learning experience for students? In addition, as already stated, the non-localised nature of digital content may have a great impact on the structures of higher of education (Cornford & Pollock, 2003; Chris

Dede, 2004). From a student perspective, is there evidence of this impact, and if so what effect has it had on the student experience of higher education? Before the days of what we now consider to be "technology" existed, Dewey asserted that interaction between students and instructors, in any environment, supports learning (Dewey, 1933). Student-student interaction has also been shown to be particularly beneficial to adult learners within the same subject interest (Brookfield, 1987; Schon, 1988). It has been suggested that new technologies are an ideal tool to make this kind of paedagogy a widespread reality in education (Wiske & Perkins, 2005).

In the light of these suggestions, together with Clark's assertions, we can define a key question for research and break it down into its constituent parts;

- **Is technology having a transformative effect on teaching and learning?**
  - *What areas of teaching and learning can be transformed by technology can be transformed by technology?*
  - *What is the evidence for this in literature?*
  - *In what areas of teaching and learning can transformative effects be observed? Can these transformative effects convincingly be attributed to technology or its use?*
  - *Is there a discrepancy between any rhetoric about the choice and use of technology and the reality of a particular implementation?*

Such a diverse and complex set of questions obviously implies the necessity for a carefully thought out approach from which a broad range of information may be obtained. Matters are further complicated by the fact that, for many of these issues, we may be seeking evidence and suggestions from which answers may be *inferred* as opposed to clear-cut results or facts. It must be recognised that there is not necessarily an easy answer to the question of "what do transformative effects look like?" and yet developing a perspective in this respect is clearly key to producing focused and effective research. Furthermore, it is worth stating that the improvements which we seek in the light of these questions are ones which may be gradual or incremental – many visible effects may only appear as the "*accumulation of learning experiences*" (Sabelli, 2004, p. 108), and hence a careful consideration of the nature of and evidence for transformation in this context is a vital starting point.

1.3 What do we mean by "technology"?

The word "technology" usually refers to the application of scientific knowledge for a practical purpose, and when the word is used, we often instinctively assume that it applies to the popular devices of the day. While this is a reasonable assumption to make, we have already acknowledged that there is often a time lag between what may constitute "technology" in the home and in the classroom. Indeed, the word may even be used to apply to different things in different classrooms. As an extreme example, consider a 1970s Betamax VCR – in a UK learning environment, this would only be referred to as "technology" if it were preceded by words such as "old", "outdated" or "defunct". However, in an isolated, rural third-world classroom, that same device may still be a treated as a welcome and useful addition to teaching and learning in that context, provided it came with a supply of compatible tapes. There is therefore a certain ambiguity about the term and what we mean when we use it will often depend on the viewpoint of the user and the context of its application, as much as by the novelty of the device itself. Hence, the terms "technology" and "new technology" as used throughout this study refer to any electronic tool, usually (although not exclusively) computer-based that is a recent addition to the educational context in which it is used. Examples of this in the UK at the time the study was undertaken may have included networked computer hardware and software, online resources and simulations, virtual learning environments (VLEs), student response (or "clicker") systems and data logging systems.

1.4 What constitutes an educational transformation?

The Oxford Dictionary defines the term transformation as "a thorough or dramatic change in form or appearance." However, instinct tells us that when dealing with *educational* transformations, the observation of a change in appearance alone may be unsteady ground from which to state that something dramatic has taken place. There is an intrinsic implication in this context that a change that is to be described specifically as a *transformation* must go to the very core of that which is being changed so that it represents a deeper shift in the beliefs, form or function of the body concerned. Hence I believe we can define a transformative educational intervention as one that goes beyond mere superficial alterations to produce deep and lasting change in a particular facet of teaching and learning in the context in which it is sought.

It must be acknowledged, of course, that "teaching and learning" is a broad and complex field, and at first the notion of observing every facet of a course in action looking for signs of transformation is a daunting one. However, there have already been a large number of studies on the effects of particular innovations on particular areas of teaching and learning and hence an important first step in this study was the analysis and aggregation of existing literature and research in order to synthesise a research tool or "framework" which could be used to identify areas in which transformation may occur and to examine their relevance to teaching and learning (Chapters 2 and 3).

1.5 A bird's-eye view

The methodology used in this study is discussed in detail in Chapter 4. However, a brief outline at this stage of the work undertaken may be helpful in explaining the path followed by this thesis. The study coincided with the implementation of a new Learning and Teaching Strategy at a well-known UK University, and a number of courses, known as *Vanguard* courses, had been selected to renovate their plans for the following year (to a greater or lesser extent) in the light of the content of the Strategy. Although the Strategy itself did *not* call for the use of technology in these courses, each of them opted to use some technological tools as part of their renovation plans, and hence these courses provided an excellent opportunity to look for transformations that may have appeared in each case as result of the use of new technologies. In order to gather data from these courses, the Framework developed in Chapters 2 and 3 was first used to construct sets of interview questions and questionnaires. Interviews and surveys were then conducted with the Undergraduate Dean, who had overall responsibility for the Vanguard courses, the organiser of each course and the lecturers and other teaching staff involved with each course. Each interview was then transcribed and the transcriptions and survey data were analysed, using the Transformation Framework, to identify

- The technologies implemented as part of the "Vanguard" strategy
- The areas in which evidence of transformation were observed from the perspective of the interviewee
- Whether or not these transformations could be attributed to the technological interventions

The results of these studies (discussed in Chapters 5 and 6) provided a wealth of information from the perspective of the Course Organisers who were largely instrumental in stepping forward to be part of the Vanguard process. Analysis of the interviews provided an overview of the expectations and perspectives upon which the courses have been built and which drive the ongoing development of the courses and also gave some context to the courses themselves. The main aim was to use the data provided through the interviews to begin to map where transformative effects may be able to be observed and to determine if such effects could be attributed to the technologies implemented in the courses. This was achieved through the use of the Framework developed in Chapter 2, and the results were also viewed in the light of numerical data from the relevant courses (in the form of final course marks) in an attempt to validate any claims made regarding student performance (Chapter 7). The perspectives of the different groups on what happened in the courses as a result of the changes that were made were compared directly with each other in order to identify areas of overlap that may add weight to any reported observations of technology-related transformation (as well as contradictions). In addition, this comparison provided an overall feel for how the vision of transformed teaching and learning was passed "down" from those who had the vision in the first place to those whose responsibility it was to deliver it on the ground (Chapter 8) and how this may have affected any implementation.

Hence, drawing together the threads of framework, interviews, survey data, exam results and comparisons of perspective discussed in chapters 2-8 may enable conclusions to be reached regarding these questions and the technology implementations in the Vanguard courses and beyond (Chapter 9).

Chapter 2. Literature review: In search of transformation

2.1 Introduction

In Chapter 1, we have already discussed the fact that Clark makes much of the separation of the teaching method from the media that may accompany it, resulting in his emphasis on the existence of "rival hypotheses" (those other factors which may actually be the cause of the observed transformations) (Clark, 2001). However, are there circumstances, such as the deliberate introduction of technology to support particular aspects of teaching and learning, where the rival hypotheses are, in fact intertwined with the technology to such an extent that they cannot, and should not, be separated? Do we *need* to separate the method and the medium, or are they inextricably linked, as has been suggested with regards to any medium and the message which it carries (Cousin, 2005; McLuhan, 1964)? Are there types of transformation, or areas of the educational process, which are uniquely affected by the use of specific technological tools? If technology can be identified as a major stimulator of transformation, even if this is inextricably linked to a change in teaching style, attitude or environment, then surely this carries it beyond the realm of "mere vehicle". The medium often has an impact on the methods chosen or used so that the medium and method are intrinsically linked. In this case, the vehicle itself becomes part of the transformation – without the vehicle, the transformation will not be delivered. This highlights the importance of both identifying as specifically as possible the *type of transformations* that occur in teaching and learning and the *reasons for such transformations* – is it the technology that has brought about the transformation, or are other factors as likely to be responsible?

Isolating transformations that are directly related to the implementation of technology is therefore key to affirming the value of technology in education. In order to be able to accomplish this, it is important to gain an overview of what existing research has already shown to be important in the "success" or otherwise of technological interventions, as well as the kind of transformations that have been observed to have been brought about by technology in previous studies. Hence the rest of this chapter contains a review of existing literature and a discussion of the foundations for transformation that have been identified and the types of transformation that may be expected to occur.

2.2 Foundations for transformation

As with any innovation, both in education and beyond, it is clear that there are things outside of the innovation itself that can nonetheless have a direct impact on how that innovation proceeds and ultimately succeeds or fails. It is neither practical nor possible to draw up a definitive list of all the external factors which may have an impact on a particular technological intervention, but it is possible to highlight some foundational "blocks" that evidence suggests should be in place to provide the best chance of the intended goals, which are surprisingly small in number and variety, being achieved. While the absence of some of these foundations does not necessarily spell disaster, the reasons for lackluster or ineffective implementations can often be traced back to a weakness in one or more of these elements. Conversely, their presence can smooth the way for technologies to be used in new and transforming ways in education. Previous studies have identified the level of "readiness" as a key indicator of the success of a specific use of technology (C. Dede, 1998; Twigg, 2000, 2003). For this reason, an analysis of existing research was carried out in order to identify any such areas that appeared to be key to the success or otherwise of a particular implementation. The importance of carefully considered choices of tools and approaches was clear (Chickering & Ehrmann, 1996; McCormick & Scrimshaw, 2001; Salomon & Almog, 1998; Salomon & Clark, 1977), while ensuring that those involved maintained a certain level of positivity towards the use of those tools was also seen as critical (Bongalos, 2006; Scrimshaw, 2004). The need to provide sufficient support for such implementations, especially in the form of time, resources and professional development, was a recurring theme (Brinkerhoff, 1996; Ehrmann, 1995; Schrum, 1999), as was the necessity for the tools themselves to easy enough to use that they did not get in the way of the intended learning goals (Jonassen, 2000; Lave & Wenger, 1991). Hence, research seems to identify the following 5 broad factors which are foundational to the successful use of technology in teaching and learning;

- The presence of a clear rationale
- The presence of willing participants
- The provision of sufficient resources
- The opportunity for professional development
- The ease of use and clarity of purpose of the technology

These 5 factors are dealt with in turn in sections 2.2.1 to 2.2.5, and in each case, the key findings of existing research have been encapsulated in a series of brief statements highlighted in bold italics. The evidence upon which these statements are built is then discussed in detail following each statement.

2.2.1 Rationale

Current research literature suggests that when an educational innovation is implemented, and particularly a *technological* innovation, transformative implementations tends to be underpinned by an explicit rationale. The existence of such a rationale for the use of the technology in a particular instance seems to make it more likely that;

- We choose the right tool for the job
- We achieve buy-in from all those involved
- the implementation is a coherent part of a larger plan or strategy

The presence of a clear rationale makes it more likely that we choose the right tool for the job. In their paper "*Implementing the Seven Principles: Technology as a Lever*", Chickering and Ehrmann state that "*Any given instructional strategy can be supported by a number of contrasting technologies (old and new) just as any given technology might support different instructional strategies*" (1996). It surely must be recognised that there is indeed a wide choice of ways to teach and tools to use to reach a particular educational goal. It seems both logical and reasonable to ask, of any educational tool, "why has this one been chosen?" Chickering and Ehrmann assert that some tools are better than others at particular tasks, emphasizing the importance of careful, thoughtful planning leading to the deliberate choice of a specific implementation. Paying attention to the research that exists on technology in education may allow the educator to carefully match the task with the tool so that teaching and learning is improved and students receive support in their work which they did not previously have.

Conversely, inappropriate or ill thought-out choices may, at best, get the job done, but will be considerably less effective than other tools may have been (Culp, Honey, & Mandinach, 2003; Salomon & Almog, 1998; Salomon & Clark, 1977). It is not every circumstance in which a new technology will automatically perform better than an existing, tried and tested tool. In fact, it has been suggested that simply transferring old methods or resources to a new medium or technology "*runs serious risks of diluting the original instruction and possibly rendering it ineffective*."(Carr-Chellman & Duchastel, 2000, p. 229) This approach is frequently found in situations where technology has been introduced without a clear rationale. For example, the presence of computers and data projectors has led many educators at all levels to transfer existing notes directly to PowerPoint or other similar presentation software. The phrase "death by PowerPoint' has since been coined to describe the poor use of such presentation tools, usually to show slide after slide of text or other information, which leads quickly to a loss of interest in the audience (Craig & Amernic, 2006;

McCabe & Lucas, 2003). Similarly, it has not been uncommon for teachers or institutions to transfer large amounts of content to the web in the name of "e-learning" (Cornford & Pollock, 2003; Grabe, 2005; Grabe, Christopherson, & Douglas, 2005; Shephard, Wong, & Phillips, 2007; Yip, 2004). This is not necessarily a bad thing, as the ability to access lecture notes or presentations online may be an extremely useful reference point for students. However, it has often been done on many occasions without considering how a change of medium may radically change how, when and where students can interact with information and with each other, and there is evidence to suggest that this can have a detrimental effect on student performance (Grabe, 2005; Grabe & Christopherson, 2005; Grabe et al., 2005). In these situations, the technology tends to be slotted or wedged into existing instruction rather than forming an integral part of it (Young, 2004). In fact, it has been suggested that technology is more likely to be introduced and applied as a "bolt-on" or viewed as merely a novel addition if done in isolation i.e. if the implementation is not driven by a clear and broad rationale in the mind of the educator or institution (Bongalos, Bulaon, Celedonio, Guzman, & Ogarte, 2006; R. Hall, 2002). Hence the existence of a clear rationale seems to reduce the chances of time and energy being wasted on applications of technology that do nothing to improve teaching and learning in a particular context.

The presence of a clear rationale increases the likelihood that buy-in is obtained from all those involved. As with anything we do in the classroom, no matter what level of education we are dealing with, we cannot automatically assume that those involved directly or indirectly in the implementation (in our context, this might apply primarily to administrators, educators and their students) will spontaneously recognise or automatically acknowledge the benefits and advantages of the use of a particular technology to support or enhance learning in some way (Blin & Munro, 2008; R. Christensen, 2002; Finley & Hartman, 2004). Indeed, educators have a reputation for being reticent in the face of the introduction of what many people believe to be innovations

(Blin & Munro, 2008; Cuban, 2001). Although, at times, this reluctance is viewed negatively, on many occasions it is born out of a need to evaluate the potential of a particular intervention before significant time and energy are invested, in addition to a wariness of being at the receiving end of the latest political initiative. In this respect at least, students may not be much different from their teachers. Having been described as "digital natives" (Prensky, 2001), many students will have grown up in a digital world and are likely to have as much, if not more, experience with technology as their teachers. While they may have high expectations regarding the technology-richness of their educational experience, they are not necessarily won over by the mere mention of using some aspect of it in their studies. Some would argue that the fact that the technology and online environment is very much part of their world seems to imply that this could also make them demanding customers, both in terms of the quality of the product and the rationale behind its use (Tapscott, 1998). There are, of course, also those who argue that the ubiquity of technology in the lives of today's students does *not* necessarily produce the traits one might expect of a native, and their experiences with technology may in fact make students less critical and discerning users than we might imagine (Bennett, Maton, & Kervin, 2008; Carr, 2010). Whichever is the case, the need for carefully thought-out implementations is clear.

McCormick and Scrimshaw stress the need for explicit "*goals and purposes*" to be expressed in order to inform the student of the reasoning behind a particular "*educational encounter*" (2001, p. 41). Hence the need for a clear rationale is equally applicable at the classroom level and institutional level. A technological intervention is much more likely to succeed in the classroom if the students are clear about why they are using it and what it will help achieve in terms of their own learning – in other words, not only is it important to have a rationale, but that rationale must be explicit and clearly understood by the students. Similarly, if an institution encourages or even mandates the use of a particular technology in its classes, the success of that technology will depend to some extent on how the purposes and goals behind the mandate are expressed to and understood by the educators who will use the tools (Culp et al., 2003; Salomon & Almog, 1998; Salomon & Clark, 1977). Educators themselves are more likely to “run with” an innovation, particularly one whose use has been mandated from “above”, if it is clearly in tune with the paedagogical strategies already in place and if there is evidence that it will be worth the inevitable effort and time commitment (Cuban, 2001; Mumtaz, 2000).

The presence of a clear rationale makes it more likely that the implementation is a coherent part of a bigger picture. The carefully thought-out use of technology in (or out) of the classroom or lecture hall will naturally take into consideration the many aspects of the environment into which it is to be placed – the nature of the course materials, how the course is taught or delivered, the structure of the course as well as the characteristics of the student body at which the course is aimed, should all have a formative role to play and may be directly impacted by the use of a particular implementation (Bates, 2005). In other words, the use of technology in education cannot be separated from the paedagogical context in which it is utilised (McCormick & Scrimshaw, 2001; Twigg, 2003). Developing a clear rationale for the use of a specific tool seems to encourage the developer to look at the big picture and to use his or her knowledge of the situation to make appropriate choices (Boyd-Barrett, 2002; Young, 2004).

The interconnected nature of paedagogy and the use of technology in the classroom does not sit comfortably with the trend over the last few years to spend technology budgets solely on hardware and software (Bates, 2005). The temptation to do this is understandable – it is easy for an institution to tout a list of state-of the-art tools as evidence of its presence at the cutting edge of education, and it is equally tempting for the general public (who may also fall into the category of “stakeholders”) to see this as an acceptable measure of the quality of teaching and learning at a given institution. Not many institutions have used their budget to ensure that educators were given a block of time free from other distractions to thoughtfully re-evaluate their courses and paedagogy in the light of the introduction of new technologies (Brinkerhoff, 2006; Schlager & Fusco, 2003). However, ultimately, "*a university is defined by the quality of its academic conversations, not by the technologies that service them*" (Motteram, 2006). Putting the technology in place is admirable, but in isolation it will not necessarily further the academic goals of any institution. It does not seem to be enough to select a technology or even a broad range of technologies to support teaching and learning in a given situation. The implementation is part of a picture with many intricate details, and if the technology implementation is not an explicit or coherent part of that picture, complementary to the overall strategies of the teacher or institution then it may not achieve the intended educational goals (Young, 2004). A successful approach in this respect is usually evidenced by a clear rationale on the part of the teacher as to the reasons behind the implementation and the choice of the tool concerned (D. M. Watson, 2001).

2.2.2 Willing participants

Researchers have noted that on occasion, the introduction of a new technology may serve as motivator for professional growth and development in itself – teachers may be keen to use the tools but may also recognise their own personal inexperience with the associated paedagogy (Bongalos et al., 2006; Windschitl & Sahl, 2002). However, research has also shown that this is not generally widespread and the use of technology does not spontaneously stimulate educators to change their practice (Bongalos et al., 2006; Condie & Livingston, 2006; Twigg, 2003). Even if adequate time is provided specifically for educators to ensure they are using tools appropriately and adopting the most appropriate teaching strategies, the default position is not one of spontaneous change – it is, rather, one in which educators are more likely to "bolt on" the use of technology (or any other educational innovation) to existing practice. This may put the onus on the institution to help stimulate an ethos of willingness to adapt and change by supporting such change providing educators with access to high quality professional development opportunities (Eraut, 1994; Schlager & Fusco, 2003; Vannatta & Fordham, 2004; G. Watson, 2006).

The consideration of technology as merely an add-on to existing practice may partly be a result of the clear association between the use of technology and a more student-oriented view of teaching and learning. Many educators, particularly in higher education, do not necessarily subscribe to this view of teaching or see it as relevant in their situation and may therefore be less inclined to use such tool (Scrimshaw, 2004). It is clear that a correlation exists between the effective uptake and use of technology and the perception of educators as to the impact technology will have on their teaching (Baylor & Ritchie, 2002; Bitner & Bitner, 2002). Those educators who see no need to do other than use technology as an add-on are often less likely to use it in the first place (Cox, Preston, & Cox, 1999), possibly because they have experienced little success with using technology in this way in the past. Technology used in this way has limited potential to impact teaching and learning in positive way, and educators are not known for enthusiastically embracing innovations that they perceive as time consuming and ineffective (Bitner & Bitner, 2002; Terry Haydn & Barton, 2008). Whether this can be achieved through the close support of educators in the face of change, in the form of serious efforts to match technology use with research-based paedagogy or whether it is simply a matter of steering clear of those who are cynical, is hard to tell. However, it is clear that a reasonable degree of “buy-in” on the part of those involved is a necessary foundation to a transformative educational innovation such as the use of new technologies (Blin & Munro, 2008; Brzycki & Dudt, 2005; Cuban, 2001).

2.2.3 Resources

It seems safe to assume that the infrastructure in place in the institution will have a direct impact on the types and use of technology in a particular course.

Although, by its very nature, the use of networked technology should enable the load to be spread away from the institution into the homes or lodgings of the students themselves, the reality is that in most cases the university must still provide a certain level of access to computers for those students who are unable or choose not to possess their own. The implementation of technology into a course, no matter how innovative or supported by research it may be, may struggle to succeed if insufficient planning and investment has been put in to ensuring that each student can have full and equitable access to the required hardware and software and the spaces provided are conducive to work for both students and teachers alike.

However, the key resource is time. Most, if not all, implementations will have time implications (some of which may be due to the technology itself while some may be due to the nature of the paedagogy applied in conjunction with its use). There is little point in introducing a technology into a course if sufficient time is not also made available to allow that technology to be properly and successfully utilised. In general, it seems that we can state that the provision of adequate time and resources makes it more likely that;

- the educator is aware of how best to incorporate the new technology
- there is sufficient space in the course itself to allow for teaching styles implied by the technology
- the technology can be used as originally intended at the planning stage

The provision of adequate time and resources makes it more likely that the educator is aware of how best to incorporate the technology. McCormick and Scrimshaw (2001) assert that introducing technology into a classroom or lecture hall must inevitably lead educators to re-think their teaching modes so that they work effectively with the new technology. Although we seem to be in a time of flux in many aspects of higher education, the traditional lecture format is still a common form of teaching and content delivery in our universities and colleges. Hence it is reasonable to assume that in most instances, at least some adjustment in paedagogy will be required whenever a course is "updated" in some way through the use of technology. Although this need to match the tool with the teaching style is based on sound educational research and theory, it may be impractical to make this demand of educators without providing them with the means to do so (Ehrmann, 1995; Smeets et al., 1999). The most desired provision is therefore likely to be in the form of appropriate preparation time. Hence, as any new implementation of technology is considered, there must be time available to the educator to make the corresponding adjustments to his or her paedagogy. An implementation which has had the luxury of well-used planning time seems to be much more likely to have a positive impact on teaching and learning than one which has been added on a more speculative foundation (C. Dede, 2005; Fisher, 2000; Sabelli, 2004).

The provision of adequate time and resources ensures that there is space in the course itself to allow for teaching styles implied by the technology. We have already seen that the implementation of new technology often requires extra time in order to ensure that the teaching methods make the best use of the technology. Similarly, the pedagogies themselves which are most sympathetic with the use of technology tend to favour a larger amount of student interaction and are themselves generally more time consuming than methods which rely solely on lecturing and one-way content delivery (Bender, Wood, & Vredevoogd, 2004; Cavanaugh, 2005). Situations where educators are constantly pressured and the demands of duties or timetables have left them unable or unwilling to change their practice, so that they merely "bolt on" the technology to existing practice, may not bode well for the effects that such implementations will have on teaching and learning. The provision of extra time, or the opportunity to re-shape a course so that more space is created within the existing time allocation, allows the teacher to introduce the types of paedagogy with which research shows the technology works best (Bullock, 2004; Wijekumar, Meyer, Wagoner, & Ferguson, 2006).

***The provision of adequate time and resources increases the likelihood that the technology can be used as originally intended at the planning stage*.** Despite the fact that the rationale behind many e-learning implementations is at least partly due to their perceived ability to save money, time and other resources, actual practice would seem to suggest otherwise (Bongalos et al., 2006; Ehrmann, 1995). In terms of time, e-learning initiatives that take full advantage of the affordances of the medium may actually be more demanding from the instructor's perspective (Carr-Chellman & Duchastel, 2000) than traditional modes of course delivery and teaching and learning. Additional time may be spent in developing new resources and making them available to students, responding to ad hoc student concerns and e-mails or engaging students in synchronous or asynchronous online discussion, which in itself is intrinsically time-consuming. Hence it follows that if adequate time is not given to an educator engaged in some form of technology-mediated learning with his or her students, it seems unlikely that he or she will be able to make the best use of the tools at their disposal.

Attempting to implement this kind of innovation without due consideration of the new demands it will make upon teacher and student time runs a serious risk of resulting in a mediocre provision of ill-devised learning materials which the students are then left to sort through without adequate support (Bender et al., 2004; Cavanaugh, 2005). Conversely, a hallmark of successful implementations of technology in blended or online courses is a carefully thought-out and sufficient allocation of time that allows the educator and students to take full advantage of the available tools and to engage with the course materials in meaningful ways.

2.2.4 Professional development

The importance of fully equipped and informed educators to the success of a particular technological intervention has already been implied. However, even if we assume that teachers are clear in their reasoning or rationale for using a particular technology, and the use of the technology is well provided for by the existing infrastructure, these two factors do not guarantee that the educator and/or support staff will indeed consider deeply how to incorporate a particular implementation. Any decision to do so may lead the teacher to adapt his or her teaching methods, so it is possible that the absence of such consideration may reflect a degree of reluctance to change on the part of the teacher, or it may simply indicate that the teacher is unaware of how the technology may best be used or how it may best be incorporated into their teaching (Brzycki & Dudt, 2005; R. Christensen, 2002). In many instances, teachers may require appropriate professional development opportunities (both technical and paedagogical) in order to select the appropriate paedagogy if their use of technology in their course is to be successful. Such opportunities may have the potential to positively impact both the confidence and competence of educators' use of technology in teaching and learning (Brinkerhoff, 2006; Schrum, 1999; G. Watson, 2006). In general, the evidence suggests that the ongoing provision of appropriate professional development increases the likelihood that;

- Teachers will feel more confident in the use of technology in their teaching
- Teachers will use the technology more effectively to support learning

The ongoing provision of appropriate professional development increases the likelihood that teachers will feel more confident in the use of technology in their teaching. A lack of confidence with particular technologies or teaching techniques which are necessary may undermine the confidence of the teacher and hence their willingness to use it to its fullest extent. The readiness of the teacher to adopt and use a particular technology will inevitably impact the success of that technology implementation (Condie & Livingston, 2006; Schrum, 1999). It is true that teachers are much more inclined to use tools with which they feel confident. This is, of course, part of the reason that educators around the world tend to stick to the same set of tools for many years – they feel comfortable with these tools and can use them confidently without fear of serious error in front of large numbers of students, and part of the reason for a certain reticence to adopt new tools (Terry Haydn & Barton, 2008). Providing teachers with the means to gain such confidence with new technologies appears to be key to ensuring the success of a particular implementation. It could be argued that that a teacher who struggles with the mechanics of using an online discussion board may be reluctant to use it and less likely to use it effectively, while one who has little problem grasping the concept and is comfortable with its use will at least be more willing to engage with the tool on a more frequent basis (Brzycki & Dudt, 2005; Ertmer, 2005; Vannatta & Fordham, 2004; G. Watson, 2006). The majority of educators now claim at least some level of computer literacy through their own personal use of computers and through a myriad of professional development programs – such programs often focus on the mechanics of using particular software tools rather than the paedagogy, but they do at least provide hands-on experience which leads to a certain level of confidence when using such tools with students. Familiarity with the practical aspects of the use of technology may at least prevent the implementation from falling at the first hurdle (Mumtaz, 2000).

The ongoing provision of appropriate professional development increases the likelihood that teachers will use the technology effectively. A lack of appropriate professional development may result in a lack of knowledge or insight on the part of the teacher as to how to use the technology or to match the paedagogy they employ to the particular technology (Baylor & Ritchie, 2002; D. M. Watson, 2001). Without the opportunity to consider or learn how the to make best educational use of the affordances of the technology, the educator may struggle to take advantage of it and use it to support student learning. We have already discussed the idea that technology can have different impacts in educational environments and can be used for different purposes, but to really achieve its potential in the classroom, the use of technology cannot be separated from the paedagogy into which it is embedded. Hence it is necessary to highlight the link between the use of technology and a change in traditional teaching modes. "*Teachers may have to change their views of the subject, what they count as school knowledge, and how they view (and implement) paedagogy*" (McCormick & Scrimshaw, 2001, p. 44). This link between technology and paedagogical change in today's institutions highlights the need for the provision of widespread professional development and in-service training which is specifically aimed at addressing these issues. Without this, teachers may miss educational opportunities through their own lack of experience, training and general awareness of how their students were using, for example, a collaborative online environment (Salomon, 2002).

Hence, it may be useful to draw a distinction between the *confidence* of the educator in using a particular technology and the paedagogical *competence* of the educator with that technology. While a teacher may be well versed in the mechanics of using an online environment, with a clear idea of what to click when, so that they feel confident that they can use the tool without any untoward difficulty, it does not automatically follow that they will be aware of how to use the tool in a way which effectively encourages and supports student learning (Chickering & Ehrmann, 1996; Condie & Livingston, 2006). It seems unrealistic to expect educators to know instinctively how to best employ each and every tool which comes across their path, and yet in the past the amount of professional development which has traditionally addressed the issue of adapting and changing one's paedagogy depending on the tools being used is often minimal (Fabry & Higgs, 1997). The ongoing lack of awareness of the relationship between the implementation of technology in education and the teaching methods that will be effective, together with the continued dominance of didactic teaching methods in higher education, make it highly unlikely that the required changes will happen spontaneously when technology is introduced (Salomon, 2002). Hence it appears that successful technology implementations may depend on the provision of appropriate and specific professional development, which not only gives teachers confidence with the tools but which enables them to use those tools competently to enhance teaching and learning in their context (Baylor & Ritchie, 2002; Ertmer, 2005; G. Watson, 2006). A coherent and widespread approach to such professional development may also have the added effect of diminishing the pervading reluctance to embrace innovation by demonstrating that such technologies are not merely the latest fad in a long list of educational silver bullets, but are rather transformational tools which encourage us to rethink how we teach in the light of research into how our students learn (Eraut, 1994; Fabry & Higgs, 1997; "Professional Development: How Technology can Enhance Teaching," ; Schlager & Fusco, 2003).

2.2.5 Ease of use and clarity of purpose

One final element which research suggests may be important in the success or otherwise of new technologies in educational environments has its roots in all of the above. The notion of the *transparency* or *invisibility* of technology has been used in this context to describe the effect the presence of the technology itself may have on teaching and learning (Lave & Wenger, 1991, pp. 102-103). It seems that technologies are at their most *transparent* in the classroom when;

- Sufficient time/ opportunity is provided for students to learn how to use the technology
- The technologies chosen are already familiar to the students

Transparency implies that the possibility exists for the technology to fade into the background or "disappear" as it is used to perform a chosen function (Ebner, Holzinger, & Maurer, 2007; Suchman, 2007), or to become a barrier to learning if there is more focus on the technology than on the principles or concepts that are being addressed. This may happen because of a poorly designed technology or task or due to a lack of explanation or training. Like any new educational tool or innovation, new technologies often (if not always) have an associated learning curve, during which attention may be focused on operating the tool in hand. While this is not an inherently bad thing, and the skills learned are often transferable, it seems reasonable to assume that there may not always be the opportunity or the time to provide the degree of training necessary to take students beyond this learning curve into the realm where the use of the technology is second nature, enabling students to engage with the required software without being distracted by the technology itself. For this reason, it has been suggested that the best forms of technology (meaning those which can contribute strongly to teaching and learning) are often those with which most students are already familiar and therefore which will have the shallowest learning curve in that particular context. Such technologies have been described as "*mindtools*" (Jonassen, 2000), and it has been suggested that the familiarity with these tools (which may be inherently simple to use or quite complex), together with their other inherent properties, enables them to be successfully used to help students learn important concepts and develop their higher-order thinking skills (Coleman, King, Ruth, & Stary, 2001; Garrison & Kanuka, 2004; Meyer, 2003; Rheingold, 2000).

2.3 Observable transformations

We have already defined a *transformative educational intervention* as one that goes beyond mere superficial alterations to produce deep and lasting change in a particular facet of teaching and learning in the situation in which it is sought. It could be argued that such transformations should be easily observable, and it follows that if, by definition, the changes will take place in particular facets of teaching and learning then by identifying those facets and observing them, such transformations should be visible if they are present. There has been a wealth of research into the effects of technology on all levels of education, and this research has also delved into the effects of technology on many aspects of teaching and learning.

Hence, an analysis of existing research was carried out in order to identify key strands of teaching and learning in which transformative effects resulting from technological interventions may be found. It became clear that in addition to having an impact on the content that was taught (Edwards, 2005; Peck & Dorricott, 1994; Wallis et al., 2006) and amount of time spent on content delivery as opposed to other teaching and learning activities (Chickering & Gamson, 1987; McCormick & Scrimshaw, 2001), technology also has the potential to transform how students interacted with learning materials and with each other (Chickering & Ehrmann, 1996; Dede, 2005; McCormick & Scrimshaw, 2001). The introduction of new technologies has also, on many occasions, been used to help change the way teachers teach and the way students think about their own learning (Hall, 2002; Meyer, 2010; Norton & Wiburg, 2003) as well as enabling students to develop a better understanding of particular concepts (Frear & Hirschbull, 1999; Jonassen, 2000; Perkins & Wiske 2005). We can summarise these key strands as follows;

- The **efficiency** of the course or programme
- The **variety** of means of student engagement with subject matter
- The course **content** or curriculum
- Student and teacher **interactions**
- **Paedagogy**
- **Student responsibility** for own learning
- **Student knowledge, skills or understanding** at the end of course or programme

Although it is acknowledged that there is inevitably a degree of overlap and interplay between some of these 7 strands, for the purposes of this study they are dealt with individually in turn in sections 2.3.1 to 2.3.7. In each case, the key findings of existing research have been encapsulated in a series of brief statements highlighted in bold italics. The evidence upon which these statements are built is then discussed in detail following each statement.

2.3.1 Efficiency

Efficiency has long been a buzzword in the world of industry and business. Lack of efficiency implies that precious resources are being poorly used, and as the twenty-first century heralds an increasing overlap between the previously mutually exclusive worlds of business and education, it is difficult to avoid a consideration of how efficiency impacts the use of technology in teaching and learning. Time, as we have seen, is an issue often raised by educators struggling to take advantage of networked technologies in their courses. In addition to the time necessary to work on any necessary course re-development, educators often report that integrating technology into their courses also increases the time it takes to deal with particular aspects of the course (Bender et al., 2004; Cavanaugh, 2005). While this may be inconvenient or provide some logistical challenges, it is not a straightforward matter to identify whether or not this is a problem in a particular context. In some instances, the use of technology may reduce the amount of face-to-face time devoted to “content delivery” and enable such time to be devoted to more interactive activities which provide more opportunities for the students to develop their understanding and use more higher order thinking skills (Boyce, 1999). However, it must also be recognised that not all forms and implementations of technology automatically accomplish more in the same, or even less, time – hence a definition of efficiency in these terms is not always sufficient. The use of asynchronous discussion may result in students and educators spending longer at related tasks, and yet the nature of such tools can also lead to increased interaction and engagement with the subject matter, which may lead to a deeper understanding of the material

(Bender et al., 2004; Cavanaugh, 2005; Wang & Woo, 2006). Even in cases like these when participants may be tempted to doubt the efficiency of such systems they by their very nature divert the time spent from passive observation to higher order activities. Merely asking questions of time will not fully reflect the potential for success of a particular intervention, but rather we must also examine what activities one is engaged in during that time. Hence in this context it may be useful to define *course efficiency* as the ratio of the course time spent on learning activities to that devoted primarily to the didactic dissemination of information. Research shows that, in this context, more efficient courses allow students more opportunities to engage in learning activities which enable them to demonstrate and develop their understanding of the course material, and hence better meet the learning objectives of a particular programme.

New technologies can be used to make courses more efficient so that students will have more opportunities, and more time, to engage in learning activities. McCormick and Scrimshaw discussed how the use of technology may impact teaching and learning, and identified three "*levels of change*". The first of these three levels is the specific use of technology to improve efficiency (2001, p. 44). While it must be acknowledged that the use of technology solely to improve efficiency may be akin to using a television to provide ambient lighting for a room (it may work but it is not necessarily making the best use of the tool), they nonetheless identify this as a valid and important criterion for measuring the success of a technology intervention in the classroom. Pressures of time often motivate educators to concentrate on using technology primarily as a tool for delivering content (Stamm & Howlett, 2002 in (Bongalos et al., 2006). There are many situations where such measures are successful in reducing the time required to disseminate information to the students, and this may well enable the educator to devote more of the available time to activities which support student understanding of the concepts in hand. There are also occasions when merely changing the content delivery system neither saves time nor effort, and the use of the technology may not have a positive effect on teaching and learning, indicating that improving the efficiency of a course cannot be left to chance.

The affordances of networked technologies are such that if they are used in specific ways, they can often engage the students in a meaningful manner such that the time spent using the technology is easily identifiable as time engaged in learning. Although some improvement in efficiency may be attained through an otherwise mundane use of technology, improvements are more likely to be observed in implementations which have been carefully planned and which put the technology to appropriate use (Bullock, 2004; Mumtaz, 2000). In this case, it seems that what is important is not necessarily the amount of time available or how much time has been saved, but the use to which any available time is put. In addition, it has been pointed out that when there is a move towards the use of some aspect of e-learning, there can also be a dramatic increase in time spent "on task" by students. If content, learning activities or interaction with faculty or other students is possible remotely then this will decrease (or possibly eliminate) the time spent commuting and so on. This implies that students will also have more time available to spend interacting with the course and the associated materials (Chickering & Ehrmann, 1996). Hence, the evidence suggests that technological interventions that maintain or improve the efficiency of a course are also likely to contribute to a better use of time and the provision and support of meaningful learning activities for the students (Garrison & Kanuka, 2004; Glover & Miller, 2001; Ruiz, Mintzer, & Leipzig, 2006).

Chickering and Gamson defined seven principles that their research found to be indicative of good practice, particularly in higher education, and which remain consistent with mainstream educational thinking. They stated that good practice;

1. encourages contacts between students and faculty
2. develops reciprocity and cooperation among students
3. uses active learning techniques
4. gives prompt feedback
5. emphasises time on task
6. communicates high expectations
7. respects diverse talents and ways of learning

(Chickering & Gamson, 1987, p. 1)

Many of these elements seem closely connected to the overall efficiency of the course as we have defined it previously – good courses by the above measures will also be efficient courses by our definition. An efficient course will be one in which content delivery is not the sole means of teacher-student interaction and which provides the educator with ample opportunity to incorporate these seven principles into the learning activities he or she designs for the students. Furthermore, it is suggested that networked technologies are ideal tools with which to provide the means of nurturing qualities such as the Seven Principles in a particular course (Chickering & Ehrmann, 1996). Despite the fact that implementing such technologies in engaging students in online collaboration and other high level tasks is demanding of both teacher and student time, the efficiency of the course itself as we have defined it can actually improve as research has shown that such activities result in a deeper level of learning and understanding (as may be evidenced, for example, by the ability to better apply concepts in new situations), reflecting the fact that the use of course time has been skewed away from content delivery and towards meaningful interaction and engagement (Beldarrain, 2006; d'Inverno, Davis, & White, 2003; Sivin-Kachala, Bialo, & Langford, 1997).

2.3.2 Variety

Perhaps one of the most obvious reasons for the introduction of any new educational tool into the classroom or lecture hall is that it will inevitably introduce some variety into the way the material is presented or concepts are explained or encountered by the learners, and the possibilities opened up by technology in this respect cannot be ignored. Despite the fact that we instinctively consider variety to be a good thing, particularly in this context, we must be careful to distinguish between variety and novelty. There is some contention that educational improvements can occur upon the introduction of any innovation simply as a result of its newness or novelty – sometimes referred to as the Hawthorne effect (Papert, 1971; Wallace & Mutooni, 1997). However, there does seem to be evidence to suggest that an increase in the number of ways students encounter material can have significant learning benefits, not least of all by enabling courses to address a broader spectrum of students' learning styles, such as visual, auditory and kinesthetic and read/write as described by the VAK/VARK model (N. D. Fleming, 1995). Whatever model of learning styles we adhere to (and there are many), Chickering and Gamson stress the importance of respecting "*diverse talents and ways of learning*" not only in an attempt to allow students to learn in a way with which they feel comfortable but also so that each student may develop a wider range of skills themselves (1987). Chickering and Ehrmann discuss the role that technology has to play in giving teachers and students such opportunities and emphasise how networked technologies offer the chance to work in text, images, audio and video and can be used to meet students' needs and broaden their "*repertoires for learning*" (1996). In addition, there are those that suggest that it will become increasingly necessary to use technology in teaching and learning because such technologies have become so intertwined with the lives of today's (and tomorrow's) students that they think and learn in ways that are different from previous generations and that are much more dependent on the use of the same variety of technologies they meet in every day life (C. Dede, 2005; Tapscott, 1998).

The use of new technologies can increase the variety of means of engagement with subject matter. The emergence of the idea of "multiple intelligences" (Gardner, 1983) and the corresponding variation in learning styles across the student population has, at the very least, resulted in a recognition of the fact that courses will increasingly need to meet the needs of this student population more completely by presenting the course content in a range of ways which correspond, at least to some degree, to the different kinds of learning styles present (C. Dede, 2005; Jonassen, Peck, & Wilson, 1999). Research suggests that such provision therefore will provide multiple points of access to the material, giving students more opportunities to engage with the material in a meaningful way. The very nature of *multimedia* is that it presents any content in a range of forms, primarily text, diagrams, audio and video. Most of what we consider to be *technology* in our context usually incorporates some multimedia elements, and hence the potential is there for a technological intervention, whatever its primary purpose, to increase the variety of means of engagement with course material (Brown & Warschauer, 2006; M. Russell, Bebell, O'Dwyer, & O'Connor, 2003). Conversely, it seems reasonable to infer that the use of such technology in a manner that does not necessarily take full advantage of this inherent potential (such as the replacement of all-text acetate overhead slides with an all-text PowerPoint presentation) may at times make less contribution to teaching and learning than one might expect.

Research into the success of projects such as the SCHOLAR project has yielded some evidence that providing students with a range of ways of accessing and interacting with course materials resulted in an increase in learning and understanding (Condie & Livingston, 2007; W. Hall & White, 1994). Students tended to use the flexibility offered in this respect to tailor and personalize their learning experiences. It is interesting to note that this process was largely unnoticed, and certainly unprompted, by the teachers involved. Another study looked at the impact of the introduction of e-learning modules into an introductory course at Hong Kong University of Science and Technology (Kekkonen-Moneta & Moneta, 2002). The researchers observed that such implementations could be successful provided the modules were well designed.

Analysis of such designs highlight both the potential for the provision of a wide variety of content types and the need to take advantage of such potential as educators supplement or replace more traditional teaching materials. Indeed, it has been suggested that any implementation of technology will demand a certain amount of paedagogical change - utilising the *affordances* of networked technologies to increase the variety of means of engagement with the subject matter is part of this process (McCormick & Scrimshaw, 2001; Wijekumar et al., 2006).

2.3.3 Flexibility of content

Putting a university course in place can be a complicated business, with intricate processes of approval, validation and accreditation. It is perhaps no surprise, therefore, that despite the apparent potential for change ushered in by new technologies, some courses may undergo very little change from year to year (Blin & Munro, 2008). To change the content of a course significantly may be an onerous administrative task. In addition, within the sciences at least, particularly in the first undergraduate years, courses often focus on the "classic" views of the subject, which may be seen as relatively unchanging. The practical elements of the course may in turn focus on particular pieces of apparatus designed to illuminate specific concepts, and as such their very presence demands attention during each run of a course. Lecturers work hard to develop lecture notes and plans to cover the relevant material and, understandably, may follow these notes, perhaps only very lightly updated, as they deliver repeated instances of a course over a period of several years. Introducing a new technological innovation into such courses may not be an insignificant task (Finley & Hartman, 2004). The integration of such new tools requires careful consideration on the part of those involved in course delivery, and may even have a direct impact on what is taught.

The use of technology can prompt a review of what is being taught, on the basis that it can enable new content to be delivered. Despite the possible existence of resistance or barriers to change as discussed above, there is evidence to suggest that if these barriers are overcome, the presence or introduction of some new technologies *can* have implications for the content of a course (MacKeogh & Fox, 2008; Pearce, Weller, Scanlon, & Kinsley, 2011). The introduction of technology has the potential to be a disruptive process (C. M. Christensen, 1997)– its use within a course may precipitate changes of one kind or another. Although this kind of change may not always be intended or seen as appropriate in a particular context for the reasons already discussed above, technology integration does seem to be an increasingly common vehicle for delivering change in universities around the world. As those involved in a particular course resign themselves to the changes necessary to accommodate the new technology, it appears that there is also the opportunity at least to review what is being delivered. Such reviews seem to be driven by two interconnected factors;

- the use of new technologies can enable new concepts to be addressed, or existing concepts to be dealt with in more depth than was previously possible (Edwards, 2005; Peck & Dorricott, 1994; Wallis, Steptoe, & Miranda, 2006)
- the need to accommodate new materials may lead to the identification of subject matter which is redundant and which can play a lesser role in the course or which can be dropped entirely from the syllabus (Edwards, 2005; Peck & Dorricott, 1994; Wallis et al., 2006).

Indeed, even if existing courses have little in common with the picture of student-centered learning as discussed previously, research has shown that the fact that teaching with technology may place additional demands on the time of the teacher and the students can, perhaps ironically, have the positive effect of forcing educators and their institutions to take a fresh look at what is being taught (Ehrmann, 1995; Vries et al., 2005; Wallis et al., 2006). Traditional courses may, for example, address issues that are no longer as relevant as they once were. Introducing technology into such courses will not solve problems that have their roots in the course content itself. However, the potentially disruptive presence of such technologies may provide the means whereby courses are re-examined and content reviewed, making space for new content and teaching strategies and increasing the potential for the course efficiency to improve (Meyer, 2010). Provided we hold to our definition of *course efficiency*, it seems that a conscious effort to ensure that the technology is used in such a way as to increase the ratio of time spent engaged in meaningful learning activities to time spent in one-way teacher-student transmission may have a positive effect on teaching and learning of the course as a whole.

2.3.4 Interactions

The research into, and acceptance of, social constructivist theories of teaching and learning have lead to an increased focus on the interactions between students and teachers that take place within our schools and universities. The spread of the idea of "social learning" has led to a new awareness of the part that various forms of interaction can play in the learning process. Today's popular technologies can often be viewed as communication tools (Branon & Essex, 2001; Greener, 2009). It is perhaps no coincidence that when teaching staff begin to become more technologically aware, the first signs of such awareness often reveal themselves in the selection of tools that have a direct impact on the ways students can interact with each other and with those delivering the course, such as student response systems ("clickers") and online discussion forums (d'Inverno et al., 2003; Wijekumar et al., 2006). Not only are such tools relatively straightforward to introduce, particularly when students are more familiar with such technologies than their teachers, but there is a general acceptance that interaction between students, their peers and their teachers is a good thing, and literature suggests that technology can enable communication and interaction within learning communities in ways not possible before (d'Inverno et al., 2003; Pearce et al., 2011; Sivin-Kachala et al., 1997).

The introduction of technology can lead to an increase in the amount and quality of teacher-student and student-student interaction. From a social constructivist perspective, the learning that occurs in an educational environment is directly influenced by the social interactions which occur – "*meaning is created through participating in social activity*" (McCormick & Scrimshaw, 2001, p. 39). McCormick & Scrimshaw also assert that introducing technologies into the classroom will inevitably lead to some form of change in practice within that classroom, and often such changes are centred on communications that take place between students and also with teaching staff. They point out that such technologies are often directly responsible for increasing the amount of communication within a particular learning context which in turn can have a significant impact on the learning which occurs. This view is shared by Hall, who states that to integrate the use of the internet into a course is primarily to make use of "*a powerful communications tool*" which, if used appropriately provides new opportunities for students to connect with each other and with their teachers and these new opportunities enable students to reflect on and improve their understanding of the topics in hand (2002, p. 152).

The importance of teacher-student and student-student interactions in the learning process is widely recognised, and, interestingly, is often the basis of arguments both for and against the use of many different types of technology in education (Beldarrain, 2006; d'Inverno et al., 2003; Donoghue, 2006; Gay, Pena-Schaff, & Martin, 2001). On the one hand, there are those who are concerned that the inappropriate use of technology will *decrease* the amount of contact between students and their instructors, while on the other there are those who argue that one of the strengths of some technologies is the possibility that they can be used to make instructors more accessible to their students. There are many benefits in face-to-face academic interactions, such as the ease and speed with which a teacher may react to the bemused look on students' faces, or the opportunities for students to seek clarification on particular points as they are discussed, and yet there may also be times when these interactions may only be either one way (teacher to student) or be dominated by the more confident or more vocal members in a given class. However, research shows that carefully implemented technological interventions can support and, in some situations, improve the amount and quality of interaction. In addition, where the technology is designed to improve access to teaching materials and even provide a platform for major content delivery, this may reduce the time spent during face-to-face meetings on one-way teacher to student delivery, allowing more opportunity for two-way interaction (d'Inverno et al., 2003; Sivin-Kachala et al., 1997).

However, there are also many occasions where the technology is used to replace (or at least simulate) a face-to face environment with either synchronous or asynchronous discussions (Branon & Essex, 2001; Greener, 2009). Although such technologies may at times appear to remove any face-to-face interaction, it could also be the case that they may be used in situations either where face-to-face contact is impractical or to augment existing face-to-face practices. More importantly, research shows that these technologies are more than mere substitutes for the "real thing", and their use can often result in a learning experience where participants find themselves more deeply engaged with the material and developing a more thorough understanding of the concepts involved (Beeland, 2002; Cole, 2009; Meyer, 2003; Ringstaff & Kelley, 2002). In general, it has been observed that "*the presence of new technology in a classroom has the potential to change the culture of the classroom and the relationship between the teacher and the students*" (Somekh, 2000). Chickering and Ehrmann (1996) highlighted the increased opportunity to collaborate which some technologies afford students, and also emphasised the fact that simple technologies such as email and forums increase access to faculty members, thus enabling students to more easily have additional interaction with teaching staff over and above scheduled face-to-face time. This experience is also observed across a wider spread of students than may be the case with a typical face-to-face class, as the nature of the technology allows socially shy or quiet students an equal say with those who may otherwise dominate (An & Frick, 2006; Pena-Shaff, Altman, & Stephenson, 2005).

There has been a considerable amount of research into what constitutes successful uses of online tools, and a number of frameworks have been developed to model how such tools can be used to stimulate interactions and create the necessary conditions for learning. A key focus is to distinguish the difference between uses of technology and *effective* uses of technology i.e. those that take into consideration how the online environment may be used to help students learn and collaborate in ways not easily achievable in other modalities. The Community of Inquiry model (Garrison & Anderson, 2003) provides a conceptual view of what is required to use online tools intentionally to support communication and build a working community, and applies whether the entire course is online or whether online tools are used to support more traditional modes such as face-to-face lectures. It focuses on the ideas of "presences" - the connections that are developed over time between students, teachers and the material being taught and which may be assumed to exist in face-to -face curricula. It is, of course, debatable whether such "presences" are any more likely to exist in face-to-face situations, but they can never be taken for granted in online environments, and it is suggested that their existence is vital to the sustained engagement and success of learners. Three types of presence are seen as key: Social Presence is defined as "the ability of participants in a community of inquiry to project themselves socially and emotionally…through the medium of communication being used"; Cognitive Presence is "*the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse*" (2003, p. 28); Teaching Presence is defined as "*the design, facilitation and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes*" (2003, p. 29). Careful use of technology can support the establishment of these "presences" in a community of learners and hence facilitate new levels of interaction among learners and with teaching staff.

2.3.5 Paedagogy

If one were to visit all the lecture theatres in the country at any particular time, one would, no doubt, be able to observe a broad range of approaches, teaching styles and methods of delivering the necessary content from the teacher to the student. Despite this variation, it also seems reasonable to suggest that not all classes have necessarily eschewed a model of didactic transmission of content to the student. This may be a result of a deliberate choice on the part of those delivering the courses, or at times it may reflect a certain amount of inertia in a particular institution, where, for example, research is seen to take priority over teaching. Whatever the case, in general it seems that in recent years there has been a greater emphasis placed on teaching within universities, leading in turn to an increased interest in how teaching and learning is approached. In particular, there has been a shift towards encouraging the social construction of knowledge through increased interaction as discussed in section 2.3.4.

The desire to make a change to the usual way of teaching a particular topic, course or subject (whether it is simply making a lesson or lecture more "interactive", providing students with more to do during the class, or involves a more dramatic paradigm shift) often appears to be associated with, or at least accompanied by, the introduction of "new" technologies. As discussed in section 2.3.4, networked technologies can largely be viewed as communication tools (Branon & Essex, 2001; Greener, 2009) and there is evidence to suggest that the introduction of such technologies can promote certain approaches to teaching and learning, and in particular those that are more constructivist in nature. Hence they are often used with the intention of transforming the way in which students access course content and interact with that content and with each other, thus potentially having a major impact on the way a particular course is taught when compared to the paedagogy used *before* the technology was introduced.

The use of new technologies can encourage the consideration and adoption of new paedagogies. We have already seen in Section 2.3.4 how this can be the case with regards to communication and interaction within a course, providing new opportunities for students to connect with each other and with their teachers (R. Hall, 2002). However, it has been suggested that in general, many implementations of technology can encourage a certain amount of paedagogical change. In the world of business, innovations (and new technologies in particular) may be described as being *disruptive* when they are introduced into the marketplace, displacing older and establishing new, paradigms, often in unexpected ways (C. M. Christensen, 1997). In recent years the term *disruptive technologies* has also come to be used in reference to technologies that are introduced into teaching and learning and that by their very nature and use stimulate an observable change to "normal" practice in the classroom or lecture hall, whether intentional or unintentional. It has been suggested that as a result of these disruptive tendencies, introducing technology, and in particular those that have an online element, may have the potential to transform learning experiences for students and are driving the need for leaders to rethink how courses are taught in their institutions (Armstrong, 2002; Garrison & Kanuka, 2004; Meyer, 2010). Hence, we can observe two situations occurring in education – one in which such changes in paedagogy happen (perhaps inadvertently) as a result of the introduction of technology, and one in which technology is introduced with the express intention of causing or advancing some change in the way courses are taught.

As already discussed in the context of the efficiency of a course, McCormick and Scrimshaw describe three degrees to which such change can occur. These are defined as follows;

- *Improving efficiency* with ICT – this refers to situations where the technology is used to support current practice and enable it to be carried out more effectively.
- *Extending the reach* of teaching and learning with ICT – in this case, the technology takes us beyond merely making existing processes more efficient and increases or expands what the teacher and the learner can achieve.
- *Transforming the conceptions* of the subject with ICT – in this case technology produces fundamental changes in how teaching and learning is done within a particular subject

(McCormick & Scrimshaw, 2001, p. 44).

It is clear that the above stages describe a progression from what might be viewed by some as the superficial to the dramatic in terms of the impact that technology may have on the way a course is taught. These levels are put forward as possibilities of what might be achieved by a specific implementation rather than certainties of what will happen each time particular tools are introduced. Indeed, there has been much discussion of why the more substantial effects of using technology are not reported by those involved as often as might be expected in the educational world. Evidence points to the fact that, while technology may be introduced by leaders in part to produce some changes in paedagogy, whether or not the desired changes occur does not depend so much on the technology as it does on the context in which it is used. In other words, a potentially transformative technology can always be implemented in such a way as to ensure that nothing happens - its natural disruptiveness is effectively neutralized (Salomon, 2002). Hence, to take advantage of what technology may offer in this respect, it may be necessary to "move with" any such disruption to make the most if it – "*redesign is the watchword of technology's promise for higher education*" (Heterick & Twigg, 2003, p. 28).

2.3.6 Student responsibility

An observation made by some involved in third-level education (and indeed by those involved at the second-level) is that today's students need to take more responsibility for their own learning (Borden & Evenbeck, 2007; Hassel & Lourey, 2006). An internal report into the development and implementation of a new teaching and learning strategy at the College of Science and Engineering at Edinburgh University noted, "*the expectations of both students and employers have changed. University life may now be seen by many as preparation for working life, rather than as a way of becoming knowledgeable about one particular subject. Graduates can often expect to have numerous jobs, and potentially changes of career within their working life. The need to gain and explicitly define transferable skills is now given greater prominence and there is an increasing emphasis on adaptability.*" (McConnell & McCune, 2007b, p. 4) Such preparation for working life focuses on the student's ability and desire to be a learning self-starter where the mantle is passed from the teacher as the deliverer of knowledge to the student as the seeker of understanding, implying a clear change in the role of the teacher alongside the responsibilities of the student. As universities feel the need to introduce changes to their courses and modes of teaching and learning for this and many other reasons, we will discuss in the following sections how it appears that technology is often viewed as having a key role to play in helping students take control of their own learning more effectively.

The use of new technologies can enable the student to take more responsibility for his or her own learning. The term "responsibility" is assumed here to describe any form of self-motivated *meaningful* contact with course content or process. This may include, but is not limited to, reading, working with audio and video resources, researching relevant and related topics, online discussion, use of calculation, analysis or simulation software and so on. The use of the term *meaningful* implies that the activity is directed towards attaining the understanding necessary to achieve the goals of the course in question. A positive effect on student efficiency and productivity may also be implied in this context. Hall described how a curriculum designed with close adherence to Bloom's Taxonomy (Bloom, 1956) and making the learning outcomes visible can increase learners' engagement with a particular module, and notes that "*deep level understanding depends upon creating an environment where the learner wants to be proactive.*" (R. Hall, 2002, p. 151)

We have already seen that the use of technologies can provide students with multiple opportunities to engage with subject matter. There is significant evidence to suggest that the use of networked technologies can open up the possibility of enabling students to structure their own learning (Warschauer, Turbee, & Roberts, 1999). The very nature of these technologies is such that the students' interaction may no longer be required to be linear or sequential, but rather may follow a less predictable route determined by the student, akin to the way one might browse a Web site. Any individual path must, of course, necessarily be limited within boundaries set by the teacher or course designer to maintain some kind of structure whereby students will interact with the material appropriately. Hence, the ability offered to students to tailor their own interactions within a course will depend as much on the course design as it will on the theoretical affordances of the technology. Hall (2002) discusses how technology can be used to create an environment where students are more likely to be proactive in their learning through the provision of a wider variety of learning opportunities.

Research shows that the use of carefully chosen technology can provide the student with new opportunities and result in just this kind of student-initiated interaction and engagement with subject material that is difficult to foster with other resources alone, so that the student is drawn towards increased meaningful contact and interaction with the course material and concepts (Morgan, 2003). For example, it has been observed that the rapidly increasing amount of information available at students' fingertips today and the corresponding move away from an emphasis on rote learning of "facts" puts a greater emphasis on "*the development of metacognitive skills, or* *learning how to learn, in order to… enable students to take responsibility for their own learning*" (Condie & Livingston, 2007, p. 3). They postulate that the use of new technologies must play a significant role in supporting this shift in focus and suggest that an added effect of offering a range of opportunities to interact with the subject matter in the manner and place of the students' choosing also has the potential to increase their motivation to study. Students were observed to be accessing materials "*on their own initiative and to improve their understanding of specific topics*." (p. 9)

There is also evidence to suggest that, in addition to being a beneficial side-effect, technology can be used *explicitly* to encourage students to take more responsibility for their own learning (Warschauer et al., 1999). Many information-based technologies often provide enhanced support for learning, enabling students to "*move beyond their current level of achievement*" (Somekh, 2000, p. 28). There may be an implication here that not only does the technology provide increased opportunities for learning as already discussed, but also encourages students to take advantage of such opportunities of their own volition. However, Somekh sees this as highly dependent on the technology and how motivating it is to the target audience. Salamon defined a key factor in learning as AIME – Amount of Invested Mental Effort (Salamon, 1992). It can be seen that some tools, such as computer-assisted learning material and drill-and practice software, may be too complex, or not stimulating enough, to increase students' AIME. However, other tools, such as well-designed simulations and even relatively low-tech interaction systems such as "clickers" may be easier for lecturers to introduce into the teaching environment and more straightforward for their students to engage with, resulting in an observable increase in the AIME of those students.

2.3.7 Knowledge, skills or understanding

In many ways, all of the above elements that research identifies as positive effects of technological implementations in teaching and learning are like the spokes of a wheel – they share the same focus and converge at a central point and purpose, which in this case is to increase students' knowledge, skills or understanding in a particular subject. That certainly is a key goal in education –

to identify and use sets of tools or methods that will help improve students' ability to acquire learning. All of the aforementioned elements are in essence about putting in place the conditions that are perceived as necessary for learning to occur, many of which may not exist in "traditional" settings. In that sense, they may indeed have the potential to transform teaching and learning. It is clear that the elements already discussed do not in themselves imply that students "learn better" with technology, and yet if we are honest, this is a primary reason behind any such educational intervention. Hence it is largely the case that research which focuses on the ability of technology to transform a particular facet of teaching and learning must also inevitably comment on the impact that the intervention has had on student competency in a particular area. Despite the fact that notions such as "understanding" and "knowledge" are inherently difficult to quantify or measure there is some evidence to suggest that technology, while not a kind of Holy Grail that some may hope for, will at times have an observable effect on students' knowledge and understanding which we will now discuss.

The use of new technologies can facilitate an increased level of knowledge, skills or understanding in a particular subject. As has already been discussed, research shows that the careful use of well-chosen technology can improve learning and increase understanding in different ways, such as by increasing student engagement with a course and improving teacher-student and student-student interaction. As students engage with materials and interact with each other and their teacher in ways with which they feel comfortable, it has been suggested that students become more self-motivated to develop a greater understanding of the material and a greater ability to apply that understanding (Ringstaff & Kelley, 2002).

However, it must again be recognised that although these are worthy outcomes to be sought from any educational intervention, they do not in themselves produce an improved understanding of the subject matter – rather, they create the necessary conditions for such learning to occur. Although there is a degree to which this is true for any aspect of teaching and learning, and there are never any guarantees that anything can improve the understanding of a particular student in any situation ("*you can lead a horse to water but you can't make it drink*"), there is evidence to suggest that the targeted use of technology such as multimedia can be used to improve understanding by stimulating and promoting the use of critical thinking and other higher-order thinking skills (Jonassen, 2000; Jordan & Follman, 1993; Protheroe, 2005; Schacter & Fagnano, 1999).

The development and application of such skills are key elements in differentiating between, for example, the rote learning of scientific *facts* and the deep understanding of the underlying scientific *concepts*. Facts may be memorized and this information may be used to answer specific questions. However, if the student is presented with a new situation in which the facts do not apply, he or she may struggle to interpret what is going on unless they also *understand* the concepts behind the facts, as described by the *data-information-knowledge-wisdom model* (Ackoff, 1989; Bernstein, 2009). True understanding in this case may be displayed as the ability to use these concepts to interpret an unknown but related situation (Perkins & Blythe, 1994; Wiske, 1997). Hence, it seems that if the technologies we are dealing with support and encourage such understanding, then the use of technology in an academic context can contribute to the leading of the student away from "mere" information towards a deep understanding of the subject matter. For example, research into the effectiveness of a particular set of web-based multimedia learning materials was carried out by comparing the students' learning outcomes in lecture-only and online versions of an introductory computing course in Hong Kong (Kekkonen-Moneta & Moneta, 2002). In particular, the researchers were specifically interested in "higher order learning outcomes" – those outcomes that reflect learning that goes beyond the recall of facts and enables the learner to apply the concepts in new situations and in new ways. This was tested by the use of multiple choice objective tests and applied-conceptual tests administered during and at the end of the course. They observed that while there were little or no differences in the marks achieved by the students on questions focusing on factual recall, the students who had engaged with the multimedia materials scored much better in the end-of-term applied-conceptual tests. The research team concluded, "*the use of carefully designed interactive e-learning modules fosters higher order learning outcomes*" (p423). This conclusion is strongly supported by other research (Wiske & Perkins, 2005). Similar studies by McFarland (1996) and Frear and Hirschbull (1999) also found that the use of multimedia could improve problem-solving skills and lead to higher-order learning outcomes.

It is clear that perceived student understanding of a subject is still, at times, based primarily on performance in examinations, and many studies seek to lend weight to their claims of improved higher-order thinking skills by grounding them in quantitative data such as exam results or grade-point averages (Chandra & Lloyd, 2008; Kekkonen-Moneta & Moneta, 2002; Lei & Zhao, 2007). Studies have provided evidence of how successful a technological intervention can be in improving student engagement with subject matter and enabling students to take responsibility for their own learning. Students whose studies have been supported by the careful use of technology have at times been observed to outperform those who were not involved, showing a possible link between the use of the online learning and improved exam results (W. Hall & White, 1994; Kekkonen-Moneta & Moneta, 2002; Twigg, 2003). At times, the teachers involved have stated that they did not think the technology had had an impact on student learning (W. Hall & White, 1994). This may at least partly be explained by the fact that teachers do not necessarily have an awareness of the degree to which students engage with the subject matter in their own time and space, and may also imply that students themselves can be the drivers of the use of the online materials rather than the teachers. In general, it seems that, although often difficult to detect or directly attribute to the technology alone, there are many instances where technological interventions have been shown to have a positive effect on aspects of student learning.

2.4 Realised potential and undelivered promise

It is clear that the use of technology in education as a vehicle for change and improvement is a complex, and at times, contradictory, notion, with evidence that can be used to point to both the realised potential and undelivered promise of technology in education. Despite this apparent ambiguity, the discussions in this chapter do clearly reveal threads of commonality in the existing research that give us clues as to where we can look for such transformations in the future and what these transformations may look like as they begin to reveal themselves. At this point, it is worth acknowledging that we cannot assume that "no effect" is necessarily a bad thing when it comes to the introduction of any teaching innovation and the use of technology in particular. Russell (2001) highlights the importance of considering such findings of "*no significant difference*" as potentially positive outcomes. Indeed, Haydn and Barton (2007) argue that the first goal of any technological implementation should be to "*do no harm*" to the existing status quo, implying that a use of technology that simply maintains current standards rather than triggering some kind of noticeable improvement in any particular aspect of teaching and learning may still be viewed as a successful one. However, this study focuses first and foremost on the search for *transformation* through the use of technology, and in the next chapter, the possible areas in which this may occur are highlighted and summarised and we discuss how they can be used as a basis for research into a particular implementation of a new technology.

Chapter 3. Developing the Transformation Framework

3.1 Introduction

We have seen in Chapter 2 that a search of the literature on the introduction and use of technology in education gives us an indication of the common features of successful implementations as well as the areas of teaching and learning which may be directly or indirectly affected. The purpose of this study is ultimately to be able to use this research to guide an analysis of the impact of new technologies that were introduced into a small number of courses in a well-known UK university as part of a new education initiative. Attempting to use the research in its raw form could, of course, be a complicated and nebulous process and so a necessary first step is to summarise the findings of the previous chapter in a way that enables it to be viewed as a whole and that will also allow us to create a "research instrument" that can be applied to the courses under review.

3.2 Foundations for Transformation

In Chapter 2 we identified a number of key "foundations" that would be appear to be necessary, or at least desirable, for technology to have the required transformative effects on teaching and learning;

- **The presence of a clear rationale**
- **The presence of willing participants**
- **The provision of sufficient resources**
- **The opportunity for professional development**
- **The ease of use and clarity of purpose of the technology**

Examining what lies behind specific interventions may reveal whether or not all, some or none of these foundations that may enable the use of technology to have transformative effects in some areas of teaching and learning are in place.

3.2.1 The presence of a clear rationale (F1)

In section 2.2.1, we have discussed the fact that the presence of a clear rationale;

- Helps us choose the right tool for the job
- increases the likelihood that buy-in is obtained from all those involved (primarily staff and students)
- ensures that the implementation is a coherent part of a bigger picture.

The idea of the need for the presence of a clear rationale not only speaks to the overarching attitudes and approach to teaching and learning within an institution, but also to the decisions surrounding the use of technology at the course level and how that may or may not have had an impact on course planning. The willingness or otherwise of those involved in planning and delivering the course will also clearly have an influence on this area – willing participants are much more likely to embrace the use of technology together with any associated disruptions or changes than those who are reluctant to adopt a particular innovation. Hence we can construct three simple questions to guide our research in this area;

Has the introduction of technology been driven by an explicit rationale?

Has the decision to implement technology influenced how the course or intervention is planned?

Has the use of technology prompted a review of what is taught?

3.2.2 The presence of willing participants (F2)

The willingness or otherwise of those involved in planning and delivering the course will also clearly have an influence on this area – willing participants are much more likely to embrace the use of technology together with any associated disruptions or changes than those who are reluctant to adopt a particular innovation (See section 2.2.2).

Are those involved in the innovation willing participants?

3.2.3 Resourcing educational interventions (F3)

Chapter 2 section 2.2.3 reveals that research suggests that the provision of adequate time and resources may increase the likelihood that;

- the educator is aware of how best to incorporate the new technology
- there is sufficient space in the course itself to allow for teaching styles implied by the technology
- the technology can be used as originally intended at the planning stage

In this case, we assume that in addition to time, resources may include sufficient personnel, space, infrastructure or equipment to enable a technology to be used effectively. It is clear that such provision does not guarantee the success or ability of any use of technology to transform teaching and learning any more than its absence will prevent it. However, the research does make it clear that not only is the consideration of these factors often an indication that the use of technology is part of a larger, serious and well thought-out plan, but also that the effectiveness of some technologies depends very much on how they are used in a particular context. Hence we can use some basic questions to draw out just how seriously an institution has taken a particular implementation of technology in terms of how that implementation is resourced;

Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?

Are new teaching spaces technology-friendly?

3.2.4 Professional development (F4)

The fourth foundation as discussed in section 2.2.4 reflects the fact that in some cases, professional development may be necessary to enable those delivering a course to be able to use technology effectively. Such professional development may consist of formal sessions during which teachers are taught how to use a technology, or it may simply be the use of existing meeting time to discuss the use of the technology among colleagues in order to share best practice or improve the use of some aspect. In general, research shows that the ongoing provision of appropriate professional development increases the likelihood that;

- Teachers will feel more confident in the use of technology in their teaching
- Teachers will use the technology more effectively to support learning

Again, we must be clear that professional development, like other resources, is neither a guarantee of success, nor is its absence always a predictor of failure. It will sometimes be the case, depending on the technology and the user, that the technology can be used effectively without the need for professional development, perhaps because the teacher is highly skilled technically or already teaches in a way suited to the use of a particular tool (in which case, there may be less need for transformation to occur). Similarly, it must also be recognised that there are circumstances where all the professional development in the world will not result in a effective use of technology; an educator who is unwilling to use a particular tool (for whatever reason) or who sees no value in it may remain deeply unconvinced even after such sessions and may only use the technology in a perfunctory manner if at all. However, while the provision of professional development is not an absolute predictor of the success or otherwise of a particular technology transforming teaching and learning in a particular context, it is, nonetheless, a useful indicator of where success may be found. Although by no means certain, it seems more likely that teachers who are clear in how a particular tool may best be used to benefit their course will make use of that tool more, and more effectively. So, by asking questions that will give us information about the amount and possible effects of any professional development, we will uncover the absence or presence of another important block in the foundations of any institutional transformation;

Has the introduction of new technologies been accompanied by appropriate training?

Are educators both confident and competent in the use of the chosen technology?

3.2.5 Ease of use and clarity of purpose (F5)

As discussed previously in section 2.2.5, the final element in institutional transformation has its roots in all of the above. The notion of the *transparency* or *invisibility* of technology has been used to describe the effect that the presence of the technology itself may have on teaching and learning (Lave & Wenger, 1991). It implies that the possibility exists for the technology to become a barrier to learning if there is more focus on the technology than on the principles or concepts that are being addressed. From the evidence gathered in Chapter 2 section 2.2.5, it seems that there are two scenarios which best support the required transparency of a particular technological intervention;

- Sufficient time/ opportunity for students to learn how to use the technology
- The use of technologies already familiar to the students

If either of these two factors is in place, then it *should* be possible for the students to see the purpose of the tool and be able to use it in the required way, and it is therefore less likely that the technology will be a barrier to learning. However, if no thought has been put into this area (for example if a technology that is difficult to use or is unfamiliar to the students is introduced for the first time without sufficient time allowed for learning to use it) it follows that it is less likely that the technology will have a positive impact on teaching and learning. Hence we can use simple questions focused on this area to gain useful information about how likely the technology is to be a barrier to any possible transformation;

Is the educational purpose of the technology clear to teachers and students?

Can students easily connect the use of the technology to specific educational goals?

3.2.6 Foundations for Transformation - summary

The five Foundations for Transformation, together with the questions designed to help inform each area are summarised in Table 3-1 overleaf. The answers to these guiding questions taken in context should give us information regarding, for example, whether an institution is introducing technology in a well thought out manner as part of an ongoing strategy in teaching and learning, or merely trying to "wedge in" a few of the latest tools. The questions should enable us to identify in a simple way whether or not some basic foundations are in place that may support the success of a technological innovation.

Foundations for Transformation *Those factors whose presence may enable technology to have the desired transformative effect*	**Guiding Questions**
F1 – The presence of a clear rationale	*Has the introduction of technology been driven by an explicit rationale?* *Has the decision to implement technology influenced how the course or intervention is planned?* *Has the use of technology prompted a review of what is taught?*
F2 – The presence of willing participants	*Are those involved in the innovation willing participants?*
F3 – The provision of sufficient resources	*Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?* *Are new teaching spaces technology-friendly?*
F4 – The opportunity for professional development	*Has the introduction of new technologies been accompanied by appropriate training?* *Are educators both confident and competent in the use of the chosen technology?*
F5– Ease of use and clarity of purpose	*Is the educational purpose of the technology clear to teachers and students?* *Can students easily connect the use of the technology to specific educational goals?*

Table 3-1: Foundations for Transformation

3.3 Identifying types of transformation

The review of recent research and literature on the nature of technology in the classroom and the transformations with which they may be associated, as described in the previous chapter, suggests that although a wide range of changes may be intended or may occur in an educational environment as a result of a new use of technology, such transformations will fall generally into three broad types;

Institutional Transformations **–** Twigg (2003) highlighted the importance of *institutional readiness* to the successful use of technology to improve learning, and this is mirrored to some extent in the Foundations for Transformation as discussed in the previous section. However, there are times when these Foundations may also themselves be encouraged or brought to the fore as a new technology is introduced into a particular educational context, as discussed in sections 2.2.1 to 2.2.5. As an institution (using the term loosely to refer to any organizational group involved in the delivery of a course such as a group of lecturers, a department or a larger organizational body within the university) seeks to implement new technologies into teaching and learning, the laying of these foundations may be accompanied by changes, whether intentional or unintentional, within that institution (Price & Oliver, 2007; Riley, 2007). These may be changes in the thinking, ideology or motivation of those developing and delivering educational content. Such transformations may be revealed in a new direction of the institution or department or more tangible changes in opportunities for staff and changes in the spaces in which they teach. They may also take the form of, or lead to, physical changes such as the provision of investment in new equipment or infrastructure.

Material Transformations – Chapter 2 sections 2.3.1 to 2.3.3 highlight the fact that the use of new technologies to support teaching and learning have been found at times to have a direct impact on the physical aspects of a particular course, such as the use of allocated time, the content of a particular course or the way that content is made available to the students. As a direct result of the use of technology, there may be changes in the substance of the courses themselves, either in the student interface or in the subject matter itself. Delivery of courses may become more efficient, or there may be new ways to interact with subject matter for students or a new opportunity for the teacher to review, update or change content.

Behavioural Transformations – The introduction of new technologies into a classroom or course may directly affect aspects of what may be described as the *behaviour* of those involved – both teachers and students, as discussed in Chapter 2 sections 2.3.4 to 2.3.7. Teachers may make intentional or unintentional changes in their paedagogy. Changes may also occur in how students are observed to interact with the courses they study by those involved in delivering the courses. This may include significant perceived changes in the level or quality of student-teacher, student-student and student-subject interactions. Such transformations are invariably linked to the level of student engagement and even their understanding of the subject matter, as well as the responsibility they take for their own learning in such environments.

It is hoped that by identifying these areas in which research has shown that transformations *can* occur when technology is introduced, we can begin to understand a little more about what can happen in specific implementations. If a particular course or class hopes to transform teaching and learning in some way through the use of technology, the areas described above should, in fact, tell us *where to look* for signs of such transformations, and what signs we are likely to see if transformation of some kind is indeed taking place. It follows that we should be able to use the research from which these three areas have been identified to develop a "lens" through which we can view a specific use of technology in order to help expose any transformations that may be taking place, or perhaps even to reveal where intended or claimed transformations are *not* necessarily taking place. Ideally, this "lens" or "framework" should define in clear terms what might be observed in each broad area if a transformation was taking place. Hence by grouping the areas identified in Chapter 2 into the three key types of transformation that may be observed (Institutional Transformations, Material Transformations and Behavioural Transformations) we can also define a set of "guiding questions" that will act as a starting point when looking at a particular use of technology in education. In one sense, these questions will perhaps merely be simple statements of common sense. However, being, as they are, grounded in the evidence discussed in Chapter 2, they also represent the synthesis of years of research from a multitude of sources. As such, when taken together and used as a "lens" through which to view any use of new technologies in teaching and learning, they could form a powerful tool for exposing the presence, or absence, of technology-produced transformation.

3.4 Institutional Transformations

It is often the case that the introduction of, or the desire to introduce, technology or other educational innovation may stem directly from the way teaching and learning is viewed within an institution. In these cases, the use of technology may be carefully thought-out, resourced and planned as part of a larger overall strategy such that the success of the innovation seems more likely. However, there is also evidence that some uses of technology may in and of themselves lead to unintended but direct changes in the way teaching and learning is viewed and approached within an institution. These changes may manifest themselves, for example, in the surfacing of an educational rationale for introducing innovations or a change in how the course is developed in the light of new possibilities opened up by the use of the technology. The introduction of technology may also drive new efforts to provide appropriate time and resources and even the development and installation of new teaching spaces.

In addition to revealing whether or not there are foundations in place that may enable the use of technology to have transformative effects in some areas of teaching and learning, examining what lies behind specific interventions may also reveal whether or not the use of the technology itself may be stirring the beginnings of transformation in this area. We can therefore develop a set of key questions that directly reflect the outcomes of existing research as discussed in the previous chapter and which may help to highlight the areas in which an institution may undergo some level of transformation, and we will look at each of these areas in detail.

3.4.1 Planning educational interventions (I1)

The first Foundation for Transformation suggests that there is a clear link between the effectiveness of a particular implementation of technology and what we may describe as the “fertility” of the soil into which it is planted in terms of the planning that goes into the implementation. However, it is clear from the discussions in Chapter 2 section 2.2.1 that the converse can also be true – the decision to implement new technologies into a particular course, and the possibly disruptive nature of such introductions into otherwise well-established courses, may actually prepare the ground for some institutional changes to occur. The availability of new technologies (or the pressure to introduce them into teaching and learning) may first of all drive those involved to look at how such technologies may benefit their particular context. This may move the institution towards the development of an explicit rationale for use in that context. As educators seek to use such technologies to best effect, they may also find themselves adopting a more detailed approach to course planning. Educators may be prompted to look carefully at why a particular technology may be used and what its strengths are, or they may be prompted to look at the course itself to see where and how the technology might best be incorporated, effectively resulting in a review of the course itself. Using three simple questions to focus on these areas, we should be able to unearth any evidence of transformative effects when a new technology is introduced;

Has the desire to introduce new technologies led the institution to explore explicit rationales for its use?

Has the decision to implement technology influenced how the course or intervention is planned?

Has the use of technology prompted a review of what is taught?

3.4.2 Resourcing educational interventions (I2)

Section 2.2.3 (and, to a lesser extent, sections 2.2.2 and 2.2.4) highlights the fact that proper consideration of how to resource an implementation of a new technology is often an indication that the use of technology is part of a larger, serious and well thought-out plan, and that the effectiveness of some technologies depends very much on how they are used in a particular context. However, it also seems that the very act of introducing educational innovations, and in particular *technological* innovations, can have a disruptive effect in this area as well, prompting the institution to at least look at what it is providing to ensure that the innovation is a success. While there may not be a surge in the amount of time or resources made available to educators, it is clear that the introduction of new technologies into a course can often bring the issue to the fore and drive conversations as those involved discuss the practicalities of what may be needed to make the most of a particular technology. For example, lecturers may see the need for extra support during lectures as they begin to use student response systems, and may also see the need for extra time with their colleagues in order to develop a suitable number of appropriate questions to be used throughout a course. Institutions may therefore begin to rearrange how their resources are used as they seek to support teaching staff. In addition, the use of new technologies may also necessitate that the institution rethinks how it uses existing teaching spaces. “Traditional” spaces may be used for different purposes or may require modification so that they can be used in a different way that stems from the introduction of new technologies. At the most extreme the expectation that such new technologies are here to stay may ultimately change how new teaching spaces are planned. Hence we can use some basic questions to begin to identify fundamental changes that may be taking place in how an institution thinks about, organises or uses its resources as it introduces new technologies in teaching and learning;

Is there evidence that the introduction of technology is prompting the institution to rethink its approach to time and other resources?

Is the use of technology resulting in existing spaces being used differently or driving a need for alternative teaching spaces? Are new teaching spaces technology-oriented?

3.4.3 Professional development (I3)

As is made clear in section 2.2.4 (and by inference, section 2.2.2), it stands to reason that some level of professional development may be necessary to enable those delivering a course to be able to use particular technologies effectively. As in the rest of society, those involved in higher education are a mixed bunch whose experience and efficacy with technology will range from novice to expert, and from technophobe to technophile. As institutions begin to embrace the use of technology in teaching and learning, they will inevitably have to consider how best to ensure that staff can make the best use of the technologies that are being provided. How a particular institution chooses to deal with this may depend largely on the context – a largely tech-savvy staff who will be implementing a technology that relies largely on generic computing skills may not require much in the way of formal training, while a less tech-savvy group introducing student response systems for the first time into a course may need substantial support in gaining the appropriate level of competence. However, in either case, the institution may at least be prompted to consider how its staff will cope with the introduction of new technologies and how professional development may or may not be required.

The specific path that a particular institution follows to ensure that those involved are equipped to use the technology in an effective manner may be less critical than the "state" of the staff – in one instance, staff may be able to use the technology to the full without any support; in another, they may require detailed instruction in the use of the technology before they can use it at all, while in another staff may "grow" into the use of the new technologies (for example, by initially using the technology in a basic manner but with the express intent of developing the skills needed to expand its use). In these cases, it seems clear that a certain level of forward momentum may be considered to be a type of transformation, as educators move from one state to another. So, by asking questions that will give us information about how professional development is being viewed and provided for, as well as how those involved are equipped to use the technologies in question effectively, we may begin to uncover any possible transformation in this area;

Has the introduction of new technologies led to a new focus on professional development?

Are educators becoming more confident and competent in the use of the chosen technology?

3.4.4 Institutional Transformations - summary

The three areas of institutional transformations, together with the questions designed to help inform each area are summarised in Table 3-2 (overleaf). The answers to these guiding questions taken in context may help to begin to illuminate whether an institution is merely applying a veneer of innovation to otherwise static practices or making a serious attempt to instigate fundamental change in its approach to teaching and learning, and whether or not there is evidence of such fundamental change in a particular area.

Type of Transformation	Area	Guiding Questions
Institutional Transformations *Transformations in how teaching and learning are viewed by the staff, department, college or university*	**I1** – Planning educational interventions	*Has the desire to introduce new technologies led the institution to explore explicit rationales for its use?* *Has the decision to implement technology influenced how the course or intervention is planned?* *Has the use of technology prompted a review of what is taught?*
	I2 – Resourcing educational interventions	*Is there evidence that the introduction of technology is prompting the institution to rethink its approach to time and other resources?* *Is the use of technology resulting in existing spaces being used differently or driving a need for alternative teaching spaces? Are new teaching spaces technology-oriented?*
	I3 – Professional Development	*Has the introduction of new technologies led to a new focus on professional development?* *Are educators becoming more confident and competent in the use of the chosen technology?*

Table 3-2: Institutional Transformations

3.5 Material Transformations

Most implementations of technology in teaching and learning are intended to have some impact on the content of a particular course or the way in which that content is delivered. It is also possible that the use of a particular technology for a specific purpose may have *unintended* effects on some aspect or aspects of the course content or the way in what it is delivered. In either case, it is clear from Chapter 2 sections 2.3.1, 2.3.2 and 2.3.3 that there is evidence to suggest that any transformation, whether intended or unintended, may reveal itself in observable effects in one or more of the following;

- **The efficiency of the course (**section 2.3.1)
- **The variety of means of engagement with subject matter (**section 2.3.2)
- **The course content (**section 2.3.2)

These three key areas of material transformations may be used to guide an analysis of a particular course in order to identify where the use of technology may be producing some kind of transformation. It must be acknowledged that *transformation* in this area may easily be confused with mere *change*, as the introduction of technology is at its most visible and will inevitably cause *something* to change. Superficial changes to the way things are done using technology do not necessarily equate to transformation. Hence it would be extremely useful if we were able to use existing research to construct a lens that would enable us both to identify possible transformations and distinguish between such transformations and “mere” change. We will now look at each of these three areas in turn.

3.5.1 Efficiency of course delivery (M1)

In section 2.3.1 we defined the notion of *course efficiency* to represent the ratio of the time spent by the students on learning activities to that devoted primarily to the receiving of information. The research discussed in section 2.3.1 indicates that new technologies can be used successfully to make courses more *efficient* so that students will have more opportunities, and more time, to engage in learning activities. So, if a course uses technology to enable lecture time to be used for workshops or tutorial-style classes, it is likely that the use of that technology has contributed to this transformation. Hence, bearing in mind our definition of efficiency, by asking simple questions to identify how the efficiency of a particular course has been affected (or not) by the use of a particular technology, we can determine whether or not it is likely that this area of the course has undergone, or is undergoing, transformation;

Has the use of the technology improved efficiency of course delivery? i.e. Has it increased the amount of time used for activities other than delivery of content?

3.5.2 Means of engagement with subject matter (M2)

The discussion in section 2.3.2 reveals evidence to show that an increase in the number of ways students encounter material can have significant learning benefits. We have also seen that the use of new technologies can increase the variety of means of engagement with subject matter. Changes in this area should be relatively straightforward to identify and it should be possible to determine whether or not the use of a particular technology has increased the variety of means of student engagement with the subject matter. However, it is important to remember that this alone will not necessarily constitute a transformation – just because there is an increased variety of means of engagement with the subject matter does not mean that the course has decided to take full advantage of this in ways that were not possible before. Hence we need to delve a little deeper into any implementation of technology to find out a little more about what is being done to take advantage of this increased variety.

Has the use of technology increased the possible variety of means of engagement with the material? *Does the course take advantage of this?*

3.5.3 Content and assessment (M3)

In section 3.4.1, we discussed how the use of technology could be part of an ongoing review of what is taught in a course, or could perhaps even prompt such a review to happen. In addition to being part of an *institutional transformation*, section 2.3.3 demonstrates that such changes can also take the form of *material* transformations as follows;

- the use of new technologies can enable new concepts to be addressed, or existing concepts to be dealt with in more depth than was previously possible

- the need to accommodate new materials may lead to the identification of subject matter which is redundant and which can play a lesser role in the course or which can be dropped entirely from the syllabus.

It is also possible that technology can have an impact on the way a course is assessed. However, although such changes are possible and have been observed, they cannot be taken for granted – just because a course begins to use a new online simulation tool does not necessarily mean that the course will begin to use that tool to study new things – the same things may simply be dealt with in a new way. It is a relatively simple matter to identify where transformations will *not* take place in this area – no changes in content or assessment will usually reflect the fact that transformation is not intended or happening. Similarly, we cannot assume by the technology that is being used whether or not such transformations will take place. Instead we can first be guided by a few simple questions that will enable us to look in the right place for any transformations that may be underway.

Has the technology enabled new content to be taught or less useful/redundant material to be removed?

Has it altered the way the course is assessed?

3.5.4 Material Transformations - summary

The three areas of material transformations, together with the questions designed to help inform each area are summarised in Table 3-3 (overleaf). These questions provide a simple mechanism whereby possible transformations in the content of a course and its delivery can be identified. When taken in context, they should give us information regarding, for example, whether the technology being used is having a transforming effect on the way the course is being delivered, whether in terms of the new things it enables students to do or simply new ways to access information or even assess students.

Type of Transformation	Area	Guiding Questions
Material Transformations *Transformations in what is taught and how it is presented to students*	**M1** – Efficiency of course delivery	*Has it improved efficiency of course delivery? i.e. Has it increased the amount of time available for activities other than delivery of content?*
	M2 – Means of engagement with subject matter	*Has it increased the possible variety of means of engagement with the material?* *Does the course take advantage of this?*
	M3 – content and assessment	*Has it enabled new content to be taught or less useful/redundant material to be removed?* *Has it altered the way the course is assessed?*

Table 3.3: Material Transformations

3.6 Behavioural Transformations

It is clear from the analysis in sections 2.3.4 to 2.3.7 that not only can the use of technology have an impact on the content of the course and how it is delivered, but also on the way students *behave* towards and respond to delivering and receiving that content. For example, the technology may enable students to communicate with each other or with their teacher in new ways, or it may enable the teacher to take a different approach to teaching the subject. In addition, the use of some online technologies may place more responsibility for learning into the hands of the student, so that he or she can, to a greater or lesser extent, learn where and when they want to, rather than waiting to be spoon-fed by the teacher once a week during a lecture. Such uses of technology may even enable student to gain a better grasp of particular topics, for example through access to additional information, or the use of simulations that enable complex concepts to be visualized in ways not possible before. In general, it is possible to identify four key areas of what we are referring to as "behaviour" in this context in which transformative effects resulting from technological interventions may be found. These strands, as discussed in the previous chapter, are:

- **Student and teacher interactions** (section 2.3.4)
- **Paedagogy** (section 2.3.5)
- **Student responsibility for learning** (section 2.3.6)
- **Knowledge and understanding of subject matter** (section 2.3.7)

By identifying and studying each of these four areas of *behavioural transformation*, we can gain a picture of the impact that a particular use of technology may have. As before, it would be useful to have a predefined set of questions to use as a basis for such a study that would enable us to focus on these key areas and illuminate any transformations that may be occurring, or beginning to occur. We will look at each of these key areas in turn.

3.6.1 Amount and quality of interactions (B1)

In section 2.3.4 of the previous chapter, we discussed the fact that learning in an educational environment is often directly influenced by the social interactions that occur – "meaning is created through participating in social activity" (McCormick & Scrimshaw, 2001). Many technologies that are implemented in classrooms and lecture halls are, at their core, communication tools – online environments enable communication of course content across distance and time, while tools such as "clicker" systems enable a different type of real-time communication between students and the teacher. Hence such technologies may be directly responsible for increasing the amount of communication within a particular learning context that in turn can have a significant impact on the learning that occurs. It is clear that *more* does not necessarily mean *better*. However, it must be acknowledged that it is possible that not only may the *amount* of interaction among students and between students and their teachers increase, but, if the right tools are used appropriately, the *quality* of such interactions may also increase. In this case, we assume that the term *quality* refers to the educational benefit gleaned from such interactions. So, for example, a carefully moderated online forum may result not only in students communicating more about a particular topic, but may also result in those students learning more about that topic as well. A single guiding question in this area will help focus any study on drawing out the necessary information about a particular use of technology to determine whether or not that technology is triggering any transformation in this area;

> *Has the use of technology increased the amount of teacher-student and/or student-student interaction?*
>
> *Has the use of technology increased the quality of teacher-student and/or student-student interaction?*

3.6.2 Paedagogy (B2)

Section 2.3.5 described how the introduction of a new technology into teaching and learning can be a *disruptive* process – its use within a course often necessitates changes of one kind or another. Not only can such disruption occur in the content of a course, as discussed previously, but it has also been suggested that an implementation of technology will often lead to a certain amount of paedagogical change. For example, as mentioned in the previous section, many technologies that are being introduced into today's classrooms are, at their heart, communication tools, and their use may require the teacher to make the appropriate space for this communication to happen. Such change may merely represent an automatic, almost sub-conscious adjustment on the part of the teacher, or it may be a more deliberate shift made as he or she considers how to use the technology most effectively. In either case, research has shown that it is possible for the introduction of technology into the classroom to prompt educators to make fundamental adjustments in the way they teach. This may often show itself as a shift *away* from a purely didactic approach where the teacher is the sole contributor to the class *towards* an approach that begins to incorporate hallmarks such as two-way communication between teachers and students, group work and collaboration. Such changes clearly have the potential to be transformative, resulting in an adoption of a new style of teaching and learning that is much more student-centred than what went before. Hence by investigating whether such changes in paedagogy have taken place or are taking place, we should be able to identify any resulting transformation in this area of teaching and learning.

Has the introduction of particular technologies forced, inspired, enabled or otherwise caused a shift in teaching styles and approaches?

3.6.3 Student responsibility (B3)

It seems logical to assume that, if the use of technology can cause a paedagogical shift towards a more student-centred ethos, then the use of such technologies may also result in students being encouraged to take more responsibility for their own learning as they become less reliant solely on the one way delivery of information from the teacher to the student. In the previous chapter, we discussed how this kind of responsibility was usually expected by teachers to reveal itself in the form of self-motivated, *meaningful* contact with course content, with students perhaps being observed to be working in a more efficient and productive manner.

Section 2.3.6 highlights the fact that the use of technologies can provide students with multiple opportunities to engage with subject matter and that this can open up the possibility of enabling students to structure their own learning. Section 2.3.6 also discusses how technology can also be used to create an environment where students are more likely to be proactive in their learning through the provision of a wider variety of learning opportunities. Hence it is possible that the introduction of a new technology into a particular course may have a transformative effect on the students themselves and how they take ownership of their learning, and it is important to guide any search for possible transformations to look in this area.

Does the implementation enable the student to take more responsibility for his or her own learning?

3.6.4 Knowledge and understanding of subject matter (B4)

Finally, the research reviewed in section 2.3.7 shows that the careful use of well-chosen technology can lay foundations that may improve learning and increase understanding in many different ways, such as by increasing student engagement and improving teacher-student and student-student interaction. As students engage with materials and interact with each other and their teacher in ways with which they feel comfortable, research suggests that some students may also become more self-motivated to develop a greater understanding of the material. It is often the case that research which focuses on the ability of technology to transform a particular facet of teaching and learning also comments on the impact that the intervention has had on student understanding. Despite the fact that notions such as "understanding" and "knowledge" are inherently difficult to quantify or measure there is significant evidence to suggest that technology can have an observable, or at least perceived, effect on these aspects. The most obvious and quantifiable measure of such increases in knowledge would be in the students' performance in course examinations or assessments when compared with previous cohorts who had participated in the same course but without the technological intervention. This might give an indication that, for whatever reason, the use of the technology had provided the students with the necessary skills to score better in the examination than their non-technology counterparts. However, it must be acknowledged that not every use of technology supports such skills, and not every examination is designed to test the knowledge and skills that such technologies *do* enable students to develop, and hence exam results alone will not necessarily give a complete picture. Indeed, more often than not, the key source of information on this area tends to be the perceptions of the teaching staff themselves. Although there is obviously a need to carefully critique any such qualitative or anecdotal evidence, it makes sense that teaching staff may indeed be well positioned to observe any transformation in this area, at least in the initial stages. Hence if we are to identify technology-induced transformations in the knowledge and understanding of students, the search for evidence cannot proceed too far without addressing a basic question to the teaching staff:

Has the use of technology facilitated a comparative increase in knowledge and understanding of the subject matter?

3.6.5 Behavioural Transformations - summary

The four areas of behavioural transformations, together with the questions designed to help inform each area are summarised in Table 3-4 shown overleaf. These questions provide a simple mechanism whereby possible transformations in specific aspects of the behaviour of teachers and students can be identified. When taken in context, they should enable us to gather information regarding whether the technology being used is having a transforming effect on the interactions that take place in the course as well as on the amount of learning that may be taking place.

Type of Transformation	Area	Guiding Questions
Behavioural Transformations *Transformations in the "normal" day-to-day activities of teachers and students*	**B1** – Amount and quality of interactions	*Has it increased the amount and quality of teacher-student and student-student interaction?*
	B2 - Paedagogy	*Has the introduction of particular technologies forced, inspired, enabled or otherwise caused a shift in teaching styles and approaches?*
	B3 – Student Responsibility	*Does the implementation enable the student to take more responsibility for his or her own learning?*
	B4 – Knowledge and Understanding of Subject Matter	*Has it facilitated a comparative increase in knowledge and understanding of the subject matter?*

Table 3-4: Behavioural Transformations

3.7 The Framework

By combining Tables 3-1, 3-2, 3-3 and 3-4, we can define a complete framework that may be used to analyse a particular use of technology in a course in order to identify not only whether the necessary foundations for a successful use of technology are in place, but also where Institutional, Material and Behavioural Transformations may or may not be taking place. The complete Framework, shown in Table 3-5, does not (and is not intended to) provide a detailed breakdown of every question that must be asked by a researcher, or even a rigorous step-by-step approach to such a study. Rather, it *is* intended as a research-based guide to where to look for transformations that may have been triggered by the use of the new technology. It is up to the researchers to determine how to ensure that they gather sufficient data in order to inform each area, but once the data is gathered, the framework should enable the researchers to undertake a broad but detailed analysis to determine what is happening in each of these areas and to draw clear conclusions as to the existence, or otherwise, of technology-driven transformation.

Type of Transformation	Area	Guiding Questions
Institutional Transformations *Transformations in how teaching and learning is viewed by the staff, department, college or university*	**I1** – Planning educational interventions	*Has the desire to introduce new technologies led the institution to explore explicit rationales for its use?* *Has the decision to implement technology influenced how the course or intervention is planned?* *Has the use of technology prompted a review of what is taught?*
	I2 – Resourcing educational interventions	*Is there evidence that the introduction of technology is prompting the institution to rethink its approach to time and other resources?* *Is the use of technology resulting in existing spaces being used differently or driving a need for alternative teaching spaces? Are new teaching spaces technology-oriented?*
	I3 – Professional Development	*Has the introduction of new technologies led to a new focus on professional development?* *Are educators becoming more confident and competent in the use of the chosen technology?*
Material Transformations *Transformations in what is taught and how it is presented to students*	**M1** – Efficiency of course delivery	*Has it improved efficiency of course delivery?* *Has it increased the amount of time available for activities other than delivery of content?*
	M2 – Means of engagement with subject matter	*Has it increased the variety of means of engagement with the material?* *Does the course take advantage of this?*
	M3 – content and assessment	*Has it enabled new content to be taught or less useful/redundant material to be removed?* *Has it altered the way the course is assessed?*
Behavioural Transformations *Transformations in the "normal" day-to-day activities of teachers and students*	**B1** – Amount and quality of interactions	*Has it increased the amount and quality of teacher-student and student-student interaction?*
	B2 - Paedagogy	*Has the introduction of particular technologies forced, inspired, enabled or otherwise caused a shift in teaching styles and approaches?*
	B3 – Student Responsibility	*Does the implementation enable the student to take more responsibility for his or her own learning?*
	B4 – Knowledge and Understanding of Subject Matter	*Has it facilitated a comparative increase in knowledge and understanding of the subject matter?*

Table 3-5: Framework for the identification of technology-related transformations in teaching and learning

Chapter 4. Methodology: Putting the Framework to work

4.1 The context of the research

The expanding applications of technology within higher education in the UK and beyond provide a wealth of opportunities to identify, study and compare transformations in key areas of teaching and learning. When technologies, or any new innovation in teaching and learning are piloted or introduced at a course level within a particular university, there is generally an acceptance that there will be the need "*to improve the initial design by testing and revising conjectures as informed by ongoing analysis of both the students reasoning and the learning environment*" (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003, p. 11). This necessitates that some consideration be given into evaluating the effects of the innovations. Hence the identification of a course or courses in the process of innovation to improve teaching and learning would provide a fertile field from which to harvest both qualitative and quantitative data relevant to the research questions using the Transformation Framework as a guide for such a study.

The College of Science and Engineering at one ancient Scottish University had recently undergone a self-initiated, in-depth review of its approach to teaching and learning, and a key outcome of this review was the development of a new Learning and Teaching Strategy that would

- increase the students' sense of responsibility for their own learning
- permit diversification in teaching practice
- reduce formal teaching and summative assessment.

The College decided to begin implementation in a manageable fashion with a set of coordinated activities in individual Schools and at College level. First, the initiative focused on the infrastructure through which teaching and learning is delivered, with planned refurbishments of teaching spaces. In addition, a small number of courses to be delivered in the 2006-2007 academic year were sought which would be considered “Vanguard” – the first wave of courses intentionally implementing elements of the Learning and Teaching Strategy at undergraduate level. Courses (or their organisers) volunteered to take on this pioneering role. Lessons learned from this pilot scheme would be applied as the Strategy is implemented across a broader range of courses so that the Principles that make up the Strategy have an increasingly significant impact on students over the next few years. The Learning and Teaching Strategy contains no direct reference to the use of technology in these Vanguard Courses, and yet it is evident that many, if not all, of those involved see technology as a key tool in achieving the aims of the Strategy. Hence these Vanguard Courses presented an ideal focus for the study. The study looked at three courses, Course A, Course B and Course C from different branches of the College of Science and Engineering. The selection of these three courses was dictated largely by opportunity and availability; the courses were just beginning their first run as Vanguard courses as the study began and those involved in the courses were willing to make time available to participate in the necessary interviews and discussions. The background to the Vanguard courses is discussed in greater detail in Chapter 5.

4.2 Deciding what to look for

In Chapter 1, we defined a key question for research and broke it down into its constituent parts;

- **Is technology having a transformative effect on teaching and learning?**
    - *What areas of teaching and learning can be transformed by technology?*
    - *What is the evidence for this in literature?*

- *In what areas of teaching and learning can transformative effects be observed? Can these transformative effects convincingly be attributed to technology or its use?*
- *Is there a discrepancy between the rhetoric about the choice and use of technology in the vanguard courses and the reality of the implementation?*

In order to address this question successfully, the first step was to carry out a detailed review of existing literature to ascertain what had already been identified by others as important in encouraging such transformations to happen (David Silverman, 2006, p. 340), as well as what exactly "transformative effects" might look like in a particular context, especially when they were triggered or produced by technology. The review focused on articles, papers and books that presented evidence for particular affordances of new technologies in teaching and learning and those that described, evaluated or otherwise discussed specific implementations of new technologies. These included, but were not limited to, contexts and technologies similar to those encountered in the rest of the study. Evidence that supported the existence of particular affordances of technology and that associated such affordances with observed transformative effects was collated in order to present a clear, concise summary of current research (Chapter 2). Once this work was completed, the findings were then synthesised into the "Transformation Framework" as outlined in Chapter 3. In simplified terms, this framework took the form of a condensed presentation of the key findings of the literature review in table form. It was designed to support further research into the transformative effects of technology on learning and teaching and described both the foundations that may be necessary for transformation to occur and the types of transformation that may be observed when technologies are implemented. The Framework was central to the rest of the study, and as such was used both as a tool for designing other research instruments, such as interview questions and questionnaires, and as a guide to interpretation of the evidence gathered.

4.3 Selecting and collecting the data

Three courses, **Course A**, **Course B** and **Course C** from different branches of the College of Science and Engineering were selected for the purposes of this study from those taking part in the first wave of the Vanguard initiative (see Chapter 5). As mentioned previously, the reasons for the specific selection of these courses over others were pragmatic (they do not reflect any bias or prior knowledge of the courses on the part of the author), and were based largely on the timings of the courses and the availability and willingness of the Course Organisers. Selecting three courses from those available provided both a representative cross-section of the Vanguard courses as a whole and a satisfactory spread of courses under the umbrella of the College of Science and Engineering, while still yielding a manageable amount of data (with a potential for more than thirty data sources over the three courses).

The study as a whole took what might best be described as a hybrid approach. In one sense, it consisted of concurrent case studies of the courses already mentioned above – Course A, Course B and Course C. The study had both longitudinal and cross-sectional overtones – *longitudinal* in the sense that the courses themselves were followed over repeated consecutive instances with a significant percentage of the same personnel maintaining their involvement, and *cross-sectional* in that inevitably, different respondents had input at different points in time. While there were a number of other types and variations of research which may have been chosen and which may have yielded beneficial results, approaching the study in this manner had a number of advantages pertinent to the research question. In particular, case studies in general provide the opportunity to detect "*unique features that may otherwise be lost in large scale data*" and may also be directly applicable to other similar situations (Nisbett & Watt, 1984). Alternatives, such as following a particular cohort through a number of vanguard courses, ran the risk of being fraught with logistical difficulties arising from a number of facts. First, the students taking these initial courses followed widely differing paths in their second year of study and second, only a fraction of existing courses had “become Vanguard”, with the number gradually increasing each year. By 2009, the notion of Vanguard courses was beginning to lose relevance in the minds of those involved as only the less willing courses remained unaffected by the process. These and other factors would have made it very difficult to follow a consistent group of students through a series of Vanguard courses and hence gather meaningful data.

Data were gathered by two main methods – structured interviews and questionnaires, and a number of steps were taken to ensure both validity and reliability in the way these are developed and delivered (see section 4.5). These two methods enabled qualitative data directly relevant to the research question to be gathered. It is accepted that data obtained through the use of interviews and questionnaires may carry a risk of bias (Cannell & Kahn, 1968), particularly when taken as evidence for a particular phenomenon without reference to other data sources (Kirk & Miller, 1986, p. 72). However, the very nature of the research question *assumes* the existence of a certain amount of bias in the attitudes and responses of those involved in delivering these courses – biases based on their own educational beliefs and how the courses should best be delivered based on these beliefs. Underlying this study was the need to both *capture* these biases and *identify* those that may have an impact on the perceptions of the individual or even on the effectiveness of a particular implementation (Bryman, 1988, p. 77; D. Silverman, 1989, p. 72). The groups of people who participated in the research were carefully selected so that any biases that did exist could be anticipated, exposed and balanced by data from groups who would not be expected to share this bias. This was particularly relevant to the investigation of the match or otherwise between the *rhetoric* (what those who had been driving the change to Vanguard style courses were saying) and the *reality* (the views of those who were a little separated from the leadership group). Biases or, at the very least, perceptions that were unsupported or that did not accurately reflect a particular situation, were further highlighted by the use of existing quantitative data in the form of the final marks for each course to illuminate claims of success in measurable areas such as the use of web-based resources or even exam performance.

The Transformation Framework was first used to construct a bank of interview questions (Appendix A) from which question sets could be constructed for each context. The question sets were carefully designed to map to each section of the Framework and to enable the user to gather accurate information about the perspectives of the interviewee on each type of transformation (Keats, 2000, p. 75). The first interview was conducted with the Undergraduate Dean at the time of the first run of Vanguard courses. The Undergraduate Dean had been instrumental in the development and implementation of the Learning and Teaching Strategy and hence would be able to provide insight into the vision behind the Strategy and the expectations regarding the Vanguard courses themselves, as well as a perspective on how the courses were living up to those expectations at that point in time. Although the core of each question set was identical to control reliability and ensure that comparisons could be made between the responses of the interviewees (David Silverman, 2006), each interview also had a more open-ended element that would also "*enable respondents to demonstrate their unique way of looking at the world*" (Cohen, Manion, & Morrison, 2005, p. 121). Hence, the responses of the Undergraduate Dean focused more on the thinking, particularly at College level, behind the Vanguard courses as a whole. A further interview was held with the new Undergraduate Dean (the previous incumbent had moved to a new position at a different university in 2008) once the Vanguard courses had become more "established". While this interview also focused on the how the Vanguard courses were perceived to be achieving their goals, it was recognised that with a new Dean (who had also been involved in the development of the Strategy but had not had the same level of influence as the previous Dean) at a different point in time came a new, and perhaps different, set of perspectives, but at the very least such perspectives would nonetheless provide further useful insight into the thinking, influences and politics that lay behind the implementation of the Learning and Teaching Strategy and the Vanguard courses.

Interviews were then conducted with the organiser of each course during 2006-2007 Vanguard year, followed by short “catch-up” meetings to keep track of any further changes that may have occurred, particularly those that may have skewed the numerical data for the post-Vanguard years. The core question set was identical to that used with the Undergraduate Deans, but in this case the open ended elements of the interviews meant that the responses inevitably had more of a focus on the impact of the changes on the individual courses themselves (Appendix A). The Course Organisers were seen as a key source of important data as in many ways they held ultimate responsibility for each individual course and its participation in the Vanguard initiative. Their roles (usually part- course administrator and part- lecturer) placed them, in communication terms at least, somewhere between the committees who developed the Learning and Teaching Strategy and those who worked at the teacher-student interface. As such, their perspectives provided useful insight into how the courses interpreted the Strategy and the rationales put forward by the Undergraduate Deans and sought to communicate the Strategy to those involved and put it into practice as they became Vanguard courses. Indeed, these perspectives of the Course Organisers were used as a central narrative of the study, with all other data sources (including interview and numerical data) being used as a means of corroborating, or casting doubt on, their claims regarding any transformations that may have taken place.

The next phase of the study focused on the use of detailed questionnaires to gather data from those who lectured each course in addition to any tutors, assistants or others associated with any element within each course. As before, these questionnaires were constructed using the Framework and shared the same core as the questions used during the interviews to ensure that the appropriate data were obtained and that comparisons could be made (Appendix A). The target groups contained a total of around 30-35 potential data sources, and the questionnaires were made available online through SurveyMonkey (http://www.surveymonkey.com). A series of reminders and prompts were sent to the target audience over the lifetime of the questionnaire to ensure that a sufficient number of responses were obtained. By the end of the allotted time, 26 (over 80%) of the potential data group had completed the questionnaires. As previously discussed, the groups were specifically chosen, not only because of their knowledge of their particular aspects of the courses how they were being delivered, but also because their input would also provide a number of "checks and balances" against any potential biases that may have existed within a particular group. In many ways, the lecturers may be considered to occupy the grey area between the Course Organisers and tutors, in that they were not necessarily directly involved in initiating the changes or innovations that took place, but still had a deep involvement in their respective courses. As such, their perspectives could be expected to be tempered by what they saw in their courses in a way that the expectations of the Deans, and perhaps even the Course Organisers, may not have been. Similarly, it seemed reasonable to expect that the more temporary contributors to the course such as tutors and assistants were significantly separated from the politics and ideologies of the University and so were less likely, for example, to view their courses through rose-tinted spectacles or to have developed any opposition to changes in courses based on previous practice. As a result, gathering data from these groups enabled a more objective picture of what was happening "on the ground" in each of the courses to be obtained.

Finally, quantitative data were gathered from the College records in the form of anonymised final course marks. These marks were obtained for the 2006-2007 course instances (when the courses became "Vanguard") together with two years before and two years after the change, in order to fully cover the period that related directly to claims and assertions made by the Deans, Course

Organisers, Lecturers and other teaching staff involved in each course. In addition to being a useful data source in and of itself, this quantitative data provided another checkpoint for the perspectives expressed by the various groups, particularly in regard to student performance and achievement, and enabled any claims made in this area to be placed on a more solid evidential footing or shown to be unsubstantiated conjecture, highlighting where there may have been bias or a discontinuity between what the Dean, Organiser, lecturer or teaching staff may have *thought* was happening and the reality of the situation.

It may be noted at this stage that the use of the students themselves as a potential data source has been omitted from this study. Although a study of students and their own perspectives would, of course, have been interesting, a deliberate choice was made *not* to include them as part of this study. This decision was taken for two key reasons. First, at the time the Vanguard courses were beginning, another study was being undertaken, focusing on the attitudes of the students involved and in particular on their attitudes to taking responsibility for their own learning. It was decided that it would be more prudent to draw on the results of this research where necessary rather than duplicate elements of that study. Secondly, this study focuses on the *transformation* of teaching and learning and assumes that this is a process that would necessarily take place over a number of iterations of a course, or, at the very least, from one iteration to the next. This is a view which students would inherently be unable to inform as they would only be expected to have a single encounter with any particular course and hence could not comment on any transformations which may or may not have taken place as a result of the introduction of new technologies. Hence it was decided that a consideration of students' experiences would not be a useful addition to this study.

The structure of the data sources used can be summarised in Figure 4-1 shown overleaf;

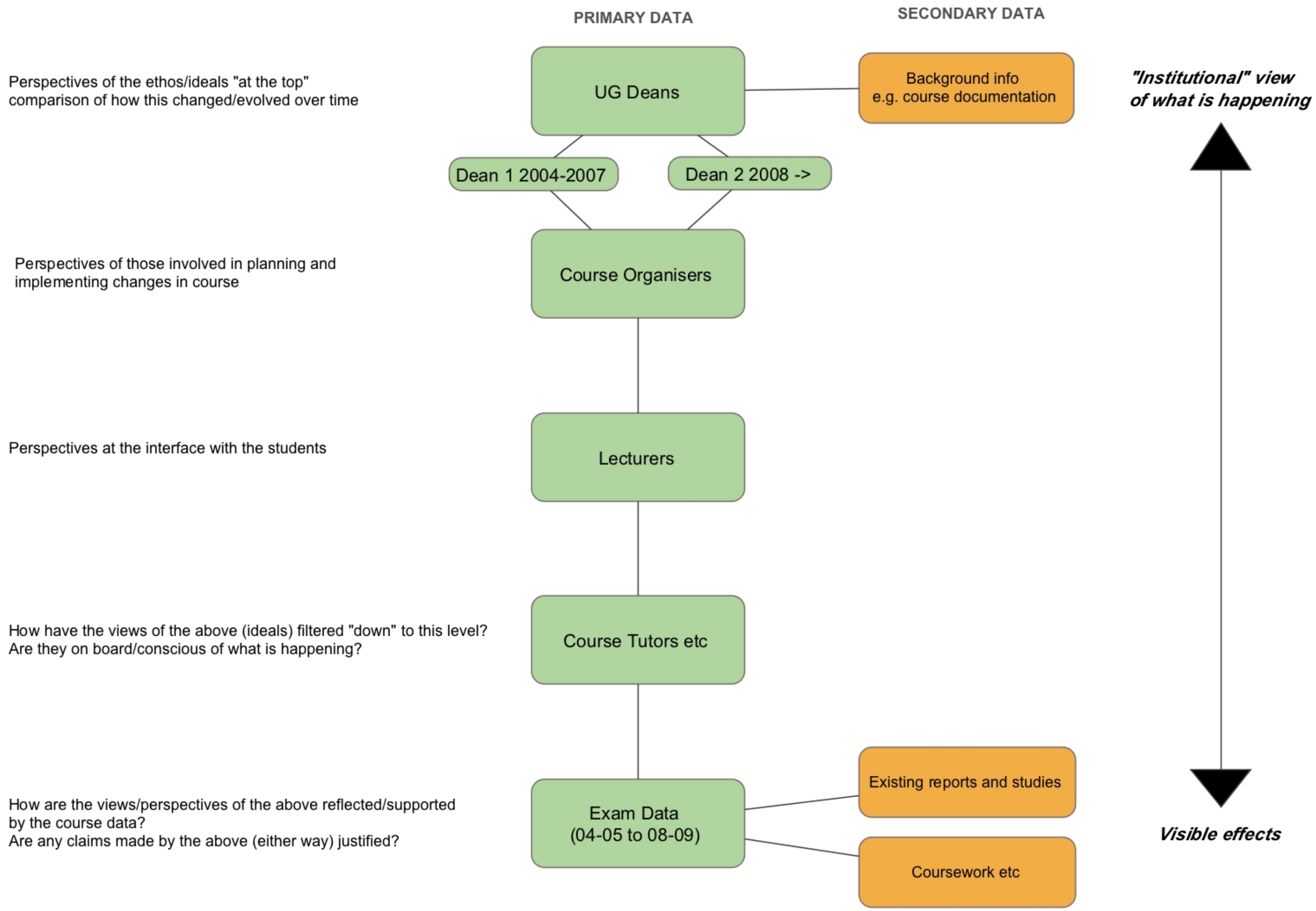


Figure 4-1: Key data sources

4.4 Analysing the data

The data collected during the study were analysed using three key tools, based on the most appropriate method for each type;

- Interview data were analysed using Nvivo
- Survey data were analysed using Survey Monkey and Microsoft Excel
- Numerical data were analysed using Excel and SPSS

Each interview was first transcribed in full, either by the author or by professional transcription services. The Framework was used to define a series of categories to which responses, comments or observations made by each of the interviewees could be assigned (Appendix B). These categories followed the Framework closely and were designed to identify, capture and categorise all comments without bias, whether they were positive, negative or neutral with regard to the element of the Framework being discussed. So, for example, the categories relating to ***M2*** *– means of engagement with subject matter* were as follows;

- **M2** - means of engagement with subject matter
  - The use of technology has increased the variety of means of engagement with the subject material
  - The use of technology has not increased the variety of means of engagement with the subject material
  - The use of technology has decreased the variety of means of engagement with the subject material
  - The course takes advantage of an increase of variety of means of engagement with subject matter
  - The course does not take advantage of any increase of variety of means of engagement with subject matter

The interview transcriptions were imported into NVivo and the categories discussed above were then set up as a series of "tree nodes" (Appendix B). This allowed each transcription to be studied in detail so that every comment that was relevant to the Framework could be accurately assigned to the appropriate node or nodes (Richards, 2000, p. p55). Due to the number of nodes required to cover the entire Framework appropriately and hence enable the transcriptions to be fully analysed, each transcription was analysed in four separate passes - the first to identify those comments that related to the Foundations and Institutional Transformations, the second to identify comments relating to Material Transformations, the third to identify comments relating to Behavioural Transformations and a final review of each transcription to ensure that comments had not been missed or incorrectly categorised (Appendix C). To ensure that the categorisations had been carried out accurately and without bias and thus strengthen the reliability of this part of the study, random samples were crosschecked by a small number of volunteers (Hammersly, 1992, p. 67). Finally, this categorised data were analysed in order to map where transformative effects were observed (or claimed) by the interviewees and to determine if such observations were likely to have been correct or were corroborated by other evidence and could be attributed to the technologies implemented in the courses.

The online surveys were conducted using the subscription version of SurveyMonkey (this version provided the full range of question types, data analysis tools and export options). The survey data consisted of a total of 26 completed surveys from lecturers and other teaching staff (such as postgraduate tutors), and exporting these into Excel provided a convenient way for the correspondingly large number of responses to be viewed. Survey Monkey automatically calculated and presented percentages for those responses that had a discrete number of options, while Excel enabled the free text that accompanied such responses (and often illuminated the reasons for them) to be viewed and compared. Use of Excel also enabled the collected data to be split into separate sections (responses that related to the Foundations and Institutional Transformations, those that related to Material Transformations and those that related to Behavioural Transformations). The data were then analysed in a similar manner to the categorised interview data, using the Framework as a reference, in order to identify where transformative effects were observed or claimed and to weigh these observations and claims in the light of the other data obtained. The interview and questionnaire data obtained from all those involved in delivering the Vanguard courses are analysed in detail in Chapters 6, 8 and 9.

As mentioned in section 4.3, the numerical data obtained consisted of the final course marks for each of the three courses over a period of five years - the year of the Vanguard initiative together with two years on either side of the implementation. A detailed statistical analysis of the data was carried out in order to identify any *trends or patterns* or *significant changes* that coincided with, and could potentially be attributed to, the changes that occurred in the courses as they became Vanguard (Field, 2009, p. 13). The first part of the analysis of this data was carried out using Microsoft Excel. Once the data had been imported, Excel was used to;

- calculate and chart the basic statistical measures of mean, median and mode for each of the courses over the five year period
- divide the course marks into their corresponding grades
- chart the distribution of grades obtained each year over the five year period for each course
- chart the distribution of pass/fail rates each year over the five year period or each course.

This allowed any possible patterns to be identified visually and also highlighted possible points for further analysis. The second part of the study was carried out using the powerful statistical analysis tool, SPSS. The tool was used to provide a wider range of statistical measures than would otherwise be possible using Excel. In particular, the chi- squared values for a range of data sets including the grade percentages, grade frequencies and pass/fail rates, were calculated. This enabled a detailed study to be carried out that focused on the detection of statistically significant changes in the course marks that may have occurred as the courses joined the Vanguard initiative. Possible reasons for any changes detected were considered before the results of this analysis were then cross-referenced against the results gleaned from the other sources. Such cross-referencing allowed more robust support, or otherwise, to be provided for claims or observations made regarding any areas of the Framework to which the numerical data may have had relevance.

4.5 Limitations, validity and reliability of the results

It has already been acknowledged that some of the results from the above study were potentially subject to a number of important limitations that could not simply be ignored, and many of the specific steps taken to ensure both the validity and reliability of the data and the conclusions drawn have already been described in sections 4.3 and 4.4. First and foremost, the data acquired were, as one might expect, largely anecdotal in nature, based on comments and observations made by the interviewees and survey respondants. The results were also inherently weighted towards being representative of their own views and perspectives. On a single reading of the transcriptions it would have been difficult to determine what was rationale – (firm convictions and beliefs) and what was rhetoric (perhaps toeing the party line and merely stating what is deemed to be expected), or what was a true representation of the facts and what was little more than wishful thinking. However, it is worth emphasizing again that the study was conducted with this very much in mind. Indeed, capturing and identifying these biases, as well as weighing them against other available evidence, was a critical part of addressing the research question and establishing what, if anything, had happened when the technological innovations were introduced into the courses. The study was designed, not to eliminate such biases, but to *reflect* them and then place them in a wider context. Hence, while any biases clearly would have reduced the firmness of any conclusions that could be based on these results in isolation, the very existence of these limitations also enabled a very clear research path to be identified. The perspectives, viewpoints and opinions of each of those groups involved in delivering the Vanguard courses are therefore expressed in this report as they were made, before being evaluated in the light of the other sources of data to establish the likely reality of what happened in the courses (Cohen et al., 2005, p. 121). This enabled a clearer picture to be painted of the existence of transformative effects in these courses and courses like them, and ultimately the part that technology may have played in these transformations.

Repeated interviews and follow-ups with those involved following the first Vanguard run may also have had a positive impact on both the validity and reliability of the data obtained by highlighting any inherent stability or instability (Denzin & Lincoln, 1994). In other words, observing the courses over this extended period as they moved from a position of novelty to one that, hopefully, would be a well-established course format should result in a certain amount of "smoothing" of the data. On the one hand, it is possible, even likely, that mistakes would have been made in the first instance of any new course or innovation that may have masked some potential transformations that may otherwise have been observed. Revisiting the courses provided the opportunity for those involved to acknowledge any such mistakes, to learn from them and for any necessary adjustments to be made. On the other hand, any effects that may have arisen more as a result of a “novelty” factor should have faded with time and so revisiting the courses could perhaps have provided at least some protection against the drawing of overly optimistic conclusions as a result of short-lived or transient benefits (Papert, 1971; Wallace & Mutooni, 1997). In addition, repeated glimpses of the same course over time may also have allowed the observation of change in some factors that may initially have had an adverse effect on the innovations implemented into the course. For example, any initial resistance to change displayed by those involved in the implementation may have begun to subside over time, and, in turn, those involved may have engaged more in the process of change, perhaps allowing further transformative effects, or more evidence of existing transformative effects, to become visible.

4.6 Summary

The process described in this chapter demonstrates how the Transformation Framework developed in Chapter 3 could be used successfully both as an overarching guide to planning a significant piece of research and as a starting point for the production of individual research instruments. The approach to the selection, acquisition and analysis of the relevant data was designed to focus the study on the perspectives of the individuals involved in the development and execution of the Vanguard courses while seeking to identify and filter the inevitable biases in their reports through the comparison of multiple data sources, both qualitative and quantitative. The resulting hybrid methodology enabled a detailed study to be undertaken of what was, by definition, a finite dataset and increased the confidence with which any conclusions drawn could be stated.

Chapter 5. The Vanguard courses

5.1 Development of the Learning and Teaching Strategy

The College of Science and Engineering is a prestigious and revered part of what is one of the UK's oldest and best-known Universities, with a long history of educational success and achievement. As the College moves ahead in the twenty-first century, academic leaders and those in positions of influence have recognised the fact that the world is changing, and have naturally been concerned with how to sustain the College's strong reputation and flourish in the future. Institutions face many challenges as they seek to meet the changing needs of students and cope with increasingly uncertain economic situations which themselves demand changes in the way the institutions operate.

It is clear that those involved in the review of the College's approach, and in particular, the Undergraduate Deans, who were interviewed as part of this study and who are quoted throughout this chapter, believed that the students coming through the doors of the institution today are very different from those who may have been deemed "typical" students in the past. Increasingly, the student body was observed to be populated from non-traditional backgrounds, with increasing numbers of international students (> 10%), students notifying some form or disability (>6%) and other groups who may require changes in the services the College provides. The onset of "top-up" fees and student loans has made financial pressures and work commitments the norm, with approximately 50% of students having some kind of paid work during the semester (*Sources: University 2005/2006 annual report, Higher Education Statistics Agency 2004-2005 data, Equal opportunities technical advisory group forth report 2003-2004 data, disability office website)*. Students themselves have different expectations as they enter university that have been influenced by other changes in secondary education and a shift in their experience of the world of work than may previously have been the case. Dean 1 observed that "*students are getting further and further away from the idea that teaching means that you are in the presence of a teacher, you learn something during that period and then you go off and do some private study. That will always happen, but the idea that that should be the main mode of interaction, which I would say is still the dominant view, it's still the dominant expectation of the students and our dominant expectation, but that's really changing and I think it's going to change quite quickly. And what we're trying to do is to accommodate that and exploit it.*" A university education is no longer thought of as "education for education's sake", but rather as a necessary means to an end – explicit preparation for the world of work. It is now commonly stated that the job for life is becoming a rare thing – change and mobility is perceived as becoming the norm, not least of all by those behind the Vanguard courses. In turn, it is assumed that employers' expectations have undergone a corresponding evolution. There is a widely held view that today's workforce is increasingly expected to be flexible and adaptable, able to learn new skills when necessary. As students emerge from their time at university, it seems likely that they will be expected to manage their own personal development so that they can cope with and survive in this new transient world of employment (Meister & Willyard, 2010).

There is little *hard* evidence to support many of the commonly made assertions about such revolutionary changes in the world of work, but it *can* be argued that the world into which today's students will emerge from university *is* markedly different from that of their predecessors in at least one respect. Perhaps the greatest single factor which sets today's students, and the world for which they are destined, apart from their predecessors is the ubiquitous nature of technology in every aspect of their lives, including education. There are many who subscribe to the notion that the current generation exhibits a certain native affinity for technology as a result of the degree to which it has permeated their lives since childhood (Prensky, 2001). Instant access to information is familiar and expected. Email, chat and sms messaging have certainly created a generation who is used to "always on" communication (Chen, 2011; Tapscott, 1998, 2009). The world of secondary education has been relatively quick to embrace such technologies when and where it can, and government funding and programs have ensured a reasonably equitable distribution of such technologies in schools across the country so that the vast majority of students are familiar with many innovative uses of technologies in the classroom. Dean 1 believed that this was indeed the case for the students who were now coming through the doors of this university, commenting that "*they are very at ease with the asynchronous nature of certain types of interaction, you know, much more at ease than we as older, less technologically literate people are. And so there was a feeling actually of having to exploit, but also manage and control technology a bit, or … control's not the word but … to exploit and to manage the use of technology and not to fall too far behind*". Hence there seems to be a pervading feeling that universities are faced with a double edged sword with each new intake –these are students who expect and are able to use appropriate technologies to support their learning much more than previous generations but who are much less able to respond to traditional lecture situations, not least of all because they are unlikely to have had much, if any, experience of such situations in school. Dean 1 put it this way; "*we don't know what the technology will be but students will want to make more choices, they will want to learn at a different time, in a different way, in different ways and that's what we have to support, I think.*" In the eyes of the College of Science and Engineering, the result of this disconnect between the students traditionally catered for by our universities and the reality of recent cohorts posed both problems and opportunities. Lectures were poorly attended. Students struggled to keep up with work and even pass as courses maintained a bias towards terminal assessment rather than ongoing learning. Yet at the same time, the potential to exploit the *new* skills and even styles of learning which students were presenting as they passed through the doors became apparent, and it was recognised that new forms of assessment that were as much an aid to learning as they were modes of measuring attainment may help meet students' needs. Dean 1 put it this way; "*We need to support them in taking responsibility for their own learning, but they will see* *alternatives and they will find themselves confronted with the need to take choices. This will make them more active learners… We've got to separate out assessment for progression and assessment for excellence, so you can progress with 40% but it should be ringing alarm bells if you get 40% in first year physics, should you really be aiming to be a professional physicist?"*

The College took a methodical approach to analysing the challenges it faced and to developing a way forward for the future in an attempt to focus on teaching and learning in a research-led university. In October 2004 a working group was established to clarify the issues involved and prepare reports for the College Undergraduate Studies Committee and the College Strategy and Management Committee in May 2005. The working group proposed the implementation of a new Learning and Teaching Strategy (Figure 5-1) that would

- increase the students' sense of responsibility for their own learning
- permit diversification in teaching practice
- reduce formal teaching and summative assessment.

The Strategy outlines a set of Principles to which the College, and ultimately all its courses, should adhere, which cover

- The scholarship of teaching and learning
- Learning with enquiry
- Personal learning
- Collaborative learning
- Flexibility of learning styles
- Assessment for learning

College of Science and Engineering Learning and Teaching Strategy
The College of Science and Engineering adheres to the following Principles. **1. The Scholarship of Teaching and Learning** We are committed to the scholarship of teaching and learning. As academics, we will learn how to develop our teaching approaches in order to achieve better learning by our students, and to help them to develop as effective and independent learners. **2. Learning with Enquiry** We are a scholarly community based on enquiry, and on generating knowledge. Students will be made familiar with the scientific method from the beginning of their studies; there will be a strong strand of learning with enquiry (learning to ask the right questions) at all levels, integrated where possible with our research activities. **3. Personal Learning** Our learning environment, and the requirements and expectations that we communicate to students, will be designed to ensure that they are given, and feel, a genuine responsibility for their own learning, seeing rewards and benefits from effectively managing their activities, and negative consequences from failing to do so. **4. Collaborative Learning** Collaborative learning of an informal nature will be encouraged and study-support measures will be designed with that in mind. Where possible, our degree programmes will contain significant elements of formal collaborative learning, supported by academic staff and by flexible computer-based interactions. **5. Flexibility of Learning Styles** Wherever possible, learning opportunities will respond to the variety of students' circumstances, experience and aptitudes. **6. Assessment for Learning** In pre-honours years, preparedness to progress to the next level and excellence will be assessed by separate elements of summative assessment. The extent of formal summative assessment will be the minimum required for these purposes. Students will monitor their own learning by self-assessment. In honours years, summative assessment will be the minimum required to assess the students' achievement. Students will monitor their own learning by self- assessment. All assessment should be formative, in the sense that students receive feedback on (or can self-assess) their performance.

Figure 5-1: College of Science and Engineering Learning and Teaching Strategy

It is interesting to note that although an increased use of technology was envisaged, a deliberate choice was made to avoid the explicit mention of the use of technology to enact the Strategy. "*We were very clear that technology* *shouldn't appear in the strategy, that it should be about students' experiences, but it's also very clear that technology facilitates, and indeed you could move towards a strategy. We could have moved towards it in the sixties or the fifties, but technology really does facilitate it, particularly, for example, with group working and giving students alternative means to study particular subjects, so websites, there's some work already done on virtual field trips, which is particularly relevant to students with disabilities but could be relevant to people more generally. So technology is important as a kind of facilitator.*"

5.2 Implementing the Strategy

The Principles on which the Learning and Teaching Strategy was based were approved in October 2005, and it was decided to begin implementation in a manageable fashion with a set of coordinated activities in individual Schools and at College level. First, the initiative focused on the infrastructure through which teaching and learning is delivered, with planned refurbishments of teaching spaces and a broader re-examination of the Teaching Estate Strategy, most notably in the extensive refurbishment of a large tower block on one of the main campuses to include the provision of studio space for group working, dedicated high-technology teaching spaces and built-in support for the use of student responses systems, or "clickers". In addition, a small number of courses to be delivered in the 2006-2007 academic year were sought which would be designated "Vanguard" – leading the way in exploring and demonstrating the application of the Learning and Teaching Strategy at undergraduate level. Dean 1 explained that "*It's coherent, but rather diverse, so there's not a kind of straitjacket telling the schools, telling the programmes and the courses what they need to do, but rather we've produced a set of guidelines for the Vanguard courses and we're supposed to be moving towards at least some of the principles in each of the Vanguard courses.*" Looking back on this time, Dean 2 commented; "*The rationale behind the Vanguard courses, well the rationale then was that … what we wanted was, rather than courses doing little bits of higgledy-piggledy change, what we felt was that we were trying to effect an overall culture change in the* *approach to paedagogy, particularly to promote notions of responsible learning and self-learning to sort of reduce the system – basically all the things that were in the strategy, and unless these were done in a joined up way and people actually had a fundamentally different approach to teaching, rather than a teach and test strategy, something that focused much more on student led, student focused learning, and that had to happen from both a staff end and the student end.*"

Some courses (or, more specifically, the Course Organisers) volunteered to take on this pioneering role and review their current teaching, learning and assessment strategies. Twelve courses in all, covering a broad spectrum of subjects within the College, formed the first wave of Vanguard courses in 2006-2007. The intention was that lessons learned from this pilot scheme would be applied as the Strategy was implemented across a broader range of courses so that the Principles would have a wider impact on students from the following (2007-2008) academic year and beyond. At all points in the implementation and rollout the project was overseen by the College Undergraduate Studies Committee. The College secured money from a University-wide e-learning fund to employ a College Learning Technologist to work with an existing Learning and Teaching Strategy Project Officer, and there were plans to employ a technology specialist as the implementation gathered speed; "*We had an opportunity through the e-learning fund to actually help kick start the project by appointing an e-learning advisor, specifically to run alongside the Vanguard courses to actually help them implement aspects of e-learning but with … be integral with the Vanguard courses.*"

A set of "guiding principles" was produced, based on the Learning and Teaching Strategy to support Course Organisers and their teams as they sought to develop their "Vanguard" courses. These Principles followed four key themes;

- Assessment

- Modes of learning
- Student support
- Resources

The description of each principle is given in Table 5-1 (overleaf).

The drive to launch the Vanguard initiative took place at relatively short notice, with some courses only having a matter of weeks to plan the transition, and as such there was no expectation that the courses involved would have integrated all the Principles outlined in Figure 5-2 into their courses. However, whether by chance or by design, all of the Vanguard Principles had been put in place by at least one of the Vanguard Courses during the first year. The College developed an evaluation strategy for this first run of courses based on questionnaires given to all students at the beginning and end of the year in addition to interviews of small groups of students. These were intended to "*provide an overview of the students' learning processes and what might influence how they engage with their studies"* (McConnell & McCune, 2007a). In this way, the College would have a first glimpse of students' attitudes and how the changes were affecting the students' perceptions of their own responsibility for learning as the Vanguard programme expanded in the following years. Three courses, **Course A**, **Course B** and **Course C** from different branches of the College of Science and Engineering were selected for the purposes of this study from those taking part in the first wave as discussed in Chapter 4.

The Principles to Guide the Vanguard Courses	
Assessment	1. Progression and excellence: Separate elements of assessment should determine a student's fitness to progress, and their achievement of excellence. (These elements might be within the same piece of assessment.) Students should receive feedback on their performance with respect to both of these criteria.
	2. Self Assessment: This should occur at suitable points during the course as a routine, rather than extraordinary, element of the assessment structure. Self-assessments should take place after the students have covered the material that relates to a particular learning outcome, so that they can assess their attainment of the learning outcome.
	3. Assessment and the curriculum: Formal assessment should reinforce good study habits. Assessments should be structured to ensure that students engage with all parts of the curriculum, and cannot avoid areas with a 'question-spotting' approach.
Modes of Learning	1. Empowerment of the students: The students should feel that they are responsible for their own learning, taking decisions about how they learn. Where alternative modes of study are available, we should in general not regard a student's decision not to participate in one mode as a sign of lack of engagement. Nevertheless, where participation in one mode of study is required to attain a learning outcome (e.g. laboratory practical) the students should be required to participate. Detailed guidance will be provided to students to ensure it is made clear which elements it is compulsory to attend.
	2. Interactive/group working: Students should be encouraged to work in groups, and supported in this. Students are likely to particularly require guidance in the Semester 1 of their first year.
Student Support	1. The "professional student": As this style of learning is different from the students' experience at secondary school, and in other university courses, they will need to be educated in this new style of learning, by a suitable induction process, and receive appropriate support during their studies. Staff will provide an encouraging environment for students as they commence Vanguard courses, with the expectation that less support will be required as students start to take responsibility for their own learning. They will need to be aware of our expectations of them, and to have an understanding of learning as a process.
	2. Pastoral care: We need to aim for a supportive environment, but one that puts the responsibility for seeking support firmly on the students. The activities of individual students may be monitored, but this information should be fed to the students to allow them to decide themselves whether they should change their participation. They should not be contacted by Directors of Studies if they do not attend academic activities. Of course, we must remain alert for evidence of serious pastoral problems.
Resources	The Learning and Teaching Strategy should not be allowed to lead to long-term increases in costs. That is, any investment in one area should be balanced by a reduction in resources elsewhere.

Table 5-1: The Principles to Guide the Vanguard Courses

5.3 Alignment of chosen technologies to the Learning and Teaching Strategy

As part of the move to become *Vanguard* and put the Principles from the Learning and Teaching Strategy into action, each of the three courses chose to make use of at least one technological innovation. Despite the fact that nowhere does the Strategy mention such a use of technology, it is clear that such tools are seen as central to enabling courses to make the changes necessary to allow students to take more responsibility for their own learning. Hence it is important not only to identify the technologies selected by each course together with the Principles that may be supported by them, but also to clarify whether such choices were intentional or merely happy coincidences. In each case, this was simply determined by looking at the additional resources provided by the course (for example, if the lecturers wrote a series of questions for WebCT, it is safe to assume that they explicitly intended to address the Principle relating to self-assessment) in addition to the evidence obtained through the interviews and surveys held with the teaching staff.

5.3.1 Course A

The department in which this course is found already had a reputation for innovative teaching, and hence it seemed a natural progression for some of its courses to be early adopters of the new Teaching and Learning Strategy. Course A, which consists of a mixture of lectures and laboratory time, is a broad-based introduction to the fundamentals of the subject, and is the first encounter with the subject students have as they enter the university. At this level, the intake is highly heterogeneous, consisting of scientists, engineers, mathematicians, and even lawyers and language students seeking to take advantage of the flexibility of first-year studies. As a result, there is a correspondingly broad range in aspirations and ability within the course. The material dealt with is familiar to most students, but a challenge inevitably arises from the difference in approach and depth of school and college courses. The department has been proactive in reviewing how courses are taught in the light of the student demographic and the effectiveness of the courses as gauged by staff and measured by student performance (most notably in the area of pass/fail rates) and feedback. The course development has been a process that has been ongoing over the past number of years – in many senses a Vanguard-Vanguard course. The main technologies implemented in the 2006-2007 year were as follows;

- A purpose built online learning environment supporting lecture notes, discussions, wikis, animations, video, simulations and self-assessment questions
- An integrated student response system (clickers which students can use to respond to teacher questions so that aggregate class responses can be displayed)
- A range of ad-hoc technologies employed to support group and lab work, such as web cameras and imaging software

Technology used in 2006-2007	Affected Principles	Use*
A purpose built online learning environment supporting lecture notes, discussions, wikis, animations, video, simulations and self-assessment questions	Assessment – 2. Self assessment	Explicit – production of self assessment questions
	Modes of Learning – 1. Empowerment of the students	Explicit – production of online notes and other supporting resources
	Modes of Learning – 2. Interactive/group working	Explicit – specific use of discussion area
	Student support – 1. The "professional student"	Implicit
An integrated student response system (clickers which students can use to respond to teacher questions so that aggregate class responses can be displayed)	Assessment – 2. self assessment	Explicit – design and use of questions to test understanding used in lectures
	Modes of Learning – 2. Interactive/group working	Explicit – Some questions involve discussion/ group work
A range of ad-hoc technologies employed to support group and lab work, such as web cameras and imaging software	Modes of Learning – 2. Interactive/group working	Explicit – lab work done in a group setting

***Explicit** use – indicates that active steps have been taken to enable students to use the technology in this manner

***Implicit** use – indicates that no active steps have been taken to enable students to use the technology in this manner

Table 5-2: Use of technology in Course A mapped to the affected Vanguard Principles

Table 5-2 shows Course A's chosen technologies mapped to the Vanguard Principles that were affected by the implementation, together with an indication as to whether the decision to use technology in that way was *explicit* (active steps had been taken to enable students to use the technology in this manner) or *implicit* (no active steps have been taken to enable students to use the technology in this manner).

5.3.2 Course B

Like Course A, Course B is a very large course comprising the entire first year specialist intake together with a diverse mix of students from all corners of the university, with a class size of around 400 students each year. The large number of "visiting" students from other faculties and colleges within the University is often reflected in a broad spectrum of motivation and ability within the student body, from enthusiastic "high flyers" to those who fail to turn up for class and who inevitably fail the exam at the end of the year. The course, which like many first year courses is intended to bridge the gap between high school and university level studies, revolves around a series of lectures delivered in six blocks over a semester by six different staff members. The lectures are supported by workshops (tutorial-style seminars) and bi-weekly laboratory sessions. Although it appears that the content and format of the course has largely remained static over the past number of years, the department has nonetheless been actively engaged in looking at various ways of meeting the academic challenges presented by such a large and varied student body, including specific technological interventions. The main technologies implemented in the 2006-2007 year were as follows;

- An online learning environment (WebCT) primarily used to support lecture notes, discussions and self-assessment questions

- An integrated student response system (clickers which students can use to respond to teacher questions so that aggregate class responses can be displayed)

Table 5-3 shows Course B's chosen technologies mapped to the Vanguard Principles that were affected by the implementation, together with an indication as to whether the decision to use technology in that way was *explicit* (active steps had been taken to enable students to use the technology in this manner) or *implicit* (no active steps have been taken to enable students to use the technology in this manner);

Technology used in 2006-2007	Affected Principles	Use*
An online learning environment (WebCT) primarily used to support lecture notes, discussions and self-assessment questions	Assessment – 2. self assessment	Explicit – production of self assessment questions
	Modes of Learning – 1. Empowerment of the students	Explicit – production of online notes and other supporting resources
	Modes of Learning – 2. Interactive/group working	Explicit – specific use of discussion area
	Student support – 1. The "professional student"	Implicit
An integrated student response system (clickers which students can use to respond to teacher questions so that aggregate class responses can be displayed)	Assessment – 2. self assessment	Explicit – design and use of questions to test understanding used in lectures
	Modes of Learning – 2. Interactive/group working	Explicit – Some questions involve discussion/ group work

Explicit use – indicates that active steps have been taken to enable students to use the technology in this manner

Implicit use – indicates that no active steps have been taken to enable students to use the technology in this manner

Table 5-3: Use of technology in Course B mapped to the affected Vanguard Principles

5.3.3 Course C

Course C is taken by all first year students in the subject and is made up of two distinct but concurrent parts. The first part is delivered in the form of a series of lectures that cover the fundamental concepts of the subject, while the second part consists of hands-on practical work. These two parts operate very closely in tandem, with the concepts introduced in the lecture part of the course being demonstrated and reinforced in the practicals. The whole course is also very closely linked to a follow-up course taken by students in the second semester. The department in which this subject sits decided at a relatively late stage to become part of the "Vanguard" project, and as such felt limited in what changes may be appropriate or possible to introduce to the traditional format at short notice. In addition, by its very nature, the course is already technology-rich, and the practicals are based in a sophisticated computer laboratory. Hence a decision was made to proceed in small steps and to focus first on the lecture part of the course, with the proviso that nothing would be done which could affect or diminish the interconnection with the second part of the course, or, indeed, the follow-up course. The main technology implemented in the 2006-2007 year was the online learning environment (WebCT), which was primarily used to support lecture notes, discussions and self-assessment questions. Table 5-4 shows Course C's chosen technologies mapped against the Vanguard Principles that were affected by the implementation, together with an indication as to whether the decision to use technology in that way was *explicit* (active steps had been taken to enable students to use the technology in this manner) or *implicit* (no active steps have been taken to enable students to use the technology in this manner);

Technology used in 2006-2007	Affected Principles	Use*
online learning environment (WebCT), which was primarily used to support lecture notes and self-assessment questions.	Assessment – 2. self assessment	Explicit – production of self assessment questions
	Modes of Learning – 1. Empowerment of the students	Explicit – production of online notes and other supporting resources
	Student support – 1. The "professional student"	Implicit

Explicit use – indicates that active steps have been taken to enable students to use the technology in this manner

Implicit use – indicates that no active steps have been taken to enable students to use the technology in this manner

Table 5-4: Use of technology in Course C mapped to the affected Vanguard Principles

5.4 Were the courses serious about being "Vanguard"?

It is clear that the courses were primarily drawn to similar implementations of the same technologies by providing access to a series of resources via a subject-specific online environment. Whether this reflects the fact that courses could see a clear link is between the affordances of online technology and specific Principles in the Learning and Teaching Strategy, or whether it was simply a "quick win" that enabled a particular course to be seen to be *Vanguard*, without having to make major changes to the course itself, is difficult to determine. However, it does seem safe to conclude that Course A was a leader in terms of the conscious decisions to address a series of Principles using a wide range of technologies, and their approach demonstrated that they were indeed serious about their use of technology, and about being "Vanguard".

Course B seems to have followed a more cautious approach and there is a sense in which they come across as being much less ambitious than Course A. However, even in its relatively cautious approach, Course B was still able to explicitly address a number of the Principles through its use of technology. Perhaps the clearest indicator that, even though Course B appeared less ambitious, this was nonetheless a serious attempt to embrace the Vanguard Principles and make the best use of technology was the fact that the lecturers were willing to repeatedly spend a considerable amount of time and effort developing and refining appropriate questions for use in lectures with the clickers. This is more likely to reflect a dedicated commitment to the new approach rather than token effort to use the latest tool.

Course C was certainly the least ambitious intervention, focusing as it did on two basic resources – the provision of notes and revision questions online. It is interesting to note that of the three courses, Course C was the only one whose choices of technology did not require any form of change or adjustment on the part of the teaching staff in how they delivered course material to the students.

It could be that of the three courses, for whatever reason, Course C was least serious in its use of technology to address the *Vanguard* Principles.

Could the projects have done more in their efforts to become "Vanguard"? Could they have made a more serious attempt to renovate their courses and embrace the Vanguard Principles, particularly in their use of technology? In the case of Course A, it is difficult to argue that the course should have done more. Certainly, the course had a history of innovation, and there was an ethos of review and improvement even before Vanguard. Had the Vanguard Principles not existed, the course may well have made some, if not all of the changes eventually anyway. However, it seems a little cynical to use this as a basis for suggesting that the course could have done more. The fact remains that the course made a series of coordinated changes and implemented a range of new technologies that were specifically chosen to be supportive of the Vanguard Principles.

On the surface, it is more tempting to suggest that Course B could have been a little more ambitious in its introduction of the clicker system and use of online tools. However, it is fair to say that Course B did not have the culture of change and innovation that seems to have existed in Course A, and so relatively small changes may have required considerably more effort, not to mention culture-change within the course. In the case of Course B, the changes began at a fairly gentle pace, but as time went on, the lecturers began to get to grips with what would be required to make the clickers work in terms of questions and paedagogy. As already mentioned, the fact that a group of lecturers who weren't necessarily the natural enthusiasts that those involved with Course A were, committed to making technology like clickers work in the long term within the course by meeting together in order to review and improve current practice reflects the fact that the pace and level of change as the course became Vanguard may have been judged well by the Course Organiser.

It is clear that Course C was different again from either Course A or Course B. The desire to make only changes that did not have a visible effect may be considered to have hamstrung the transition to Vanguard from the beginning – the desire to play things as safely as possible (and there may well have been very sensible and compelling reasons behind this decision) and to "not rock the boat" meant that the innovations seem to have had little lasting impact. The technologies chosen, in particular the use of WebCT, directly addressed at least two key Principles. However, the decision not to make active use of this technology in the Vanguard year suggests that this choice was a gesture in the direction of Vanguard, rather than a serious attempt to enact the Principles. Had the course been prepared (or able) to be more committed to implementing the Principles and the Technology, the WebCT platform and the materials on it could easily have been publicised more widely and their use could have been formalized so that students were required to access the materials in a systematic way throughout the course. It seems that the course viewed this level of engagement with the online materials as being a little more risky than they would like, although it is difficult to tie down exactly what the risks would be in this kind of implementation. However, this kind of approach may have enabled the course to address the Vanguard Principles in a more convincing way while still leaving much of the course unchanged.

Chapter 6. Perspectives of the teaching staff

6.1 Introduction

The perspectives and attitudes of the teaching staff involved in a particular course are a good place to start when investigating any possible effects of a particular innovation or initiative. Not only will this hopefully provide an overview of what is happening "on the ground" but it may also provide useful insight into how the ideals of those further up the planning chain have been communicated and adopted by those directly involved in delivering the courses. Course Organisers, lecturers and post-graduate assistants from the three "Vanguard" courses were interviewed (Course Organisers) or surveyed (lecturers and post- graduate assistants) at various times over a four-year period, beginning just as the courses became "Vanguard." The Framework developed in Chapter 3 was used to construct simple sets of interview questions and corresponding online questionnaires. Interviews were first conducted with the organiser of each course – one while each course was running and one at the end the semester. Each interview was then transcribed and the transcription was analysed in NVivo using the Transformation Framework as the primary lens through which the responses were viewed (Appendices B and C). The course lecturers and post-graduate assistants were then polled via online surveys. The results from these questionnaires were then compiled and analysed in Microsoft Excel.

The key aims of the interviews and surveys were as follows;

- To identify the changes and technologies that were implemented as an explicit part of the "Vanguard" strategy
- To elicit the views of the teaching staff regarding the Teaching and Learning Principles and the changes that were implemented in support of the strategy

- To gain an understanding of those areas in which the teaching staff suggest that some degree of transformation may be observed
- To determine whether or not the teaching staff feel that any such transformations may be attributed to the "Vanguard" changes and more specifically to any technological interventions

The remainder of this chapter deals with the interview data from the Course Organisers, and with the survey data from the lecturers and post-graduate assistants. As discussed in Section 4.3, the perspectives of the Course Organisers form a large part of the narrative of this chapter, with the data obtained from the other teaching staff being used as a means of corroborating, or casting doubt on, their claims regarding any transformations that may have taken place. For each course, the possible types of transformation summarised in the Framework are taken in turn and the perspectives of the teaching staff are presented from the qualitative data obtained and interpreted in the light of the framework.

6.2 Foundations and Institutional Transformations in Course A

6.2.1 Rationales and planning educational interventions

It was clear from both sets of discussions that, from the perspective of Course Organiser A, who was part of the lecturing team for the course and was also the department's Director of Teaching at the time the interviews were conducted, every innovation (those with technology and those without) was carefully considered before implementation. He was adamant that the use of technology was deeply rooted in an explicit desire to add value to the existing methods of teaching and learning. *"What we're trying to do is support the face-to-face teaching and get the best out of the online environment, rather than simply say,* *"it's all online, just go and study it!" or use it as a way to dilute contact with the staff"*

He stated that the department's approach to teaching and learning had been heavily influenced by Eric Mazur's Peer Instruction method (Crouch & Mazur, 2001; Mazur, 1997) and many of the changes which had taken place and which contributed to the "Vanguard" nature of the course had been implemented according to these principles. Indeed, as part of the group that developed the Principles in the first place, Course Organiser A explained that he saw the use of technology as a one key part of "becoming Vanguard," describing their use as the "*implementation of one particular strand or one particular principle of the Teaching and Learning Strategy*." To that end, Course Organiser A stated that encouraging students to take more responsibility for their own learning (a central tenet of the Principles) was a key aim, and the online tools in particular had been chosen specifically to enable students to "*take greater control over their learning and to manage it more effectively*".

It is also interesting to note that there were several technologies that had been looked at by the department but deemed not to be appropriate at the time. One such example was podcasting. *"That's one example of how… technology is put in front of the educational or the academic reason why you might want to use it… we always try to get it the right way round."* The Course Organiser clearly stated the rationale for the use of technology in terms of justifying existing choices and highlighted the fact that the rationale was in place *before* key decisions were made. It is worth noting that almost the entire teaching staff, right down to teaching assistants and postgraduate tutors, were not only aware that the course was a Vanguard course, but could also give clear and consistent explanations of why particular technologies were chosen. The Course Organiser himself summed it up in this way; "*What we've tried to do is we've tried to get the educational aims right and then look for a way for technology to help us in achieving those aims.*"

As has been mentioned before, there has been an ethos of ongoing development and review within teaching and learning in this department, and this makes it a little difficult to attribute every change and innovation that has taken place to the fact that the course was "Vanguard". As the Course Organiser himself stated, "*it's hard… to disentangle what you could label as effects from being a Vanguard course and effects as a result of the sort of natural trajectory that the course has taken from it's … I mean, it's been undergoing pretty much continual development for nearly ten years.*" However, it is clear that there was a feeling among the teaching staff that technology that had been introduced at least partly as a result of the course's "Vanguard" status has had an impact on how the course was planned – 5 out of 6 respondents felt that this was indeed the case. In particular, the use of the "clickers" during the lectures meant that the traditional lecture format has had to be re-thought; "*The PRS ("clicker") questions are now becoming a real focal point of every lecture. It's getting to the point where some lectures are entirely built around them. The notes are there and you get the notes, you get a skeleton on paper, you get the online notes - but that's not what we use the lecture time for. So that's really changed. We had this first year of getting comfortable with the technology and seeing how it felt to use it for us and for them, and then this year is the second year that we've had it and that's really become a very solid part of what we do in the lectures."* In that sense, the Course Organiser seemed to indicate he believed that the use of this particular technology necessitated some deliberate rethinking of the way in which content is delivered. However, this does not necessarily imply that the use of technology also prompted a review of what was to be taught in the course. Discussions with the Course Organiser did reveal that there had been some shift in what is taught, specifically in the laboratory sessions, but this had been driven primarily by the provision of newer, more flexible teaching spaces, rather than by the introduction of technology.

6.2.2 Resourcing educational interventions

The department seemed to have little difficulty in securing the physical resources it required to implement the desired teaching innovations, and had sufficient manpower and expertise to develop in-house tailor-made technical solutions as and when needed, such as the online learning environment, when available resources did not fully meet its needs. However, the Course Organiser alluded to a disconnect between the premise of the Teaching and Learning Strategy, with its focus on what goes on in the classroom, and the legacy of hundreds of years of tradition which places the emphasis on the research activities of departments and their staff, and indeed with the funding which is available to directly support teaching staff themselves; "*at the moment there's very, very little in terms of recognition and reward – but I think the college would be the first to recognise that.*" He commented that considerable progress had been made in the light of the recent UK-wide pay and reward modernization so that there would be scope for more emphasis to be placed on the teaching activities of academics. However, he still felt that at this time there was very little in terms of recognition or reward for staff who became deeply involved in the teaching and learning of their institution.

Several of the innovations that were implemented in Course A were supported through a major renovation of some teaching spaces in the main university campus. Three small tutorial rooms were converted into a single, large open-plan studio designed to seat around 100 students in groups of six, which the department now uses for a series of workshops. These workshops work in tandem with laboratory sessions to help students develop their problem-solving and group work skills. In the same building, every lecture theatre has been refurbished and fitted with the new student response systems which play a central role in the course – it is clear that the design of the department's courses has had a wider impact on the way teaching and learning is "delivered" across the institution, a sentiment echoed by Course Organiser A, who commented "*The teaching format… has actually driven some changes in the way that the*

University thinks about space and teaching space." It is also interesting to note that the teaching staff reported unanimously that the availability of these new teaching spaces is having a direct influence on what is taught in the course; "*Now we've got more space we can reintroduce some redesigned experiments into the workshop sessions*." The provision of an appropriate environment has resulted in the introduction of some up-to-date activities which would previously have been impossible to stage, and these new experiments utilise technologies such as webcams in ways which are focused on improving teaching and learning according to the adopted Principles.

6.2.3 Professional development

The bias towards research activities over teaching and learning observed by the Course Organiser will inevitably have an impact on the emphasis placed on providing professional development in that area. Indeed, conversations with the Course Organiser implied that this kind of professional development was not yet seen as a priority. However, he did comment that in line with a changing approach to promotions within the department, such professional development may become more important in terms of career advancement; "*the culture always used to be you sit in your office and wait for the knock on the door and it's the head of department who says "I think it's time you put yourself forward for promotion!" It's not like that anymore – it's about whether you are doing activities that map onto a certain grade which is now fixed and standardized, and it's all self-nominating now, so in principle anyone can put themselves forward for regarding (they're still calling it promotion but effectively it's regarding) and the head of school, or the head of department has no sort of value judgment or ranking of candidates like they used to. It's simply a case of "This is what I do, does it match this scale or this scale," so that will change things, but you know these things take a little time.*"

It is perhaps also worth noting that the teaching staff did not come down heavily on the side of a clear need for such training to be provided, and this may well simply be because they have been on the leading edge of using such tools and therefore come to the table with a higher degree of experience than may be the case elsewhere; "*We'd been doing quite a bit like that within this course for a number of years actually – starting back when I joined the university at the end of 1999 it was already a fairly well developed blended learning course.*"

6.2.4 Choice of technology

The discussions on the rationale for the use of particular technologies in Course A revealed that the Course Organiser felt that the chosen tools were implemented for very clear and carefully thought-out reasons, and it was implied that the purpose of each technology used was also obvious, at least to the teaching staff. Indeed, there seem to be few, if any, concerns about the use of such tools among the teaching staff – which may have been an indicator that the teachers themselves feel that their use was worthwhile.

The Course Organiser was also confident that the technology was more *transparent* (its purpose was clear and its use did not get in the way of the educational objectives) than previous tools. He illustrated this by referring to the introduction of the student response system (clickers) into the lectures. As mentioned previously, the Course A staff had used a coloured card-based student polling system for a number of years, whereby student responses to questions asked from the front could be gauged *en masse* by the lecturer. However, the use of this system had a drawback, in that the lack of anonymity meant that students tended to view the responses made by others and possibly change their own response accordingly. The Course Organiser explained the visible benefits of the new system in terms of the transparency of the medium; "*There are obvious benefits to the technology for us and for the students. For us, we get, you know, data captured that we can then go and analyse. For the students, they get, aside from the novelty value, the anonymity as well. So they no* *longer have to feel self-conscious about potentially being the only one to wave the wrong coloured card. And that's important, because we used to see that with the cards. We used to see people looking down the rows and changing their mind."*

6.2.5 Summary: Foundations and Institutional Transformations in Course A

The design and implementation of Course A as a Vanguard course had, from the perspective of the teaching staff involved, many of the Foundations necessary for transformation to occur already in place, and there have been some observable effects reported in the area of Institutional Transformations. The staff felt that very precise steps were, and continue to be taken, to evaluate the educational impact and added value of each potential innovation, and the foundations of both the Principles themselves and the pre-existing focus on Mazur's Peer Instruction have provided a consistent direction for innovation which seems to have been a direct result of a rationale not just proposed or stated, but embraced by those involved. This has also resulted in the selection of technologies that have a clear purpose.

Such a deep-rooted change was not claimed so enthusiastically with regards to time and resources. The operation of this course and others appears to depend largely on the commitment of staff who are willing to devote considerable time and effort above and beyond what may otherwise be required from those delivering more traditional courses. The Course Organiser recognised that the School has a skilled technical team that has been able to create resources that are ideal for its specific situation and that funding for such projects has been available from the greater institution. However, the absence of compensation and reward for dedication to the teaching side of any university as opposed to research seemed to be an issue.

The existence of tangible, and considerable, renovation work on the campus that can be taken advantage of by the course is, at first glance, fortuitous. However, although the existence of “Vanguard” courses cannot be credited as being the sole motivation for such investment, the Course Organiser was convinced that the course, and the School’s whole approach to teaching and learning, has had a direct impact on the way the renovations have taken shape. He felt that t he correlation between the teaching styles employed and the design and equipping of the new teaching spaces reflects the fundamental change in thinking that is being stimulated by these innovations in teaching and learning, and in particular, those which are built on the use of technology. These perspectives, and how they relate to both the Foundations for Transformation and the Institutional Transformations that may or may not have occurred are summarised in Table 6-1 below and Table 6-2 (overleaf);

Foundations for Transformation		**Teaching Staff Perspectives**		
		Evident	**Possible**	**Not Evident**
F1 – The presence of a clear rationale	*Has the introduction of technology been driven by an explicit rationale?*	**X**		
	Has the decision to implement technology influenced how the course or intervention is planned?		**X**	
	Has the use of technology prompted a review of what is taught?			**X**
F2	*Are those involved in the innovation willing participants?*	**X**		
F3 – The provision of sufficient resources	*Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?*			**X**
	Are new teaching spaces technology-friendly?	**X**		
F4 – The opportunity for professional development	*Has the introduction of new technologies been accompanied by appropriate training?*			**X**
	Are educators both confident and competent in the use of the chosen technology?	**X**		

F5 – Ease of use and clarity of purpose	*Is the educational purpose of the technology clear to teachers and students?*	X		
	Can students easily connect the use of the technology to specific educational goals?	X		

Table 6-1: Summary of the Foundations for Transformation reported in Course A

Institutional Transformations		Teaching Staff Perspectives		
		Evident	**Possible**	**Not Evident**
I1 – Planning educational interventions	*Has the desire to introduce new technologies led the institution to explore explicit rationales for its use?*		X	
	Has the decision to implement technology influenced how the course or intervention is planned?		X	
	Has the use of technology prompted a review of what is taught?			X
I2 – Resourcing educational interventions	*Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?*			X
	Is the use of technology resulting in existing spaces being used differently or driving a need for alternative teaching spaces? Are new teaching spaces technology-oriented?		X	
I3 – Professional Development	*Has the introduction of new technologies led to a new focus on professional development?*			X
	Are educators becoming more confident and competent in the use of the chosen technology?	X		

Table 6-2: Summary of the types of Institutional Transformation reported in Course A

6.3 Material Transformations in Course A

6.3.1 M1 – Efficiency of course delivery

It is interesting to note that improving efficiency was never stated as an objective of the technological innovations introduced into the course. Indeed, in the narrowest definition of the word, introducing changes simply to save time or even money would not seem to fit with the clear ethos permeating the development process. However, the conversations with Course Organiser indicated that he felt that the implementation of technology had resulted in an increase in efficiency in a number of ways, both inside and outside the lecture hall. The Course Organiser reported that the transition from using coloured cards to the electronic clicker system streamlined the process of asking questions and interpreting student responses in class; "*The technology changes and certainly the handsets make it a lot faster, a lot better, feedback's instant, you know I don't have to look at the class and say, well, that's about 30% red and 40%... the students can see that immediately*." Building an online presence for the course had, according to the Course Organiser, also enabled the different teaching staff involved in delivering the course to work towards a more coherent approach. "*What we've sought to create is something where you can have a single golden copy of your material, because a lot of these courses are taught by 3 or 4 or 5 people, so it's no use me having my notes on my laptop and someone else has theirs in a different style – it all begins to look very jumbled and incoherent then to the students, so we wanted a single source that we could then deploy in any number of different outputs to the students.*"

The Course Organiser also indicated that the uses of technology employed in the course have begun to enable the teaching to move away from "mere" delivery of content so that the available time could be used more effectively. This appeared to be both an intentional objective and one that is entirely in keeping with the teaching and learning strategy. Students are now provided with a basic set of notes online, and this in turn has allowed more use to be made of the clickers; "*these PRS questions, are now becoming, you know, they're a real focal point of every lecture. It's getting to the point where some lectures are entirely built around.... - the notes are there and you get the notes, you get a skeleton on paper, you get the online notes - but that's not what we use the lecture time for,*" states Course Organiser A. Instead, traditional lecture time was reportedly used for providing explanations and checking understanding through question sessions known as “Time-to-Thinks”. In addition, the Course Organiser stated that the new interactive atmosphere of these sessions appears to have encouraged students to use this time to *ask* questions and clarify concepts; “*we only see any one person in the class for six hours a week, and that’s a lot less than the notional average amount of time that you’re meant to spend on a particular course in first year. I know they’ll differ widely for students of different abilities, but I think one of the key things for us was to try and address that.*” It is worth noting that as a body, the teaching staff of Course A did not describe the course in quite such progressive terms, with 4 out of 6 reporting “no noticeable change” in the time spent delivering content in lectures. This may reflect the fact that previous iterations of the course also had interactive elements, making any differences appear less dramatic than may otherwise appear from the Course Organiser’s perspective.

6.3.2 M2 - Variety of means of engagement with subject matter

Conversations with the Course Organisers in general revealed an interesting dichotomy in the challenges posed by constructing a course in line with the stated Principles. On the one hand, they realized, for courses such as this one that may be delivered by 3, 4 or even 5 members of staff, they saw a need to develop a unified approach so that students were not on the receiving end of material that might begin to look “*jumbled and incoherent.*” On the other hand, the organisers were acutely aware of the diverse nature of the incoming students and the resulting variation in learning styles (Chickering & Ehrmann, 1996; Chickering & Gamson, 1987; N. Fleming, and Baume, D., 2006). As already mentioned, Course Organiser A explained that; “*We wanted a single source that we could then deploy in any number of different outputs to the students*.” He went on to outline the educational needs that guided their thinking in this respect; “*what might we typically want to give them as learning materials? Well, we want to give them paper notes or handouts, we would want to be able to put those notes and additional material online for them, sometimes using the power of the online* *environment to do things that you couldn't do on paper, like simulations or videos or applets and stuff like that.*" The development of the bespoke online system has allowed them to do just that through the provision of supporting materials using a range of media. "*It's richly interactive… these elements that allow different students to take different routes through the material.*" Hence Course Organiser A believed that the introduction of appropriate technology has provided students with a variety of means of engagement with the subject matter not possible before, and in this he has the overwhelming agreement of all the teaching staff involved in the course.

It seems that providing students with an increased variety of means of engagement with subject matter was an intentional move on the part of the staff and, in particular, the Course Organiser. He also stated that he was keen to stay focused on how this range of materials could then be used. "*We are always trying to hang on to this principle that what we're trying to do is support the face-to-face teaching and get the best out of the online environment rather than simply say 'it's all online, just go and study it!'*" He went on to express the opinion that to make the most of these opportunities, the resources need to be carefully planned and reviewed on an ongoing basis so that they don't just duplicate what is already available but take advantage of the media to enable students to make the best use of these opportunities to engage. "*There's things built in there that allow extra depth in line, so that the page actually expands and there's more detail, and there's also these offshoots that go off the beaten track.*" However, Course Organiser A also had some reservations about the subject's provision of these resources, implying that the course has not yet reached a point where he feels that a balance has been reached that benefits the students in a way that meets the course staff's aspirations; "*I think the one thing that I would say about all the support material we provide for students is we maybe make it a little bit too easy for them to find the information and … so it's all there for them.*"

6.3.3 M3 - Content and assessment

In the section ***Resourcing educational interventions***, we have already discussed the Course Organiser's belief that the provision of new, technology-oriented teaching spaces led to the development of some newly redesigned workshop sessions to replace existing laboratory sessions; "*the labs just weren't working – they'd not been revised for 20 years, they were deeply unpopular - students just perceived them as a complete waste of time...*" Experiments that were deemed to have little value due to their mundane nature and archaic skill set and which were demanding of precious space have been reintroduced as a group activity. The Course Organiser felt that the careful use of technology in the new space has allowed the content to be brought up to date and made relevant to today's students. In addition, he was also convinced that the integration of the student response system into the infrastructure of the rooms has led to its frequent use and adoption into the fabric of the teaching of the course. Although there is little to suggest that this has impacted *what* is taught, there is the suggestion that the use of these tools may have reached the stage of challenging what may be taught in the future. "*It prompts us to think more deeply about what we do and how we do it.*" Hence, the Course Organiser reported that although the way subject material is dealt with has changed fundamentally, at this stage any change in the subject matter itself has been limited. "*Not much has changed, okay, you do this a bit different and what you do in the workshops is a bit different and lectures might be a bit different, but I think if you had the perspective across say three or more years, then you would see a gradual evolution, I think, across all aspects of the course, the lectures, the workshops and the way the material is presented, not so much in the actual content, a lot of that stays fixed and we sort of perturb it round the edges.*"

Another point of focus in the development of the course has been assessment. "*We wanted to introduce peer assessment, where students would actually mark one of each other's assignments.*" This peer assessment was piloted and is now part of the course. In addition, elements of the end of year examinations have been re-thought in an effort to give students more of an opportunity to express and gain credit for what they know; "*I was concerned that the MCQs didn't give them the opportunity to get partial credit for partially correct reasoning. I saw this when I was talking to them – going through their papers, and they'd say "yeah, I got to that point, but then I chose the wrong answer," and the reasoning and thought processes were correct up to a point and yet they still got minus half a mark or something. So, what we did was we changed that component of the exam and made short answer questions built from the stems of the MCQs … now they were short answer questions worth 5 marks, and the huge improvement on pass rate is almost exclusively down to a huge improvement on that section.*" The Course Organiser emphasised that the driving force behind these changes was the core set of principles in the Learning and Teaching Strategy. However, it is also interesting to note that technology did not appear to play a major role in assessment outside the informal formative assessment provided by the use of the clicker system during lectures. Hence, from the Course Organiser's perspective, the technologies used in the course did not seem to be a driver for the changes taking place in the way the course is assessed.

6.3.4 Summary: Material Transformations in Course A

More often than not, the transformations we first look for in a course upon the introduction of any kind of innovation are Material Transformations – those that are visible in the content and its presentation – the fabric of the course itself (MacKeogh & Fox, 2008; Pearce et al., 2011). The Course Organiser felt that the very deliberate move to use technology to re-allocate many mundane aspects of traditional course delivery, particularly the giving of notes, to a time and place outside the limited contact time with staff did seem to have produced a shift in the way this contact time is used and is viewed by the students, as was evidenced by their new willingness to interrupt and ask questions despite the large class size. It is also interesting to note the Course Organiser felt that the shift may also have begun to be evident in the *mindset* of those who conduct the “lectures” and who continued to develop and improve the ways in which they used the available time and the technology.

There was also some indication that considerable effort had been made to utilise technology to provide as many different points of access to, and routes through, the teaching material developed for the course. A wide variety of materials and means of engagement were available and the students were encouraged to use these resources. However, the Course Organiser admitted that this was an evolving and rather inexact process. While most learning styles were catered for at various points throughout the course, the choice was not infinite and the development is influenced at least as much by the content as by the expected learning style and varies from topic to topic. The Course Organiser was confident that as the course continues to evolve, so will the use of the wide range of media available so that a balance between providing for different learning styles while avoiding the feeling of spoon-feeding students.

The course, although evolving, was relatively young in its present state and the teaching spaces, and the integral technology, were available for the first time in the 2006-2007 year. However, the Course Organiser believed that the impact of building the course in this context was demonstrated by the introduction of the workshop scenarios to support laboratory work. He felt that small steps had been taken in this direction prompted directly by the availability and use of the new teaching tools, and the potential exists to use the new-found freedom provided by the available means of engagement and the technology-equipped teaching spaces to review and expand what is being taught, and perhaps even to introduce content which has been inaccessible in the past. There was no such feeling that there was much potential for such change in how the course is assessed. This may be partly due to the constraints placed by the exam structure of the institution and partly due to the nature of the chosen technologies and where their affordances lie. However, it has also been a conscious choice (or non-choice) of the Course Organisers based yet again on their guiding principles. Any changes made in assessment were consistent with the principles, but the Course Organiser found it difficult to see how existing technologies could contribute anything else at this time. We can summarise these perspectives on Material Transformations in Course A as shown in Table 6-3 overleaf;

Material Transformations		Teaching Staff Perspectives		
		Evident	Emerging	Not Evident
M1 – Efficiency of course delivery	*Has it improved efficiency of course delivery? i.e. Has it increased the amount of time available for activities other than delivery of content?*	X		
M2 – Means of engagement with subject matter	*Has it increased the variety of means of engagement with the material?*	X		
	Does the course take advantage of this?		X	
M3 – content and assessment	*Has it enabled new content to be taught or less useful/redundant material to be removed?*		X	
	Has it altered the way the course is assessed?			X

Table 6-3: Summary of the types of Material Transformation reported in Course A

6.4 Behavioural Transformations in Course A

6.4.1 B1 - Amount and quality of interactions

The interviews revealed that there was an increased awareness of the importance of the interactions which take place within the context of the course both student-student and student teacher. Indeed, care was taken in the development of the in-house learning environment to include the now ubiquitous discussion forum that gives students the ability to interact asynchronously online with each other and with staff. However, the Course Organiser reported that other methods of interaction have been given more prominence in the course as they have been deemed more useful, as always, when viewed in the light of the teaching and learning strategy and the ethos of the Course Organisers. He highlighted the use of the student response systems as perhaps the most deliberate innovation aimed specifically at improving the interactions which occur between the teacher and the students during the lecture time, despite the fact that the department has been encouraging its students to respond en masse in lectures for many years using a simple system of coloured cards. He noted that the presence of the technology as part of the infrastructure seems to have liberated students to some extent in the context of lectures; "*They no longer have to feel self-conscious about potentially being the only one to wave the wrong coloured card.*" This is turn seems to have prompted teachers to give these interactions an expanded role and to allow the path of the lectures to be flexible enough to be guided to a certain degree by these interactions as observed by Course Organiser A. "*Just the feedback we get from them – even the feeling in lectures. I mean, this year – I never encouraged this, or not explicitly anyway, but I would have people from the back of the room calling out questions in the lecture, and they were valid questions, and you know I'd never said "you can stop me any time and just ask questions," because it's quite disorienting actually when someone throws a question at you you've got to think on your feet and it kind of dislocates your flow from what you were thinking about. But I went along with it, and it actually made for a very, very relaxed, enjoyable atmosphere in the lectures.*" The students' attitudes in the lectures as reported by the teaching staff, together with more formal feedback in end of course evaluation sheets, suggest that the students themselves are aware of the increase in student-teacher engagement that has occurred, or are at least aware of the increased scope for such interactions. The Course Organiser was keen to add that efforts have also been made to use technology to provide new opportunities for student-student interaction. Most notable has been the piloted use of wikis – student created and edited sources of online knowledge that introduce a type of interaction that is difficult to replicate without the use of such technology; "*we want to give the students the opportunity to take the lecture notes and collectively as a group edit them.*" Students were also given the opportunity to use a wiki to work on past exam papers and they were encouraged to collaborate in developing solutions to questions online.

6.4.2 B2 - Paedagogy

It is difficult to discuss the kind of changes that have been implemented as a result of the course becoming *Vanguard* without reference to the effect that those changes may or may not have had on the way the subject is taught. Indeed, it is clear from the interviews with Course Organiser A that he felt that the approach or approaches taken in delivering the course were open to change should there be an obvious educational reason for doing so, and that from his perspective there were observable changes in the paedagogy used within the course. As an example he pointed to an increasing emphasis on peer involvement in assessment; "*we've got to the point now with this course where we are not afraid to experiment within it, you know, so, we have these ideas – for example what we wanted to introduce last year - we wanted to introduce peer assessment, where students would actually mark one of each of each other's assignments.*" Although there is no connection claimed or otherwise between this and the use of technology in the course, the Course Organiser was convinced that technology (in the form of the clickers) has played a direct role as the teaching staff seek to put Mazur's Peer Instruction method (Mazur, 1997) into practice in their lectures. "*We had this first year of getting comfortable with the technology and seeing how it felt to use it for us and for them, and then this year is the second year that we've had it and that's really become a very solid part of what we do in the lectures.*" In addition to facilitating this kind of instruction, Course Organiser A recognised that although there are many factors at work, the technology in this case could not be discounted as a possible driver of such paedagogical shifts; "*it prompts us to think more deeply about what we do and how we do it… whether it is the technology which is actually enabling that, so I guess they're pretty tightly linked.*" Hence in the eyes of the Course Organiser, there was some evidence to suggest that the technological tools being used in the course are playing their part in supporting and enabling paedagogical change.

6.4.3 B3 - Student responsibility

A key focus of the Principles which emerge from the Teaching and Learning Strategy is to "*ensure that they are given, and feel, a genuine responsibility for their own learning, seeing rewards and benefits from effectively managing their activities, and negative consequences from failing to do so*." The increased engagement and interaction which had been reported by the Course Organiser and the teaching staff was potentially an outworking of the kind of responsibility that is required – a student who has difficulty with a particular concept being dealt with in class has a choice – take responsibility for their own learning by speaking up and seeking clarification, or avoid the issue by remaining silent. The Course Organiser was convinced that the former was becoming increasingly common and that this was an indicator that the changes that have been made are beginning to have an impact on this area. Indeed, in line with the Teaching and Learning Strategy, enabling students to take responsibility for their own learning has been an explicit focus of the Course Organiser as he has developed the course; "*one of the main things we were trying to do was increase student responsibility for what they were doing, you know, to get them to take greater control over their learning and to manage it more effectively. Because we'd gone to a lot of effort to create a support structure and materials and teaching activities which we thought were well aligned with what the course was trying to do, but at the end of the day they have to engage with that, be persuaded to engage with it and be persuaded to engage with it outside the face to face contact from the class as well.*" However, teachers of the course also reported the usual list of contra-indicators and the not unsurprising existence (particularly considering the intake) of a broad spectrum of student attitudes, approaches and attainment. In addition, it appears that there is also a feeling that each tranche of incoming students is perhaps *less* prepared than their predecessors to take responsibility in the way that is required; "*I do see a change in the preparedness and the attitude of students coming in… a sort of gradual decline in, if you like, the level of responsibility that students are willing to assume when they come in on day one.*"

6.4.4 B4 - Knowledge and understanding of subject matter

Evidence of transformation in this area is, of course, difficult to observe and even more difficult to attribute to a particular factor or intervention. Anecdotal evidence of stronger-than-usual student engagement and interaction was again cited by the Course Organiser in connection with this area as an indication of a more positive *approach* to learning, but he admitted that it was difficult to connect directly to the level of knowledge or understanding. "*It's very, very difficult to evidence that – it's really difficult. The only instrument we've got is the end of course exam, and, you know, the cohorts change each year, so it's not necessarily an exact comparison from one year to the next.*" Course Organiser A acknowledged that although exam performances are perhaps the most measurable, if hotly debated, indicator of knowledge and understanding, there are difficulties in reading too much into such data; "*there's tremendous variation in things that you have absolutely no control over, like cohorts are different from one year to the next. There is this sort of idea of, you get a good year and you also get less good years as well, and they can have bigger inherent impacts than the thing you're trying to measure sometimes. It's very hard to try and quantify that.*" However, despite these qualifications and the very real possibility of outside factors having at least as great an impact on exam results as any Vanguard-related change, the Course Organiser still felt confident enough to make a bold statement: "*I think we demonstrated pretty clearly that the change we made [in assessment], along with the other improvements to the course, had a huge impact on their learning and understanding, and so we can even quote that the pass rate for the course went up from 75% to 90%.*" The exam data for this and the other subjects is analysed in more detail in Chapter 7.

6.4.5 Summary: Behavioural Transformations in Course A

It is clear that from the Course Organiser's perspective, the technological innovations implemented in this course lend themselves to the facilitation and support of both student-teacher and student-student interaction, and have been used to highly transformative effect in this area. He was confident that the improvements that have been cited in the course can be directly associated with the application of these technologies, and felt that the increased uptake by staff, together with the availability of instant feedback (over and above the visual estimation based on the simple coloured-card system) that is visible to student and teacher alike vindicates the unique nature of the student response system and the impact it is having in this context. Similarly, the Course Organiser cited some wiki-based projects as examples of how technology was enabling students, distributed in space and time, to interact in ways not possible before, reflecting that such interactions have also been designed around meaningful tasks which are beneficial to the entire group and which are difficult to envisage being possible with other modalities.

While he acknowledged that the existence of increased student-teacher interactions is at least a precursor to students taking full responsibility for their own learning, the Course Organiser and his staff reported little other evidence to support the idea that transformation in this area was in progress. They pointed out that changes in students attitudes and behaviours may be slow to materialize as at their most extreme they may effectively reflect the change of habits of a lifetime and the development of brand new skills, particularly when this may be the only course of its kind which students are taking, and he expressed confidence that there was potential for the course in its existing form to nurture and support students in this direction. However, the Course Organiser stopped short of saying that the technology as it is currently implemented is or will be responsible for existing student attitudes or any dramatic change of student attitudes in this respect.

From the comments of the Course Organiser and teaching staff, the use of the specific technological tools chosen by the course has certainly accompanied an evolution in the methods of instruction used. The "chicken and egg" conundrum applies here as the Course Organiser admitted that he is not particularly clear whether the paedagogy leads to the use of the technology or vice versa. However, he was convinced that they are closely linked and it is also clear that the technology makes the use of more constructivist teaching methods such as Mazur's Peer Instruction Method easier to put into practice.

Similarly, the Course Organiser felt that the non-trivial increase in pass rate cannot simply be ignored as a reflection that there has been some impact on the level of knowledge and understanding of the subject in the class when compared to previous years. The Course Organiser cited the range of innovations as having an impact on this but also described a significant change in the way one of the final exam papers was marked. Previous versions of this paper had been fully multiple choice and had been marked by computer. For this course, students were for the first time given credit for "working out" and partial answers (rather than an all-or-nothing approach), which necessitated a move away from computer-based testing. The resulting improvement in scores from this change alone may be significant, rendering it difficult to say if other factors also contributed to the increase in this years' pass rate. Hence, although improvement has been detected, neither the teaching staff nor the Course Organiser concluded that there was much in the way of evidence that the implementation of any of the technological innovations applied to this course have had any transformative effects in this area. These conclusions are summarised in Table 6-4 (overleaf);

Behavioural Transformations		Teaching Staff Perspectives		
		Evident	**Emerging**	**Not Evident**
B1 – Amount and quality of interactions	*Has it increased the amount and quality of teacher-student and student-student interaction?*	X		
B2 - Paedagogy	*Has the introduction of particular technologies forced, inspired, enabled or otherwise caused a shift in teaching styles and approaches?*		X	
B3 – Student Responsibility	*Does the implementation enable the student to take more responsibility for his or her own learning?*		X	
B4 – Knowledge and Understanding of Subject Matter	*Has it facilitated a comparative increase in knowledge and understanding of the subject matter?*			X

Table 6-4: Summary of the types of Behavioural Transformation reported in Course A

6.5 Foundations and Institutional Transformations in Course B

6.5.1 Rationales and planning educational interventions

Discussions with the Course Organiser yielded two interesting facts about the reasons and rationale behind the decision to become a "Vanguard" course and the use of particular technological innovations to support teaching and learning. First, it is clear that the Course Organiser (who did not deliver any of the lecture blocks but was involved in both the practical sessions and the workshops throughout the course), together with most of the teaching team, was sympathetic to the principles outlined in the new Learning and Teaching Strategy, and shared the same desire to improve the student experience. However, the Course Organiser stated that this alignment could best be described as "*passive*" – acquiescence rather than cheerleading, explaining, "*my idea was to make the change evolutionary, rather than revolutionary.*" Hence, any innovations were viewed very much as experimental, and were not presented as central to the course. There appear to be several reasons for this – some members of staff who were reluctant to change lectures they had been delivering for a number of years, and previous difficulties with technological implementations, had generated an unwillingness to commit to changes where the necessary investment of time may not yield immediate and obvious benefits or rewards. The Course Organiser saw the shift to Vanguard as a vehicle for "*driving change… for example convincing people that we want to try the clicker system.*"

Despite the cautious approach and the allusion to possible obstacles as outlined above, the Course Organiser was clear that the choice of technology (the use of "clickers" in lectures") had been thought out and there were some positive expectations on the part of the Course Organiser both in terms of increasing student engagement during lectures and in encouraging students to take responsibility for their own learning; "*I think PRS fits perfectly with the Vanguard because it allows them to check that they're following and understanding, so they're taking responsibility for their learning during the lecture, and they're engaging during the lecture.*" Hence, although the rationale was perhaps not as explicit as with Course A, the Course Organiser felt that there was an emerging justification for use that fitted well with the "Vanguard" principles.

It seems that, just as the actual introduction of technology into the course has been intentionally non-disruptive, so the Course Organiser has a similarly cautious approach to allowing the use of such tools drive any change in the plans for the course. The structure of lectures has kept to the traditional mode of focusing on content delivery with no specific focus on using the "clickers". However, the Course Organiser did recognise that the use of these clickers may necessarily have an impact on what happens in the lectures if they are to be used to their full effect, but was in no hurry to review current practice or to plan for those changes; "*I think it might change, but I think it might take a while before its changing, in this particular course anyway.*" However, despite this cautious approach, there are clear expectations that the technology *could*, with appropriate input from the staff involved, have an impact on course planning and even prompt a review of what was delivered during lectures; "*for everybody to make full use of the clickers they need to do what the [Course A] guys are doing which is provide the students with alternative ways of getting involved in the content. So if we're going to decrease the amount of material we present in a lecture then we've got to allow them to go off and learn by themselves, so more detailed reading lists and things we can give them or we can put information on the website.*"

6.5.2 Resourcing educational interventions

The Course Organiser voiced an almost instinctive feeling that any major change to the course to support the Learning and Teaching Strategy would have a significant time cost for those involved. For that reason, he felt that "*staff are reluctant to get involved… everyone's 100% committed [in terms of time]… you'll only get them to sign up if they think they're going to save time by doing it.*" Hence, in the Course Organiser's eyes, unless an innovation visibly saves time, it may go largely unsupported by those who are expected to implement it. However, there was no assumption of the need for a corresponding increase in the time provided for those involved, at least at the level of Course Organiser. Instead, contrary to the pervading suspicions of the staff involved, the Course Organiser assumed the innovations to be time-neutral, requiring no more commitment than other styles of course; "*I don't think it would necessarily be more demanding of time – I think some of the first year staff, a lot of it is fairly basic so it's introducing people to the rudiments which doesn't change very much year on year, so people are giving the same lecture as they might have been giving – some of the people have been on the course quite a long time, so they may be ten-year-old lectures, so there's not very much work. It's not like maybe third year or fourth year where you completely rewrite the thing to update it. So, because of the nature* *of the material I suspect that it shouldn't, probably, make things more difficult.*" Hence there was little feeling on the part of the Course Organiser that there was any need to provide additional resources or time to enable teaching staff to make the best use of the available technologies.

Finally, It is perhaps interesting to note that although the course takes advantage of the new teaching spaces that have been designed to facilitate the use of such technologies, the Course Organiser made little mention of the impact of such spaces on the course or on the use of the technology, while only one member of the course staff felt that it was important that the teaching spaces were appropriately equipped to support the use of technology.

6.5.3 Professional development

As already mentioned above, the Course Organiser did not see any particular challenge in the introduction of the chosen technologies into the course, and his comments implied that not only should there be little overhead in terms of time but there should also be little need for staff to receive any significant training in the use of the technology. These opinions were similar to those discussed in Course A – in that case, they were founded at least partly in the confidence the Course Organiser placed in the ability of the teaching staff to use the technology successfully without any such training. However, it appears that the Course Organiser of Course B did not yet feel that his teaching staff had reached this level of confidence with the clickers in particular. Comparing the use of the clickers in his own subject with that in Course A, he observed; "*I went to one of his lectures last year just to see how it kind of worked and they've got it really well worked out so that if the students respond in one way then his lecture will go off in one direction, while if they respond in another way he'll go off in another direction, and we don't really have folk – I mean, we might ultimately get to that kind of level but we're not really there yet – it's not easy with this kind of course.*" However, the Course Organiser does not seem to see the provision of professional development as a practical solution to this, although the specific reasons for this are unclear.

6.5.4 Choice of technology

The evolutionary approach taken by the Course Organiser to the shift to Vanguard status for the course, combined with his expressed desire to use *Vanguard* to encourage change in a possibly reticent group of teaching staff, seems to have led to some unintended consequences in how the technology was received and viewed by those involved. For example, the Course Organiser reported that he initially chose to "test" the clickers for the first year of the course. However, instead of reducing the potential disruption caused by introducing such a tool into a course, this decision appears to have frustrated students and perhaps even obscured the purpose of using the tool in the first instance. "*The only difference I made this year was to "sell" the PRS system to them in a different way – last year, I said "this is an experiment and we're trying it out" which wasn't a good idea – they were unhappy about being used as guinea pigs and they didn't see that they were getting any value from it.*" It is clear that Course Organiser B viewed this frustration and loss of focus as a threat to the success of the technology in the course, and he has taken steps to bring the purpose front and centre of the students' awareness; "*this year I've tried to convince them that this is really for their benefit and they really gain from it.*"

Taking this more explicit approach seems to have paid off in the Course Organiser's opinion, at least in terms of reducing student frustration. However, "selling" the technology in the course has not been the only issue. "*There have been ongoing problems with the software and stuff which turns it into a bit of a palaver and that puts people off.*" He shared the view that when any "technology" (and here we could widen any definition to include anything that has moving parts and/or runs on electricity) is used in the classroom, there is always the danger that it will not work, or at least not work as planned. Although the majority of such issues are likely to be both temporary and out of the control of the teaching staff, they will inevitably have an impact on the perceived usefulness of the tool in the eyes of the user, and the existence of the tool in all its imperfection will almost certainly at that time obscure the purpose for which that tool was intended. In that way, software or other technical glitches can rapidly transform a *transparent* tool into a *distraction*. In this case, it is worth noting that such problems obviously occurred frequently enough for the Course Organiser to deem them worth mentioning and to acknowledge that they had an impact on the student experience. Although one cannot read much into it, it is also interesting to consider that there were no technical problems mentioned in relation to Course A. This could be an indication of the relative levels of comfort with the software of the two groups of teaching staff, or it may merely be a measure of the misfortune of the staff of Course B.

6.5.5 Summary: Foundations and Institutional Transformations in Course B

The views expressed by the Course Organiser and his staff indicated that they did not feel that the decision to become a "Vanguard" course within the College of Science and Engineering and the corresponding technological implementations were built on a fully formed foundation or have had any observable transformative effects on the institution and infrastructure in which the course sits. Although sympathetic to the principles in the Learning and teaching Strategy, the Course Organiser felt that the ethos driving its introduction is one of willing compliance rather than revolution. He explained that the technologies were introduced on the basis that they may have some positive effects, and while he expressed the hope that they would become a drive of change, he saw little to suggest that they were currently driving a change in the way the course is planned, structured or delivered. There is a perceived need among some staff for extra time resources to be provided, and yet this perception appears to be obscured at the Course Organiser level, making change in this respect unlikely. The Course Organiser's view of the technology use as initially “experimental” may also have reduced the likelihood of it having any transformative effects on the spaces in which it is taught – indeed, in this case, it was the existence of the PRS-equipped teaching spaces in the refurbished tower block that have led to the adoption of this technology by the course, rather than the nature of the spaces being determined by the innovation.

The Course Organiser recognised that the teaching staff were less comfortable (and therefore less ambitious) with the technology than they might otherwise have been, but as with the issue of time, he did not see the need for the provision of more in the way of staff development or training as a way of improving their use of the technology. He also admits that an overly cautious introduction of the chosen technologies to the students may have caused their purpose and usefulness to have been obscured. Despite a clear effort on the part of the course organise to address this issue, technical problems meant that at times the technology was, in the eyes of the teaching staff at least, more of a hindrance than a help.

The perspectives of the teaching staff as a whole on the presence or otherwise of the Foundations for Transformation and Institutional Transformations are summarised overleaf in Tables 6-5 and 6-6.

Foundations for Transformation		Teaching Staff Perspectives		
		Evident	Emerging	Not Evident
F1 – Planning educational interventions	*Has the introduction of technology been driven by an explicit rationale?*		x	
	Has the decision to implement technology influenced how the course or intervention is planned?			X
	Has the use of technology prompted a review of what is taught?			x
F2 – The presence of willing participants	*Are those involved in the innovation willing participants?*		X	
F3 – The provision of sufficient resources	*Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?*			X
	Are new teaching spaces technology-friendly?	x		
F4 – The opportunity for professional development	*Has the introduction of new technologies been accompanied by appropriate training?*			X
	Are educators both confident and competent in the use of the chosen technology?			X
F5– Ease of use and clarity of purpose	*Is the educational purpose of the technology clear to teachers and students?*		X	
	Can students easily connect the use of the technology to specific educational goals?			X

Table 6-5: Summary of the Foundations for Transformation reported in Course B

Institutional Transformations		Teaching Staff Perspectives		
		Evident	**Emerging**	**Not Evident**
I1 – Planning educational interventions	*Has the desire to introduce new technologies led the institution to explore explicit rationales for its use?*		X	
	Has the decision to implement technology influenced how the course or intervention is planned?			X
	Has the use of technology prompted a review of what is taught?			X
I2 – Resourcing educational interventions	*Is there evidence that the introduction of technology is prompting the institution to rethink its approach to time and other resources?*			X
	Is the use of technology resulting in existing spaces being used differently or driving a need for alternative teaching spaces? Are new teaching spaces technology-oriented?			X
I3 – Professional Development	*Has the introduction of new technologies led to a new focus on professional development?*			X
	Are educators becoming more confident and competent in the use of the chosen technology?			X

Table 6-6: Summary of the types of Institutional Transformation reported in Course B

6.6 Material Transformations in Course B

6.6.1 M1 – Efficiency of course delivery

The preceding discussion highlights the general feeling among the staff of this course that improving efficiency is a desirable, perhaps even necessary, affordance of any innovation if they are to commit to it. The reluctance of staff to get involved seems to reflect the fact that they remain unconvinced that this is a given for any particular implementation. "*In practice that has the potential to save time because you can answer a question once on a discussion board instead of 12 e-mails or something, it also has the potential to be something that if I have* *to look at it every day and interact with it every day as against just seeing students once a week or something – if that's there as a support mechanism, it only works as a support mechanism if someone's answering the queries and so on, and that person's got to commit time to it – that's why staff are reluctant to get involved with it.*" The Course Organiser observed that the use of the clickers in lecture time would require some level of change in how content is presented to students; "*for everybody to make full use of the clickers they need to do what the [Course A] guys are doing which is provide the students with alternative ways of getting involved in the content. So if we're going to decrease the amount of material we present in a lecture then we've got to allow them to go off and learn by themselves, so more detailed reading lists and things we can give them or we can put information on the website.*" Indeed, two of the lecturers reported that there was a noticeable decrease in time spent delivering content through lecturing. However, it seems that although they see what is required to maximize the potential of the clickers in class, he and the teaching staff expressed reluctance to let go of too much of the time needed to deliver the material in its current form. "*If there's a downside, it's that we have to cover a lot of information in Course B – and there's 32 lectures or something, and they're only 50 minutes long, and if you start taking 5 minutes out to have this break in the middle then there's a loss of time to deliver material.*"

6.6.2 M2 - Variety of means of engagement with subject matter

WebCT forms a central part of the course team's approach to teaching and learning. According to the Course Organiser, it was used first and foremost as a repository; "*pretty much everything is on WebCT – everybody uses PowerPoint presentations… so they will put them on after the lecture. All the information from the course books will be reproduced as well. There are tutorial assignments – so it's quite a sophisticated site.*" The teaching staff also used the online environment to supply a resource of questions based on the lecture materials; "*we give them sets of multiple choice questions that we put on the web after each block of lectures and they can use those to practise, to check that that they've* *learnt what they're supposed to learn and then they can use them again to revise.*" The Course Organiser commented that the main motivation for this was to provide students with a range of ways of accessing and engaging with the course content, and the staff felt that students do make use of this facility. Finally, Course Organiser B reiterated that the use of the Student Response System is beginning to provide students with the opportunity to engage in a new way during lecture time. Although he admitted that the use of these resources was still at the experimental stage, he believed that in time a mature structure and purpose behind the use of these tools will evolve within the course. Hence, although he provided much evidence that the variety of means of engagement with the subject matter has increased, and the staff also reported overwhelmingly that they felt that the technology had increased the ways in which students could engage with the content, the Course Organiser's overall perspective was that full advantage has yet to be taken of this increased variety.

6.6.3 M3 - Content and assessment

The pervading experimental nature attributed to the technology which merit this course being able to describe itself as "Vanguard", not surprisingly resulted in a cautious approach on the part of the Course Organiser to changes in the fabric of the course. It must be acknowledged that there is often a close relationship between apparent caution and actual resistance, and here it must be stressed that in the case of those involved with Course B the evidence merely suggests the former rather than the latter; for example, the use of the Student Response System was not even publicised to the students during the first year of use – it was "slipped in" to see what would happen. However, based on that year's experiences, the Course Organiser was keen to point out that the system had been given a more substantial role going forward. Despite this, the Course Organiser stated that the course itself had in reality yielded little from its traditional format. "*I think it has the potential to, but I think it's too early,*" and he observed that "*these big courses have a gigantic momentum, so it's very difficult to change anything – it's difficult to convince people to change things.*" However, he goes on to comment that he feels there are perhaps some signs that it is beginning to make teachers "*think a little bit about how they're delivering and what they're delivering*." Interestingly, those involved in delivering the course seemed to notice a larger degree of change than the Course Organiser reported, with two thirds of the staff feeling that the choice of technology had already begun to influence how the course was being taught.

This is perhaps reflected most in the field of assessment within the course. The staff have gone to some lengths to develop banks of multiple choice questions to be used as formative self-assessment by the students at the end of each lecture block and, at times, during lecture time with the Student Response System. "*The course team drew up a list of 120 things that we think everyone leaving the course should know, and there's a multiple-choice question that tests each of these, and they're in blocks for each of the lectures so we release these onto the WebCT site as a block of MCQs at the end of a block of lectures.*" In addition, the staff has also participated in developing and sharing questions for use with the SRS. "*They* [the teaching staff] *all write their own clicker questions that they ask in lectures, and people put a lot of thought into that… Last year we did that and everyone presented their clicker questions to the rest of the staff and we all got ideas about what we could do for next year*." In this whole area of formative assessment, despite the issue of staff reluctance which he has discussed at some length, the Course Organiser seemed a little more positive; "*the staff are actively involved in trying to use the technology to improve things....*"

The Course Organiser stated that at present, it is left to the students themselves whether or not they make use of this resource on WebCT, and by all accounts the uptake is low, particularly as the course progresses; "*not that many students do it, maybe a quarter of them try the first block, and by the time we get to fifth block it might be only 20 or 30 students, so there's a huge tail-off.*" It seems that the staff remain committed to this aspect and continue to develop questions together with new feedback for incorrect answers for the existing questions to try and encourage use. Despite the emergence of a novel approach to assessment as a learning tool for the student, the Course Organiser reported that this has not been carried forward to summative assessment of the course as a whole, which has remained untouched by the implementation.

6.6.4 Summary: Material Transformations in Course B

"Potential" is a common thread in the Course Organiser's perspectives on many of the facets of Material Transformation in this course. The general feeling surrounding the technological innovations introduced in Course B is that they could have some transformative effects in this area, but it is too early to expect to see such transformations or perhaps even to try to achieve them. Indeed, as things stand, the Course Organiser noted few such effects in terms of the efficiency of the course delivery. Nor did he report any impact on the body of the content which is delivered in the course – those who lecture seem content at present to use the tools to support their current teaching through light use rather than revolutionise it through total integration. However, the Course Organiser and teaching staff did express a determination to move beyond the current status quo, evidenced by the slow but steady progress with the tools at their disposal, as much a reflection of a refusal to go backwards as a reluctance to go forwards, which the Course Organiser considered to be the first green shoots of growth in this area. The staff has not yet begun to change what or how they teach in the light of using the new technologies, but he is confident that they are beginning to consider the possibility. It is interesting to note that the Course Organiser felt that, without the implementation of WebCT and the Student Response System, it may have been less likely that they would have been prompted to think in this way.

It is clear from Course Organiser B's viewpoint that the reasonably full use of WebCT has brought about a definite change in the means of engagement with the subject matter – students have more points of access to the content in different forms than was previously possible before the use of the online environment. However, for this change to be truly transformative, for it to produce deep change in the way students engage with the course content, he acknowledged that the course itself must take full advantage of this variety, and he makes it equally clear that this has not yet happened on a number of fronts. The WebCT environment has yet to be integrated into the day-to-day teaching of the topic, such that the online resources provided move beyond being just a repository for existing materials and begin to make full use of the range of tools available.

The perspectives of the teaching staff as a whole on the presence or otherwise of the Material Transformations in Course B are summarised below in Table 6-7.

Material Transformations		Teaching Staff Perspectives		
		Evident	Emerging	Not Evident
M1 – Efficiency of course delivery	*Has it improved efficiency of course delivery? i.e. has it increased the amount of time available for activities other than delivery of content?*			X
M2 – Means of engagement with subject matter	*Has it increased the variety of means of engagement with the material?*	X		
	Does the course take advantage of this?		X	
M3 – content and assessment	*Has it enabled new content to be taught or less useful/redundant material to be removed?*			X
	Has it altered the way the course is assessed?		X	

Table 6-7: Summary of the types of Material Transformation reported in Course B

6.7 Behavioural Transformations in Course B

6.7.1 B1 - Amount and quality of interactions

Although it is perhaps fair to say that the amount and quality of interactions in the course weren't necessarily a priority for Course Organiser B, much of the technology implemented in the course, and the uses to which it has been put this time around, has been aimed directly at enabling students to interact with each other, the staff and the subject matter. The Course Organiser highlighted one particular use of the discussion forum on WebCT that seems to have been given particular thought. Instead of being used as a "traditional" bulletin board, the Course Organiser described how students were set a task on which they were expected to collaborate with each other online. "*We do an assessed problem*," explained Course Organiser B, "*which is sort of a long problem… which they get 3 or 4 weeks to work on in the middle of the semester. What we do is encourage them, instead of mailing staff with questions, to post questions onto the discussion board, then very often other students will answer them, so you get a discussion going. If it doesn't, there's a staff member monitoring it and they can chip in to the discussion.*" This appears to have been a reasonably successful exercise. However, Course Organiser B reported that analysis of the online activity revealed that in reality, very few students actually post, while the majority log in from time to time to observe what is going on, raising the question of how interactions experienced by the students have actually been impacted.

In a similar vein, he felt that the Student Response System can provide opportunities for students to contribute to the lecture scenario. "*I guess the advantage of the clicker thing over the cards is anonymity – some of the students are a bit shy at volunteering opinions if they think their neighbours can see – they don't want to look foolish in front of their friends.*" The Course Organiser seemed to be convinced that the technology is very much an enabler in this respect; "*the* *technology does allow us to introduce this type of interaction with the audience in a way that we probably wouldn't have done any other way.*" The course lecturers unanimously reported that they felt that interactions within the course had increased. From the students' perspective, it is interesting to note that, according to the Course Organiser, they have had little to say about any changes or improvements in their opportunities to interact, and they appear unexcited at the opportunity to interact online. "*And that's not technophobia, because they're all on Facebook and all these other kinds of things. WebCT is a little bit more difficult to use than them but it's not that much more really. They use Facebook because they feel they get more out of it.*" Course Organiser B put it down, at least partly, to the more general nature of the cohort taking the course each year. "*I think so long as we keep teaching these extraordinarily large first year courses with a very diverse range of students in them for different reasons that we're going to keep facing these problems. And I'm not sure that there is a technological solution to it. We can make these things available to them, but it does create work for us and I'm not utterly convinced of the benefit to the students.*"

6.7.2 B2 - Paedagogy

The Course Organiser's comments regarding the effects of the implementation of the new technologies on the way the course was taught were focused largely on the *potential* of the tools to enable and even drive such change. "*I think the positive things are that it will really get the lecturers thinking about the stuff they're delivering and how they're delivering it.*" In particular, he sees the major opportunity for his course lying in the design and use of questions for the clickers, and the possibility of a radical shift in the nature of face-to-face class time if this potential is realized; "*if the students get used to this as a way doing things, that in ten years time or something then what we'll be doing is instead of having a lecture where I stand up and drone on for an hour and then, some of which they absorb and some of which they don't, you give them some reading, so the week before or at the beginning of the course or whatever they'll go off and* *read this, this and this and then we'd set up a set of questions which test that they'd understood the concepts that we'd given them, so you've got a much more interactive form of learning than the traditional lectures.*"

However, despite his apparent optimism of where the technology *could* take the course in terms of paedagogical approach, Course Organiser B was also quick to recognise what he sees as the possibly insurmountable obstacles to this kind of transformation. "*They're like super tankers, these big courses, you know, once they're on course it's very difficult to stop them or change them…*" it seems that in this particular case the Course Organiser felt that at least some of the responsibility for this inertia lay with the teaching staff, and that the kind of potential change he described may not be practical in Course B. "*I'm not sure that will work, because that gets to be a lot of work for people in the team and they can be reluctant to do that. That's kind of what was done with [Course A]. One was re-written from the ground up in a very imaginative way, but I think it would be quite difficult to drive that from … it would be quite difficult to convince all the other members of the team that this was a sensible thing to do, a useful thing to do, really, that would actually make any difference at the end of the day.*" Indeed, the course staff themselves felt that there had been little change in the way the course had been taught, despite the use of the clickers during lectures.

6.7.3 B3 - Student responsibility

It is clear from the emphasis within the Learning and Teaching Strategy that each "Vanguard" course should be focusing on encouraging students to begin to take responsibility for their own learning rather than expecting to be passive receivers of knowledge. The Course Organiser was under no illusions as to the magnitude of this task, and the subject prompted some unusually strong reactions; "*maybe we need to force them to take more responsibility for their learning but I don't know how you do that. I mean, they just fail, they don't engage, they don't come to anything… Part of what I felt about being a Course*

Organiser is a lot of the time it's like being a policeman. It's chasing them perpetually to do things that they bloody well ought to be doing by themselves!" However, he was also keen to point out that the Student Response System had the potential to be very much a "Vanguard" tool in this respect, enabling students to check in real time that they are following and understanding the material being dealt with. The banks of questions, used sometimes with the SRS during lecture time but developed primarily as a revision and self-assessment source to be used by the students at the end of each lecture block, are presented as another step in helping students along the road to taking control of their learning. However, the response has been disappointing; "*they're not using it, they're not engaging with it, they're not even trying the questions*." – only a quarter of students made use of the first block of online questions, and this figure tailed off significantly as the year progressed. Feedback groups at the end of the year indicated a large degree of apathy, with many expressing doubts as to the benefits of the use of such tools. This was further backed up by the course staff, who reported that they felt that the technology had neither encouraged nor enabled students to take more responsibility for their own learning. The Course Organiser theorized that either the students do not value the interactions, or the tools are not necessarily having an impact on this area of the teaching and learning environment, and pointed to the diverse nature of the class intake, explaining; "*There's a whole group of Polish undergraduates this year who are incredibly hardworking and enthusiastic and constantly asking for more feedback and more information and want to take things further and really engaged in doing what I kind of would like all the students to be doing. And you've got that all the way through to the people who can't even be arsed to turn up to any of the six practical classes. So it just has this extraordinarily broad spectrum*." He goes further, suggesting that, in general, there has been little progress in drawing in the least motivated in the group; "*the big problem with Course B, I think, is engaging that group of students, and I'm not sure that Vanguard has helped that.*" Course Organiser B summed up his experiences with this aspect of the course in this way; "*I'm just not particularly convinced that technology is a* *way of engaging the first year students and making them, or encouraging them to take responsibility for their learning.*"

6.7.4 B4 - Knowledge and understanding of subject matter

As already described in the previous section, the Student Response System was seen by the Course Organiser as a tool which had the potential to keep students engaged with the material during lectures so that they can gauge their own understanding and ask appropriate questions if necessary. He also saw the potential for the teacher to use the responses to gauge the understanding of the students and adjust his or her approach accordingly; "*I do think it allows us to get things across and you can see, you can feel from the audience the surprise at the answer being wrong and then you talk them through why it was wrong and what they've misunderstood and I think that's a very positive use of it.*" although it appears that few of the staff have yet reached this level of comfort or confidence with the tool. Indeed, the Course Organiser had a long -term view of the potential benefits of using this kind of approach and how it could affect knowledge and understanding within a particular course. However, he remained skeptical about the demographics of the course; "*There's just an incredibly broad range of students; you get very, very enthusiastic hard working students who love it and engage with everything and you get people who are barely turning up to anything and getting 8% in the exam at the end of the year and absolutely everything in between.*" The Course Organiser was clear who will benefit from the use of these tools; "*I bet you know the answer, which is the students who were responsibly turning up every week and bringing their clickers along will be the students who are at the top end of the class and the unengaged ones are at the bottom end.*" The staff agreed and were unanimous in their opinion that they had seen no evidence of increased student learning. So, there seem to be few, if any, expectations regarding the impact of the technologies on student knowledge and understanding of the subject matter, and hence there was little feeling that this facet had been noticeably affected.

6.7.5 Summary: Behavioural Transformations in Course B

The Course Organiser stressed that some efforts had been made to increase student-student and student-teacher interactions in the course. Progress has been made in this respect and he believed that the will exists to refine current approaches in future iterations of the course. However, he felt that any observable transformative effects precipitated by the use of technology were only beginning to emerge. Although the collaborative question task is both innovative and valuable, the Course Organiser was disappointed with the low participation rate, and while no steps have been taken to ascertain the reasons for such a phenomenon, he felt that it may reflect a lack of consensus regarding the importance of such interactions within the class – something which is also evident in the student attitudes to the use of the Response System in lectures. He was not clear whether this consensus may be unintentionally encouraged by the cautious approach of the staff or whether it is due to other factors outside the direct control of Course B. He expressed the hope that as this caution diminishes with familiarity and confidence in the tools themselves then the effects of the technology on student interaction may become more visible.

Course Organiser B recognised the potential of the technologies chosen to transform the paedagogical approaches used in the course. However, the course is currently delivered in much the same way as before and he expresses the opinion that there is reluctance on the part of the teaching staff to make the kind of dramatic changes necessary to realize the potential of the tools in this respect.

The Course B team had a clear expectation that the students taking their course need to take more responsibility for their own learning – not only to succeed in this course but also to continue to succeed in today's and tomorrow's world. However, this worthy ambition for its students appears to fall foul once again of the pervading caution within the team that seems to regulate the speed and depth of any changes that are implemented. Students are expected to become more responsible and are given opportunities to do so particularly through the use of the online self-assessment banks of questions. These questions have been carefully thought out and are frequently reviewed for effectiveness, and yet the conscious decision was taken initially not to "sell" these to the students, for fear of pushing a technological gimmick. The Course Organiser admitted that this may have been interpreted as a signal that the questions themselves were not important as they generally went unused by the students. Hence, even though the online environment created by the staff clearly provides opportunities for further study and self assessment which would have been much less accessible in previous years, it was felt that there has been very little opportunity to observe any evidence of the impact the technology may otherwise have had if it had been given a more mainstream position in the course. Finally, the Course Organiser agreed that evidence of transformations in the knowledge and understanding of subject matter is notoriously difficult to unearth. The use of the Student Response System is beginning to give staff more feedback about what the students are grasping in class and have the potential to allow students to influence the direction of the lecture in order to focus on areas of difficulty. However, this requires great flexibility on the part of the teacher, which in turn comes with confidence and experience in working with the tool in lecture situations. The Course Organiser expressed a willingness to get there, but he suggested that the staff has yet to reach that level of use. Hence he could not conclude that the use of technology has had any transformative effects in this area. These conclusions are summarised in Table 6-8, shown overleaf;

Behavioural Transformations		Teaching Staff Perspectives		
		Evident	Emerging	Not Evident
B1 – Amount and quality of interactions	*Has it increased the amount and quality of teacher-student and student-student interaction?*		X	
B2 - Paedagogy	*Has the introduction of particular technologies forced, inspired, enabled or otherwise caused a shift in teaching styles and approaches?*			X
B3 – Student Responsibility	*Does the implementation enable the student to take more responsibility for his or her own learning?*			X
B4 – Knowledge and Understanding of Subject Matter	*Has it facilitated a comparative increase in knowledge and understanding of the subject matter?*			X

Table 6-8: Summary of the types of Behavioural Transformation reported in Course B

6.8 Foundations and Institutional Transformations in Course C

6.8.1 Rationales and planning educational interventions

As has already been mentioned, the decision for Course C to become a "Vanguard" course was taken at a relatively late stage, just prior to the beginning of the academic year; "*there was not a lot of time to do anything and we didn't want to rush into doing something because we were only going to do it initially in the [one part of the course and not the other], and we didn't want to break the interaction between the two*." Hence the Course Organiser, who was involved in both the delivery of the lectures and in the practical aspects of the course, reported that there was also little time available after the decision was taken to consider how an explicit adoption of the Principles contained within the Learning and Teaching Strategy might influence how the course itself may be taught. Consequently, there was also little time to consider which technologies might be used and how they might be implemented. Ease and speed of implementation were the key factors as the Course Organiser explained: "*The reason we chose WebCT, which is a bit tangential but just in case this is of interest, was simply speed. So, WebCT was there, we needed to have something to be able to set up the material, present some quizzes and so on – in [subject deleted] we could have done it ourselves with web forms – if we had, we might have had a bit more flexibility – we could have rolled it out in a different style than what's there, but we knew we didn't have time to roll it in the semester we were heading for, so then we were better off just going with the flow – that was the deal!"*

Indeed, the late decision coupled with the concern that any major innovation in the lecture part of the course might adversely affect the practical section precipitated low expectations of what may be achieved in this instance, and may have limited what was communicated to the broader teaching team (when asked what the rationale was behind the use of a particular technology in his course, one lecturer responded "*How would I know?*" The same lecturer also denied that the Vanguard Principles had been responsible for any of the changes that took place in the course). That the Course Organiser and his team are committed to delivering a quality course is clear, but their attitude was also one of "*leave well alone*" and as a result there seems to have been little room for further development of the course once the current format had been created. The Course Organiser explained that the technology was hence chosen largely because it was available and would not impact any other aspect of the course, rather than primarily because it would support any underlying educational rationale or move the course itself in a new direction - "*what we're doing…essentially is duplication and redundancy*".

6.8.2 Resourcing educational interventions

As previously highlighted, the WebCT implementation was chosen on the basis that it would cause minimal disruption to the running of the course, not least of all because the course itself is already technology-rich and the teaching staff involved in the course are already highly computer literate and could easily manage the technology. Hence the Course Organiser felt that it was a given that there was little need to provide additional equipment or staff preparation, and so the implementation had little, if any, visible impact on how the course was resourced.

Similarly, as this is a technology based course and the implementation was designed to be accessed remotely from the physical department, the Course Organiser and teaching staff were clear that although there was a general requirement in many parts of the course for computer access, the introduction of WebCT had no effect whatsoever on how the course was accommodated.

6.8.3 Professional development

It may be a reflection of how professional development is viewed in general in higher education, or it may simply be a reflection of attitudes within each subject, but it seems that there is an assumption that "professional development" would apply specifically to the technical operation of any technology newly implemented in the course, rather than, for example, to the acquisition of new paedagogical skills in order to make the best use of such technologies. To that end, it is clear that in a computer-based course such as Course C, as one would expect, the Course Organiser had little expectation or perceived need of that kind of training.

6.8.4 Choice of technology

The Course Organiser stated clearly that ease of use and clarity of purpose were at least implied objectives of the use of WebCT in this course. The central reason for the cautious approach that was adopted, and for the choice of the technology itself, was a desire to avoid causing any disruption to the existing equilibrium or introducing any potential source of confusion to the students; "*So, what we decided to do was to keep the lectures, keep the practicals as they were, because to break that would be saying, you know, sometimes you'll be doing something which is radically different and sometimes you'll be doing this other thing, which could be confusing.*" However, he also admitted that the low-key of the implementation itself had perhaps blurred the purpose of the online elements, which in turn may have had an impact on how or when these tools are used. Parts were intended to explicitly support lectures while others are clearly aimed at supporting revision as exam time approaches. Yet, initially at least, the Course Organiser explained that it was essentially left to chance whether or not the students would make use of it, and if they did, when and how they would do that; "*the way I think about it more is that there is just a resource there now.*"

6.8.5 Summary: Foundations and Institutional Transformations in Course C

It is clear that, in some ways, the circumstances surrounding the implementation and the decisions made by the Course Organiser and teaching staff were designed to ensure that that few if any transformative effects were observed or experienced as a result of the use of WebCT. Despite the clear subscription of the Course Organiser to the ideas behind the Learning and Teaching Strategy, the last minute nature of the implementation meant that there was little time to consider an explicit rationale behind the innovation.

The computer-based nature of the course set it apart from other Vanguard courses in that many teaching spaces are already technology-orientated, and the staff involved are highly literate in the use of such technologies, so it was understandably difficult for the teaching staff to identify how the use of WebCT may have had an impact on these aspects of their institutional surroundings.

It seems that concerns about upsetting the balance between the different elements of the course resulted in the innovation being held in the background - behind, but not touching, the existing course so that transformations of how the course may be resourced and accommodated were, to all intents and purposes, deliberately avoided. This has resulted in an implementation that the teaching staff feel is non-disruptive, but that may not be entirely clear in its purpose – it is just “there”.

The perspectives of the teaching staff as a whole on the presence or otherwise of the Foundations for Transformation and Institutional Transformations in Course C are summarised overleaf in Tables 6-9 and 6-10.

Foundations for Transformation		Teaching Staff Perspectives: Evident	Teaching Staff Perspectives: Emerging	Teaching Staff Perspectives: Not Evident
F1 – The presence of a clear rationale	*Has the introduction of technology been driven by an explicit rationale?*			**X**
	Has the decision to implement technology influenced how the course or intervention is planned?			**X**
	Has the use of technology prompted a review of what is taught?			**X**
F2 – The presence of willing participants	*Are those involved in the innovation willing participants?*			**X**
F3 – The provision of sufficient resources	*Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?*			**X**
	Are new teaching spaces technology-friendly?			**X**
F4 – The opportunity for professional development	*Has the introduction of new technologies been accompanied by appropriate training?*			**X**
	Are educators both confident and competent in the use of the chosen technology?		**X**	
F5– Ease of use and clarity of purpose	*Is the educational purpose of the technology clear to teachers and students?*		**X**	
	Can students easily connect the use of the technology to specific educational goals?		**X**	

Table 6-9: Summary of the Foundations for Transformation reported in Course C

Institutional Transformations		Teaching Staff Perspectives		
		Evident	Emerging	Not Evident
I1 – Planning educational interventions	*Has the desire to introduce new technologies led the institution to explore explicit rationales for its use?*			**X**
	Has the decision to implement technology influenced how the course or intervention is planned?			**X**
	Has the use of technology prompted a review of what is taught?			**X**
I2 – Resourcing educational interventions	*Is there evidence that the introduction of technology is prompting the institution to rethink its approach to time and other resources?*			**X**
	Is the use of technology resulting in existing spaces being used differently or driving a need for alternative teaching spaces? Are new teaching spaces technology-oriented?			**X**
I3 – Professional Development	*Has the introduction of new technologies led to a new focus on professional development?*			**X**
	Are educators becoming more confident and competent in the use of the chosen technology?			**X**

Table 6-10: Summary of the types of Institutional Transformation reported in Course C

6.9 Material Transformations in Course C

6.9.1 M1 – Efficiency of course delivery

As has been mentioned in our discussions the use of an online environment to provide access to lecture notes and other explanatory materials has the potential to improve the efficiency of the course by removing more mundane elements of "content delivery" from precious face-to-face contact time, thus allowing this time to be repurposed effectively. However, in the case of Course C a specific decision was made by the Course Organiser to ensure that the technology and its use in the course did not interfere with anything delivered in the lectures, and as such the implementation was actually intended to be neutral with regards to its effect on the efficiency of the course. The teaching staff, the vast majority of whom reported that there had been no noticeable change in the way the course was delivered, corroborated this. The Course Organiser was concise in his comments regarding this, describing the use of technology, as we have previously mentioned, as "*duplication and redundancy,*" expressing a certain cautiousness regarding making any changes to the use of contact time with students; "*I'm not quite sure whether we would be brave enough to move completely – well, bravery is the wrong word – adventurous enough to shift very radically away from the traditional lecture format*."

6.9.2 M2 - Variety of means of engagement with subject matter

Despite the conscious decisions to explicitly limit the impact of any implementation on the course and the expressed needs-based motivation for the specific use of WebCT, it was recognised by the Course Organiser and teaching staff that the use of the online environment could enable them to provide an alternative access path to the subject matter. "*What we did was to take the course material and move an awful lot of it into WebCT, so the idea was that somebody, at least my sort of acid test for this was, that somebody who for some reason hated me or the lectures could have gone to the WebCT material for the course and could, in theory, have got through the material and passed the exams*". The Course Organiser was aware of the potential of the tool and the promise it may have in their own context, but saw this as being in the long term. The majority (11 out of 14) of those involved in delivering the course felt that the technology had already increased the ways students could engage with course content; lecture notes, PowerPoint slides, tutorial questions and so on were produced and placed online, but in keeping with the pervading mood of caution, the course staff intentionally did not direct the students towards the resources – the students were made aware of the existence of the resources at the beginning of the course but these were not referred to regularly during lecture time, perhaps in the often-expressed fear that the provision of these alternative resources might affect attendance; "*The main reason for the introduction was to provide another avenue or access path for students to the subject matter, not to replace the lectures*." This appeared to have had a great influence on both the number of students accessing the resources and the frequency with which they accessed them, but the Course Organiser felt it was impossible to quantify the overall impact this was having. The average participation rate online was reportedly around 30% - reflecting the fact that, interestingly, a significant number of students needed little encouragement or intervention from the teaching staff to make use of the resources.

6.9.3 M3 - Content and assessment

We have already discussed the fact that a key decision was made at the start of the year not to change the lectures, practicals or the subject matter delivered within them; "*we didn't make any changes to the lectures at all – it's a very passive use of technology.*" One major reason for this is the close link between the two separate elements of the course. The two strands of Course C have been running together for quite some time and have been developed in tandem so that there is a large degree of interdependence. Hence the Course Organiser stated that there is a concern that major changes to one "half" of this partnership may adversely affect the other, which has obviously prevented any consideration at this stage of how the content and assessment strategies in the course may be improved through the use of the technology. Lecture content has therefore remained static. A bank of self-assessment questions have been placed on WebCT which students are free to access as the course proceeds. No other changes have been made to the way the course is assessed. However, the Course Organiser did discuss the potential of the technology in this area and commented that despite the present cautious approach, the hope existed that a natural progression over the next number of years of this implementation may be that there should be an eventual shift away from the traditional lecture format; "*at the moment, the technology has no influence on what we teach, we've just slotted it in and tried not to disturb things. It might be possible to change* *things and move away from the traditional way of doing things in the future but we'll just have to wait and see*."

6.9.4 Summary: Material Transformations in Course C

It is interesting to note that the decision to limit the impact of the implementation of WebCT seemed to be, at least to some extent, a result of the belief of those involved that use of this technological tool in a course context had the potential to stimulate material transformations (or at the very least be the cause of considerable disruption), and references to this potential were made throughout the conversations with the Course Organiser, not least of all in the expression of hope that in future years the implementation may grow to change the delivery of lectures in the course. The Course Organiser felt that as the course moves towards this stage and the level of caution diminishes, the elements of material transformation that are missing at present (he saw no effect on the efficiency of the course, its content or the way it is assessed) are more likely to manifest themselves. Despite the ongoing caution, he did have ideas of how the technology *may* augment the course and highlighted that with limited time for planning, the technology was introduced with the key intent of increasing the variety of means of engagement with the subject matter. That the course, or the students, had yet to take full advantage of this is obvious in the Course Organiser's comments, but nonetheless, the estimated 30% student use of the tool (measured through the built-in features in WebCT) seemed encouraging to the Course Organiser and to the teaching staff. Hence, his perspectives on Material Transformations in the course resulting from the introduction of the chosen technologies may be summarised as shown overleaf in Table 6-11 overleaf;

Material Transformations		Teaching Staff Perspectives		
		Evident	Emerging	Not Evident
M1 – Efficiency of course delivery	*Has it improved efficiency of course delivery? i.e. has it increased the amount of time available for activities other than delivery of content?*			X
M2 – Means of engagement with subject matter	*Has it increased the variety of means of engagement with the material?*	X		
	Does the course take advantage of this?			X
M3 – content and assessment	*Has it enabled new content to be taught or less useful/redundant material to be removed?*			X
	Has it altered the way the course is assessed?			X

Table 6-11: Summary of the types of Material Transformation reported in Course C

6.10 Behavioural Transformations in Course C

6.10.1 B1 - Amount and quality of interactions

Despite seeing the implementation of WebCT as being able to provide students with more opportunities to engage with the subject material, providing students with more opportunities to interact with each other and with staff was simply not a priority of the Course Organiser or teaching staff, and each group reported overwhelmingly that no changes had been observed in this area. In the short time available, the decision was made to focus on one technology to achieve a single, low-risk benefit that would not interfere with existing practice. Hence, no formal use was made, for example, of the discussion facilities within WebCT. Use of such tools in the future seems uncertain; "*I've no idea really how we'll play it… I'd have to have this conversation with the people doing [the follow-up course],* *because Course C fits in with [the follow-up course] – you have to be a bit careful about how things interact.*"

6.10.2 B2 - Paedagogy

In the case of Course C, we have already seen that the decision to go "Vanguard" was made at a relatively late stage, and many of the decisions made regarding the choice in technology and the way it was implemented were heavily influenced by this and the desire to avoid any disastrous effects on the delicate equilibrium that exists between the two sister halves of the course. "*So, what we decided to do was to keep the lectures, keep the practicals as they were, because to break that would be saying, you know, sometimes you'll be doing something which is radically different and sometimes you'll be doing this other thing, which could be confusing.*"

The Course Organiser was clear that it was the intent from the beginning to use the technology in as passive as manner as possible, expressly avoiding any disruption to the normal flow of the lectures; "*what we have used it for really is just presenting – here's the junk of the course that is useful to be looking at now, here's some self tests you can do – it's pretty basic, straightforward I suppose…*" The rest of the staff involved in the course echoed this and it was clear that from their perspective the technology had made no difference to the way the course was taught. Despite this consistently cautious approach, again it is clear that Course Organiser C was aware of the possibilities that may exist with this kind of tool and that the potential exists for the technology to have much more of an impact on the way the course is taught; *"I'm not quite sure whether next year we would be brave enough to move completely – well, bravery is the wrong word – adventurous enough to shift very radically away from the lecture format."* It is interesting to note that although he could not envision any dramatic changes to the way the course was delivered, Course Organiser C expressed the feeling that there was an increasing expectation from the students themselves that things may need to shift from the traditional way of doing things. "*I suspect we would* *have to have something which would fill that gap in expectation for the students, unless we were to change [the other part of the course] very radically as well next year. I'm hoping it might be a different style of things though.*"

6.10.3 B3 - Student responsibility

The approach of the Course Organiser and teaching staff in this respect was very much one of providing the *means* for students to take more responsibility for their own learning in the shape of the materials on WebCT and waiting to see whether or not they would. "*There's an issue about whether they will, because they are first years and they are not accustomed, as far as I know, to having complete free will – do it when you like and see what works best for you is not so familiar for them. So there is a little bit of danger in doing that*." However, 8 of the 14 respondents felt that the technology had actually encouraged or enabled students to take more responsibility for their own learning. As already mentioned, the percentage of students accessing the online materials, although not staggering, was nonetheless seen as encouraging by the Course Organiser considering the deliberate choice not to advertise or push its use by the teaching staff, and he suggested that when these students were given the opportunity, they were able to take more responsibility for their own learning by willingly seeking out the extra material provided. "*I believe the last time I looked it was about a third of them were using WebCT a bit. I think that was because – again, intuition – they were using it to try and fill in the gaps, thing that they weren't sure of in the lectures*." He also recognised that it could be argued that canny students were merely going online to get notes they had otherwise missed. However, the former notion is given more credence by looking more specifically at *what* the students were accessing. A key part of the WebCT implementation was the provision of a bank of online quizzes which students could use to test and develop their understanding of key concepts. At the beginning of the course, approximately 30% of students were accessing these questions – a figure which sits well with the overall estimate. As the course progressed, this figure gradually increased, implying to the Course Organiser that the student use of the online environment was not merely to fill in missing notes, but was a serious attempt to get to grips with the material through the *voluntary* use of the question banks.

6.10.4 B4 - Knowledge and understanding of subject matter

A major motivation behind providing access to questions online was to support and promote students understanding of key concepts, and it is interesting that, as previously stated, the Course Organiser highlighted that this part of the online environment was one of the most widely and consistently used by the students. It may be tempting to suggest that this should automatically equate to an increase in student understanding. However, the Course Organiser steered away from making such a claim; "*I have no real perception of the impact of what we've done on students, either in terms of engagement or learning.*" There are no plans to evaluate the implementation in this respect. Hence, despite the relatively encouraging level of student participation, the Course Organiser (together with 12 of the 14 course staff who responded) felt they had no evidence that there had been a corresponding increase in understanding of the subject matter.

6.10.5 Summary: Behavioural Transformations in Course C

From these discussions we can see that this is an implementation that was very specific in its targets, and boundaries were clearly set delineating what should and should not be affected by any innovation. In this instance, introducing WebCT was simply not intended to have an impact on student interactions with each other or with their teachers, and the focus on student use would require no change in paedogogy by the teaching staff. However, the Course Organiser was very focused (by circumstances as much as by planning) on a key purpose of the Learning and Teaching Strategy – to provide students with the opportunity to take more responsibility for their learning and to move away from a model where learning was perceived as a passive absorption of knowledge transmitted from teacher to student. WebCT was available, relatively straightforward to set up and provided an obvious route whereby students could be given the opportunity to access material at the time and place of their choosing. Course Organiser C reported that a significant proportion of students did just that, and without much in the way of prompting from the teaching staff. He and his staff felt the provision of these online resources gave students opportunities to learn at their convenience they did not have before. However, he was less sure whether the implementation encouraged students to take *more* responsibility for their own learning, or simply provided them with the means to demonstrate a willingness that already existed.

Hence from the Course Organiser's perspective, although he could not say for sure that there has been any impact on the knowledge and understanding of the subject matter, he did imply that the implementation of WebCT in this course may be, in fact, *beginning* to produce behavioural transformations in the area of student responsibility. These conclusions are summarised in Table 6-12 below;

Behavioural Transformations		**Teaching Staff Perspectives**		
		Evident	**Emerging**	**Not Evident**
B1 – Amount and quality of interactions	*Has it increased the amount and quality of teacher-student and student-student interaction?*			**X**
B2 - Paedagogy	*Has the introduction of particular technologies forced, inspired, enabled or otherwise caused a shift in teaching styles and approaches?*			**X**
B3 – Student Responsibility	*Does the implementation enable the student to take more responsibility for his or her own learning?*		**X**	
B4 – Knowledge and Understanding of Subject Matter	*Has it facilitated a comparative increase in knowledge and understanding of the subject matter?*			**X**

Table 6-12: Summary of the types of Behavioural Transformation observed in Course C

Chapter 7. Analysis of course marks 2004/05 – 08/09

7.1 Introduction

The qualitative data gathered through the structured interviews and questionnaires with the postgraduate deans, Course Organisers, lecturers, tutors and other postgraduate assistants provide a wealth of information regarding the perspectives of those groups as well as their observations of the success or otherwise of the technological implementations and the other Vanguard innovations of which they form a part. However, it is clear that they can only tell part of the story - a significant part, but only a part nonetheless, and it would be helpful to perform a separate examination of any available quantitative data for the period under study in order to identify any changes in this aspect of student achievement (Chandra & Lloyd, 2008; Frear & Hirschbuhl, 1999; Lei & Zhao, 2007; Protheroe, 2005; Schacter & Fagnano, 1999). Not only will this enable us to search for any measurable change that has occurred in the final marks as the courses became "Vanguard", but it will also enable us to determine whether any claims or assertions found in the qualitative data can be supported by the quantitative data. The primary source of quantitative data available for the three courses is the final course mark (comprising coursework marks and examination marks) for each student. The three courses became "Vanguard" in 2006/07. Hence it was decided to obtain the final course marks for the years 2004/05, 2005/06, 2006/07, 2007/08 and 2008/09, thus enabling us to get a snapshot of the courses before, during and after the adoption of the Vanguard Principles. The results were analysed in a number of different ways to identify any possible changes during that period;

1. Visual analysis of means, modes and medians
2. Visual analysis of grade distributions
3. Visual analysis of pass and fail rates
4. Chi-squared analysis of grade distributions
5. Chi-squared analysis of pass and fail rates

7.2 Analysis of means, modes and medians

The basic statistical measures for each of the courses were calculated and the results examined for any observable patterns or trends that may coincide with the changes that occurred in each course at the time of the Vanguard initiative.

7.2.1 Means, modes and medians in Course A

	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Mean	**55.19**	**57.38**	**61.61**	**56.70**	**59.27**
Std. Error of Mean	1.015	1.021	1.101	.963	.950
Median	**55.00**	**58.00**	**63.00**	**59.00**	**59.00**
Mode (lowest)	**56**	**58**	**60**	**54**	**51**
Std. Deviation	16.341	15.748	17.166	16.195	15.846
Skewness	.031	-.151	-.774	-.464	-.290
Std. Error of Skewness	.151	.158	.156	.145	.146

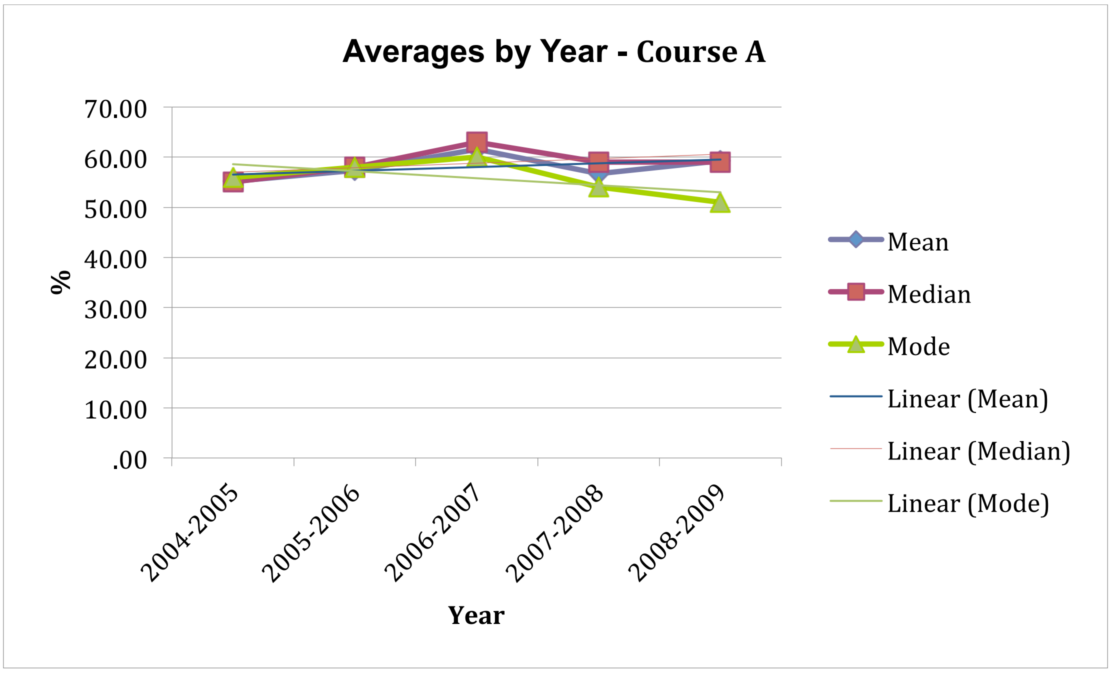


Figure 7-1 Descriptive statistics of final course marks over time in Course A

Plotting the Mean, Median and Mode graphically as shown in in Figure 7-1 suggests that that there are some observable patterns in these values over the period of study as follows;

- Both the mean and the median course marks appear to be on a general upward trend
- The modal mark appears to display an overall downward trend
- A “spike” is visible in all three statistics coinciding with the 2006/07 year.
- The skewness value indicates that the mark distribution shifts over time from being skewed towards lower marks to being skewed towards higher marks

This snapshot may be our first indication that *something* has had a measurable impact on the course marks obtained by students during this time period. Not only is there an observable upward trend that takes us from the non-Vanguard years, through the transition to “Vanguard” to “post-Vanguard”, but the spike observed corresponds directly with the course’s transition to “Vanguard” status and the associated conscious effort to use technology and other paedagogical tools to shift the emphasis to student-centred learning. The downward trend observed in the modal mark is more difficult to explain without a closer analysis of the marks and grades obtained in each particular year– it could easily reflect a particular group of students scoring higher or lower than they would have previously, or may simply be a result of natural statistical variation.

7.2.2 Means, modes and medians in Course B

	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Mean	**60.31**	**59.33**	**59.36**	**59.80**	(Marks not available)
Std. Error of Mean	.683	.529	.650	.518	
Median	**62.00**	**60.00**	**61.00**	**61.00**	
Mode	**69**	**58**	**64**	**62**	
Std. Deviation	13.562	11.535	13.380	11.532	
Skewness	-.800	-.423	-.783	-.806	
Std. Error of Skewness	.123	.112	.119	.110	

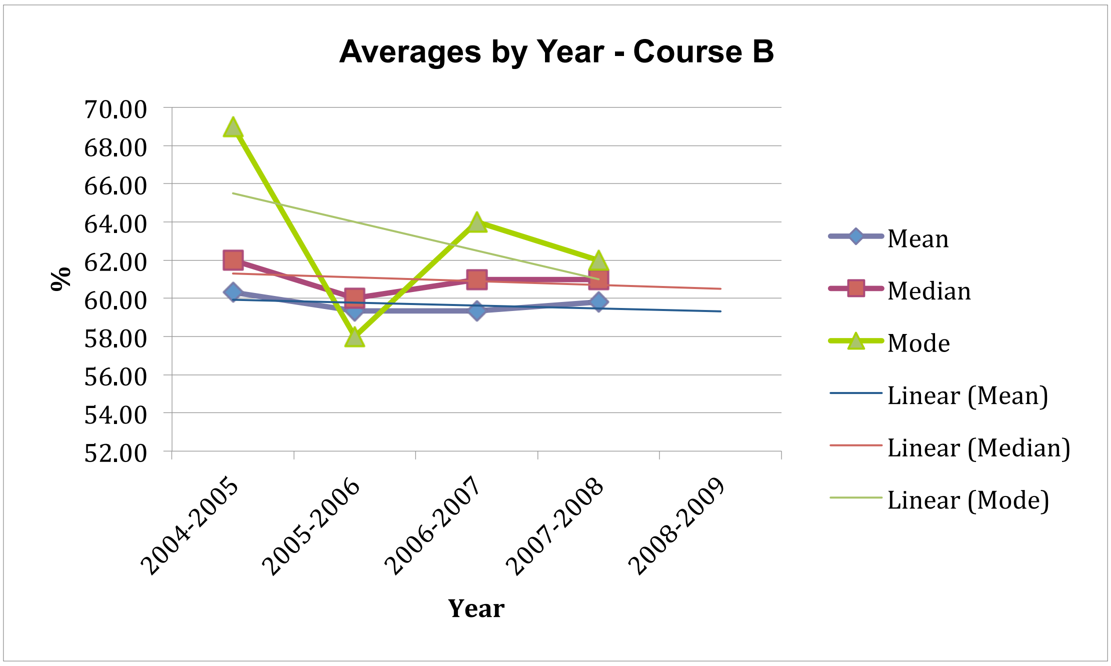


Figure 7-2 Descriptive statistics of final course marks over time in Course B

In this case, from Figure 7-2 there again seem to be observable patterns in the statistics as follows;

- The mean, median and modal course marks display decreasing trends (this is slight for the mean and median and more noticeable for the mode)
- A dip can be observed across the statistics (a very dramatic one in the case of the mode) in 2005-2006
- The skewness value indicates that the marks remain skewed towards the upper end of the range

It seems likely that the dip, occurring as it does in the year 2005-2006, *before* any Vanguard-related changes were made to the course in question, may simply be a result of a weaker-than-normal year group or other adverse circumstance outside the scope of the study. The marks for 2008-2009 were unavailable for this course.

7.2.3 Means, modes and medians in Course C

From Figure 7-3 (overleaf), it appears that for Course C;

- The mean course mark has fluctuated slightly but with no significant trend visible
- The median mark displayed a very slight upward trend until 2008-2009.
- The modal mark increased noticeably, with a significant spike occurring in the 2005-2006 year.
- The skewness value indicates that the marks remain skewed towards the upper end of the range

It is clear that the transition of Course C from "non-Vanguard" to "Vanguard" status had little impact on either the mean or median marks. The mode is perhaps a little more interesting as, aside from the existence of the large peak in the pre-Vanguard year, the upward trend may suggest that while the distribution of marks showed little variation, a change has occurred resulting in the most frequent mark obtained by students to increase steadily. An explanation of why this has happened requires further analysis of the course marks.

	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Mean	**66.27**	**69.07**	**69.21**	**68.72**	**67.887**
Std. Error of Mean	1.628	1.488	1.596	1.592	1.2177
Median	**69.00**	**72.00**	**73.00**	**74.00**	**71.500**
Mode	**57**	**91**	**73**	**80**	**84.0**
Std. Deviation	21.535	19.054	19.552	18.899	16.8285
Skewness	-.396	-.850	-.781	-.774	-.730
Std. Error of Skewness	.184	.190	.198	.204	.176

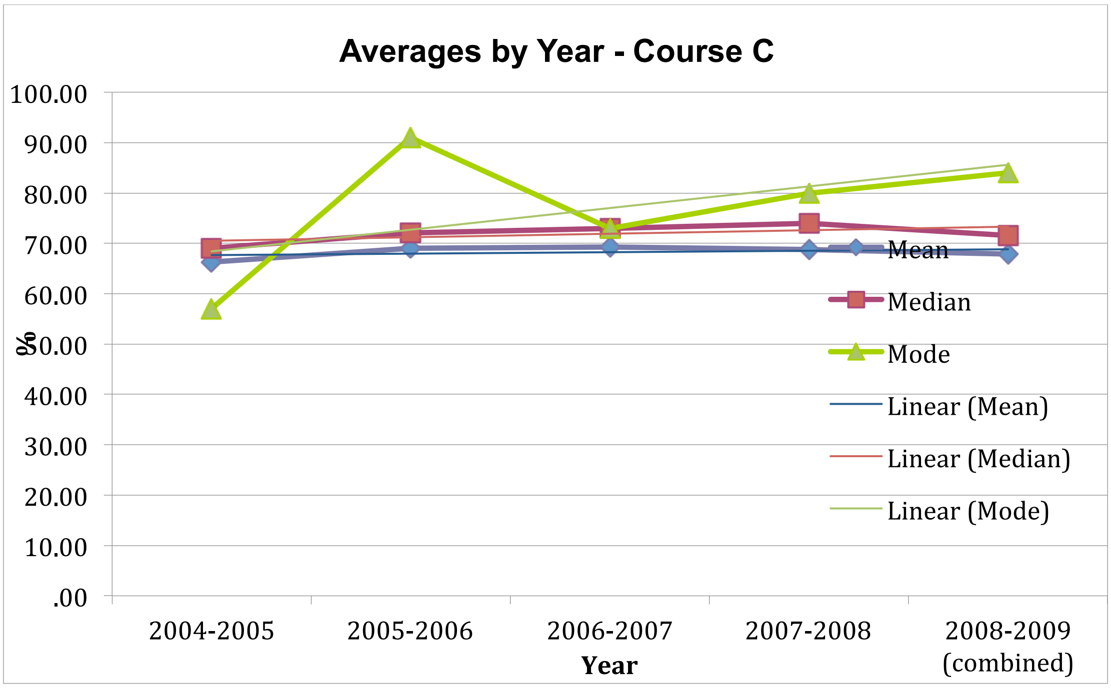


Figure 7-3 Descriptive statistics of final course marks over time in Course C

7.3 Grade distributions

The next step was to take a closer look at the distributions of the grades themselves within each subject across each of the 5 years in order to identify any possible shifts towards higher (or lower) grades as the courses became "Vanguard". The grade boundaries were determined for all grades and the percentage of each class obtaining each grade were determined and plotted in a series of bar charts. The bar charts were then studied for any observable patterns or changes in the distributions that may be attributed to the paedagogical changes occurring within the courses.

7.3.1 Grade distributions in Course A

In general, from Figure 7-4 (overleaf) we can see that as we move from 2004-2005, there is an overall leftwards movement visible within the distribution – i.e. as we look from pre-Vanguard, through the Vanguard transition to the post-Vanguard years, it appears that the distribution shifts from one which is approximately centred around the midpoint (C grade) to one which is skewed towards the A/B boundary. It is clear that this shift occurs most dramatically in 2006-2007 and is largely sustained beyond this. It is also worth observing that this shift in grade distributions also corresponds to the steady increase in both the mean and median marks obtained by the students and helps support the assertion that something significant occurred during this time.

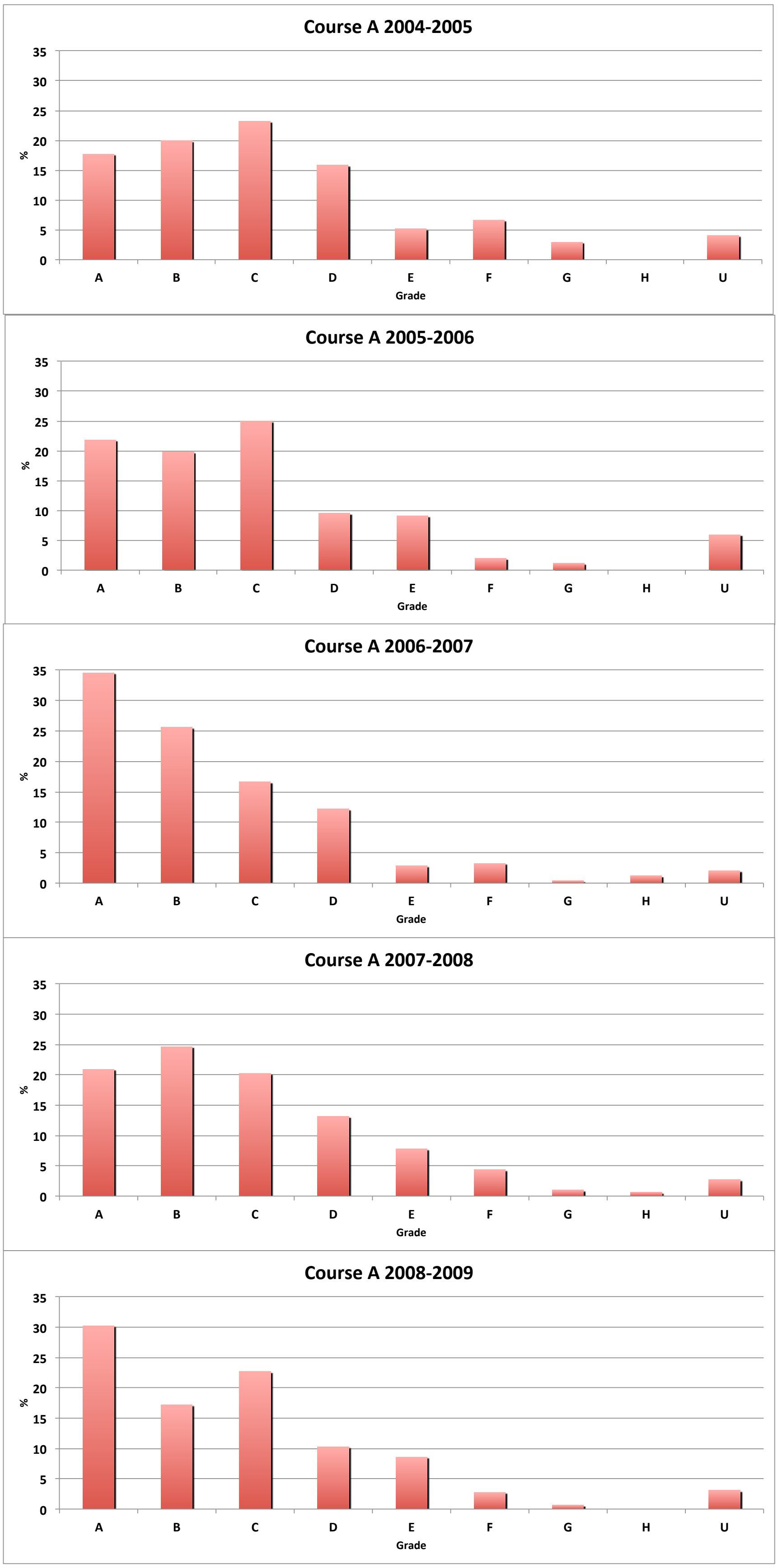


Figure 7-4 Grade distributions in Course A 2004-05 to 2008-09

7.3.2 Grade distributions in Course B

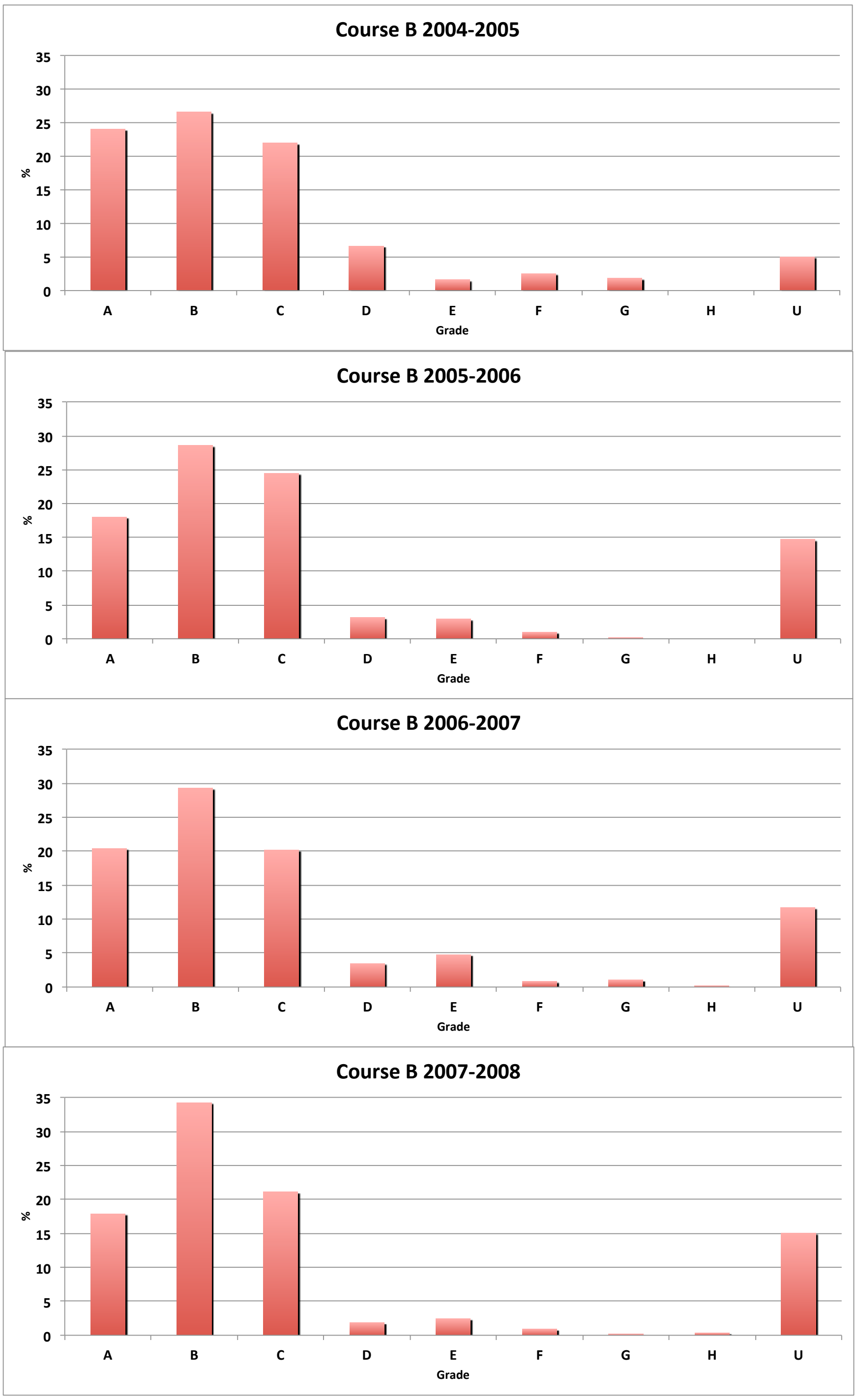


Figure 7-5 Grade distributions in Course B 2004-05 to 2007-08

In contrast to the noticeable shift observed in Course A, Figure 7-5 indicates that the overall distribution appears to change little for Course B during the period of study. If anything, the distribution becomes a little more sharply centred on the B-grade at the expense of some A-grades, but in general the distribution of each grade remains fairly consistent with little evidence of any dramatic change having taken place. The overall decrease in A grades (with the corresponding increase in B grades) may illuminate the slight downward trend in both the mean and median marks scored by students over this time.

7.3.3 Grade distributions in Course C

Again, Figure 7-6 (overleaf) would suggest that the dramatic change in grade distributions observed in Course A seems to be absent from Course C – across the years in question, the distribution holds to a steady pattern - a large percentage of A grades with a scattering of the other grades, generally decreasing as we move down the grades. However, a closer look reveals a slight increase in A grades in 2005-2006 that *may* correspond to the spike observed at this time in the modal course mark. Another interesting shift that occurs in 2006-2007, when the number of both B and C grades dips while the number of A grades increases. This increase in the A grades coincides with the course's transition to Vanguard status. The number of A, B and C grades return to previous levels the following year and beyond, suggesting that whatever the cause, the effect was short-lived.

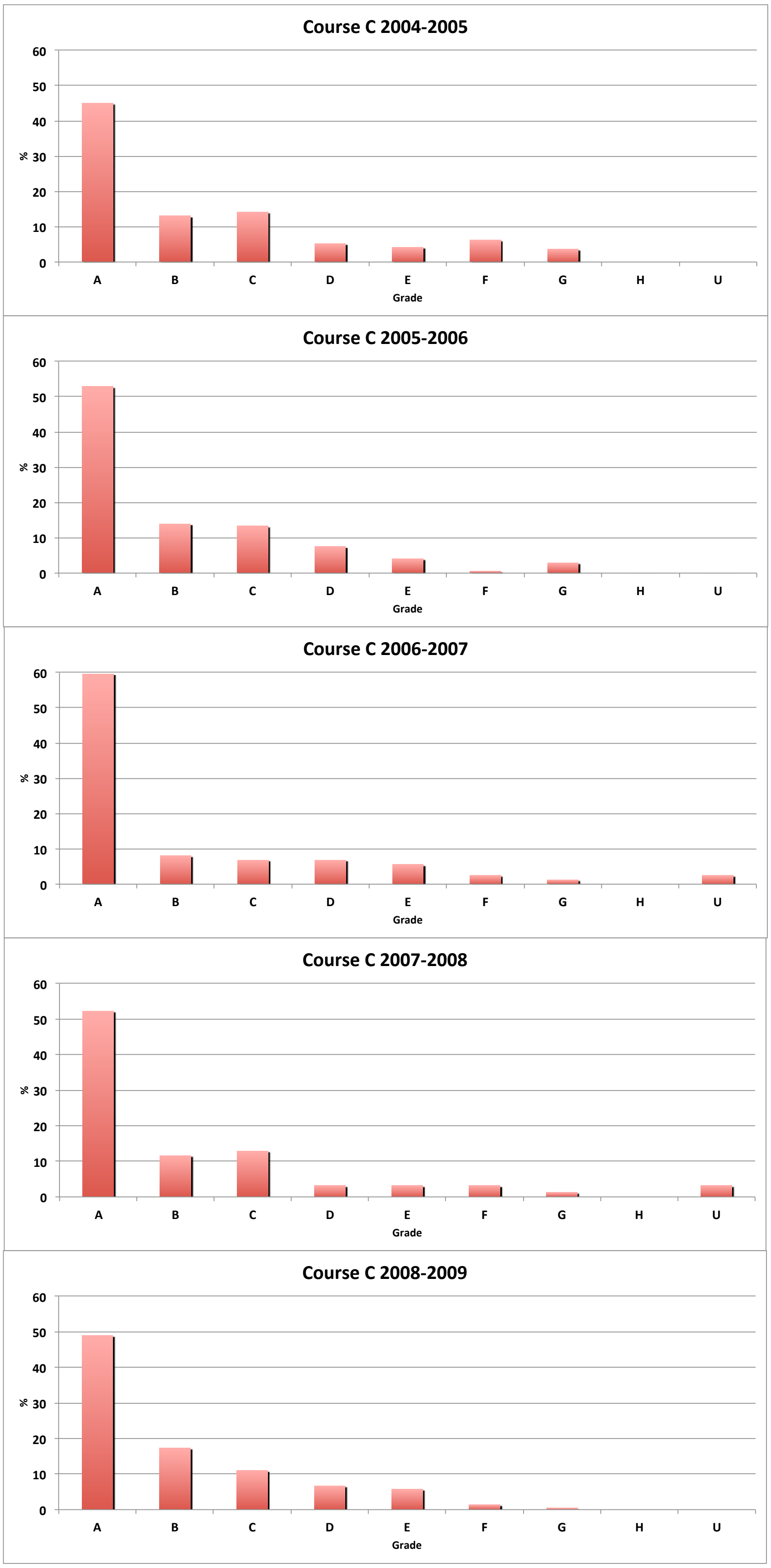
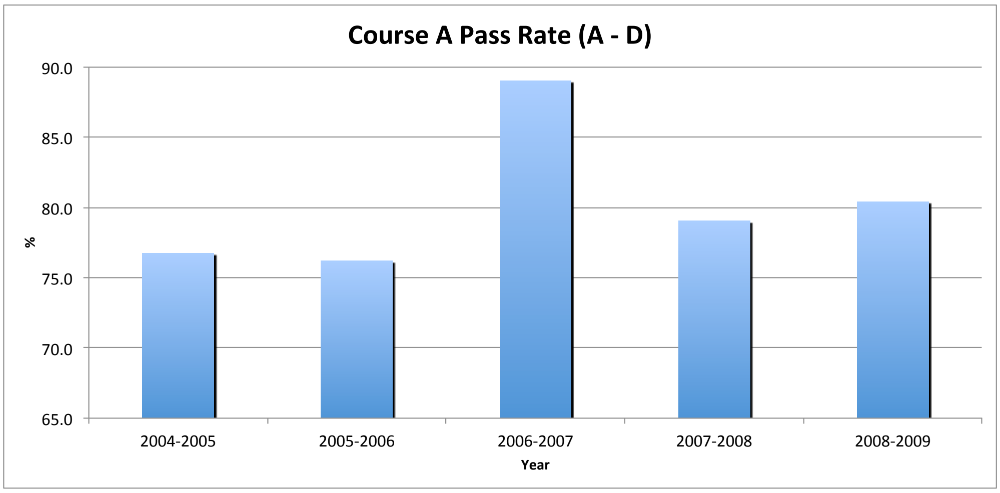


Figure 7-6 Grade distributions in Course C 2004-05 to 2008-09

7.4 Pass and fail rates

Perhaps more telling than the distribution of grades year-on-year for a particular subject is an analysis of the pass and fail rates. It is perfectly possible that there may be variation in the grade distributions and yet the pass and fail rates remain the same, or that the number of A grades increases but the overall pass rate drops. Hence the grades as discussed in the previous section were used to calculate the overall pass (A-D) and fail (E and below) rates for each subject and year. The results were then plotted for ease of examination.

7.4.1 Pass and fail rates in Course A



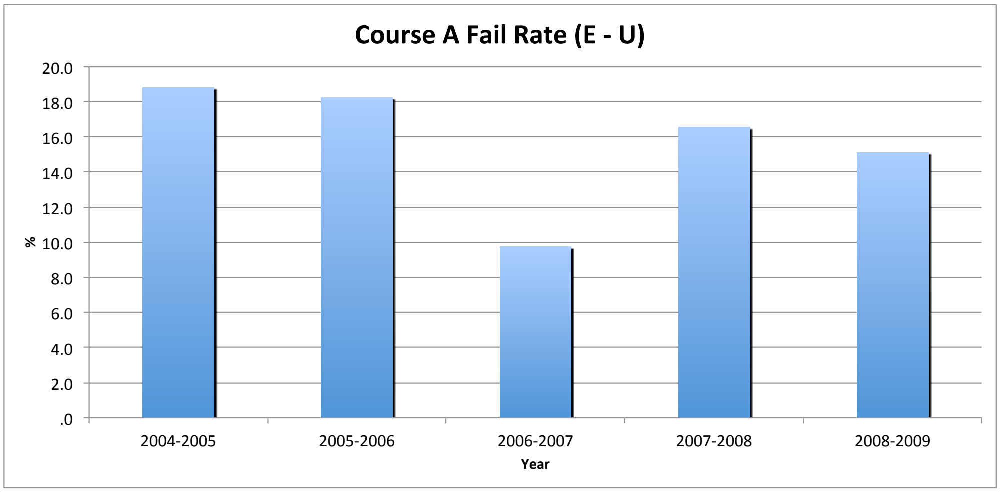


Figure 7-7 Pass and fail rates in Course A 2004-05 to 2008-09

In the pre-Vanguard years, it can be seen from Figure 7-7 that the pass rate hovered around the 75% percent mark, with a corresponding fail rate of around 18% - the discrepancy can be accounted for in the small number of dropouts in each year. In the year the course transitioned to Vanguard status (2006-2007), there is a surge in the pass rate that coincides with the increase in the mean and median marks as well as a general shift to higher grades revealed earlier. Although this surge in pass rate is not sustained in the post-Vanguard years, there is nonetheless a visible increase in the pass rate in 2007-2008 and 2008-2009 when compared to the pre-Vanguard years.

7.4.2 Pass and fail rates in Course B

The most noticeable feature of Figure 7-8 (overleaf) is the relatively high pass rate achieved in 2004-2005 when compared to the following years. In fact, the pass rate decreases markedly the following year (another pre-Vanguard year) and again (albeit by a very small amount) in 2006-2007, the year in which any Vanguard-inspired innovations were introduced, although given that the fluctuations are small in these years we may assume that the pass rate has remained relatively steady following an unusually high peak in 2004-2005. It is worth noting that the change in pass rates is not immediately visible in the grade distributions, the pass and fail rates do mirror the observations made based on the mean, median and modal course marks which show a corresponding peak in 2004-2005 followed by a dip and a pattern that could be interpreted as more stable.

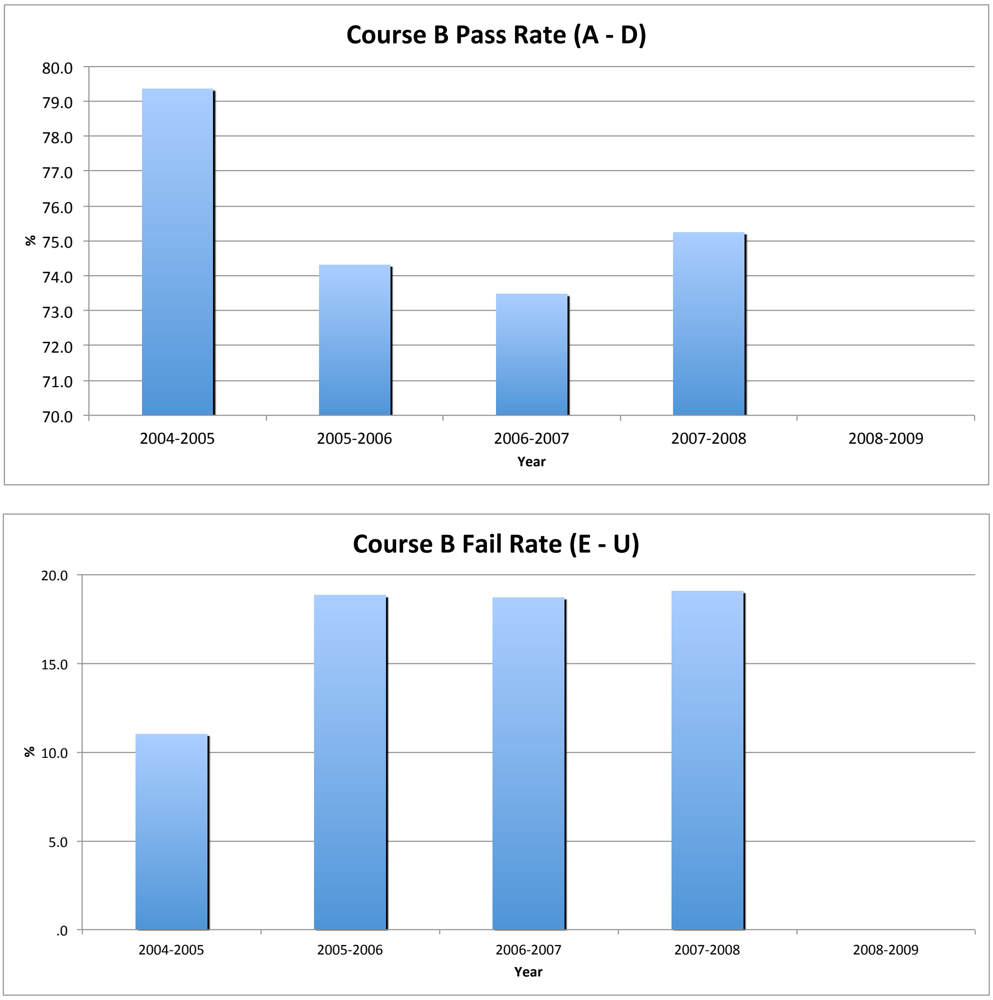
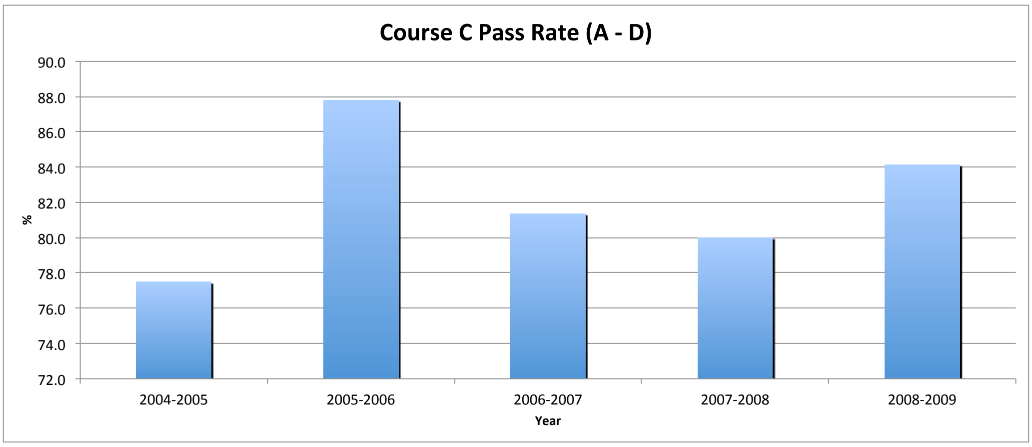


Figure 7-8 Pass and fail rates in Course B

7.4.3 Pass and fail rates in Course C

In Figure 7-9 (overleaf) it can be seen that the most obvious feature of the plotted pass rates for the period under study is the increase in pass rate (and associated decrease in fail rate) that occurred in 2005-2006, the year before any Vanguard innovations were introduced. This peak corresponds to that observed in the modal mark in that year, and also in the increase in B and C grades revealed in the grade distributions graphs. There is no apparent pattern or trend in the pass rate for the other years, something which again was clear from the previous analyses, and in particular there seems to be no clear effect on the pass rate as the course makes the transition to Vanguard status.



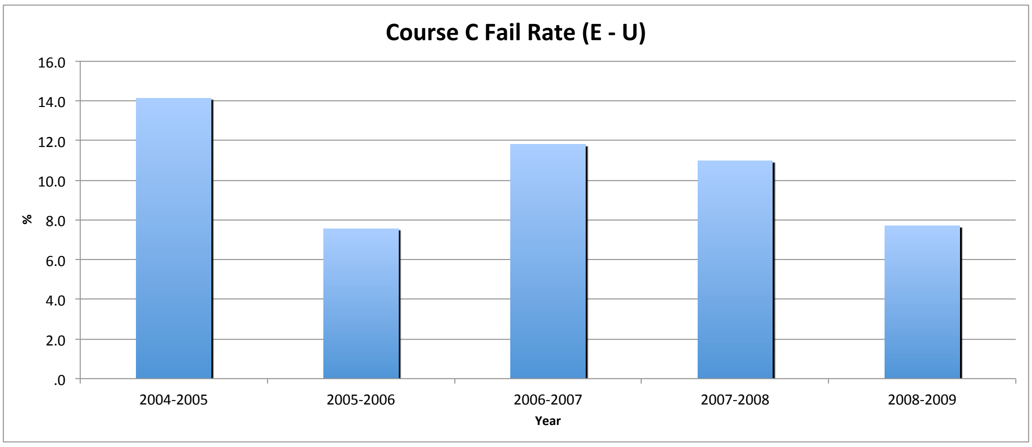


Figure 7-9 Pass and fail rates in Course C

7.5 Are the changes statistically significant?

It is clear that by representing these statistics visually we can quickly identify possible trends as well as the appearance of significant differences in results from year to year for each subject and draw some conclusions, or at least make suggestions, based on these observations. However, it is accepted that while such visual analysis is both valid and useful, it does not enable us to state with any degree of certainty whether any of the changes or trends observed are statistically significant. In other words, using visual analysis alone, we can not safely determine whether or not any observed changes have occurred merely by chance and hence lie within the normal range of statistical fluctuation or whether they lie outside this range and are therefore likely to have been caused or produced by external factors.

So, we need to choose the most suitable form of statistical analysis that will allow us to determine whether or not the changes that have occurred represent a significant departure from the "norm".

7.6 Chi-squared analysis of grade distributions

The grade distributions across the 5 years under study for each course were subject to a series of chi-squared tests. In each case, the data from a particular course was analysed in 3 distinct groups – ***pre-Vanguard*** (all year groups preceding the change to Vanguard), ***boundary*** (including the year before and the year following the shift to Vanguard) and ***post-Vanguard*** (all years following the adoption of the Vanguard Principles). The chi-squared values were calculated and the results obtained in each case were analysed to determine whether or not any changes or variation across the years are statistically significant. The values obtained for each course are summarised in Table 7-1:

Course	Period	χ^2 Value	Significance Value
Course A	Pre-Vanguard	2.290	0.808
	Boundary	11.310	0.046
	Post Vanguard	11.396	0.327
Course B	Pre-Vanguard	5.383	0.371
	Boundary	0.865	0.973
	Post Vanguard	1.479	0.915
Course C	Pre-Vanguard	4.440	0.488
	Boundary	5.581	0.349
	Post Vanguard	9.264	0.507

Table 7-1 Chi-squared values for grade distributions in Courses A, B and C from 2004-05 to 2008-09

7.6.1 Chi-squared analysis of grade distributions in Course A

A comparison of the final course grade distributions during ***pre-Vanguard*** years yields a chi-squared value of 2.29, which gives a significance value of 0.808. This value reflects the probability that the data under comparison are not significantly different – the larger the value (tending towards 1.0) the less likely it will be that any observed differences or changes are anything other than the usual fluctuations that may occur from year to year in such data. Hence we can assume that in the ***pre-Vanguard*** years the chi-squared test tells us that the grade distributions in Course A before the introduction of Vanguard Principles remained on a statistical par with each other.

Performing the same test on the ***boundary*** years (i.e. one year before and one year after the Vanguard Principles were adopted) yields a chi-squared value of 11.3 and a significance value of 0.046. We can see that this value is much lower than for the ***pre-Vanguard*** years – in fact, the accepted cut-off value, below which we can assume that the difference between the data groups under comparison *are* significant, is 0.05. Hence it appears that a statistically significant change has occurred in the distribution of grades as the course became Vanguard.

The ***post-Vanguard*** chi-squared value of 11.396, coupled with a significance value of 0.327, would appear to suggest that the major change observed in the boundary years was largely confined to that point in time, with any changes occurring in the grade distributions over the following years being less statistically significant.

7.6.2 Chi-squared analysis of grade distributions in Course B

The comparison of the final course grade distributions during ***pre-Vanguard*** years for Course B as shown in Table 7-1 yields a chi-squared value of 5.383, which gives a significance value of 0.371. As previously mentioned, this value reflects the probability that the data under comparison are not significantly different. Hence we can assume that in the ***pre-Vanguard*** years the chi-squared test tells us that any observed change in the grade distributions before the introduction of Vanguard Principles were not statistically significant.

Performing the same test on the ***boundary*** years (i.e. one year before and one year after the Vanguard Principles were adopted) yields a chi-squared value of 0.865 and a significance value of 0.973. This value is even higher than for the ***pre-Vanguard*** years and suggests strongly that the difference between the data groups under comparison is negligible and no significant change has occurred in the distribution of grades as the course became Vanguard.

The ***post-Vanguard*** chi-squared value of 1.479, coupled with a corresponding significance value of 0.915, would appear to suggest that any variations that have occurred in the grade distributions over the time period have been within the bounds of expected year-on-year fluctuations and are unlikely to represent a significant response to external events.

7.6.3 Chi-squared analysis of grade distributions in Course C

Table 7-1 shows that the comparison of the final course grade distributions during ***pre-Vanguard*** years yields a chi-squared value of 4.440, which gives a significance value of 0.488. From this value we can assume that in the ***pre-Vanguard*** years the chi-squared test tells us that any observed change in the grade distributions before the introduction of Vanguard Principles were not statistically significant.

Performing the same test on the ***boundary*** years (i.e. one year before and one year after the Vanguard Principles were adopted) yields a chi-squared value of 5.581 and a significance value of 0.349. Although this value is reasonably low, it nonetheless indicates that the differences observed between the data groups under comparison (primarily an increase in A grades at the expense of B and C grades) are unlikely to be significant.

The ***post-Vanguard*** chi-squared value of 9.264, coupled with a corresponding significance value of 0.507, would appear to suggest that yet again any year-on-year fluctuations are unlikely to represent a significant response to external events.

7.7 Chi-squared analysis of pass-fail rates

The pass-fail rate across the 5 years under study for each course was then subject to a similar series of chi-squared tests. Again, in each case, the data from a particular course was analysed in 3 distinct groups – ***pre-Vanguard*** (all year groups preceding the change to Vanguard), ***boundary*** (including the year before and the year following the shift to Vanguard) and ***post-Vanguard*** (all years following the adoption of the Vanguard Principles). The chi-squared values were calculated together with other related statistical quantities and the results obtained in each case were analysed to determine whether or not any changes or variation across the years are statistically significant. The values obtained for each course are summarised in Table 7-2 (overleaf).

Course	Period	χ^2 Value	Significance Value
Course A	Pre-Vanguard	0.434	0.805
	Boundary	6.881	0.032
	Post Vanguard	5.191	0.268
Course B	Pre-Vanguard	2.892	0.236
	Boundary	0.062	0.970
	Post Vanguard	0.287	0.866
Course C	Pre-Vanguard	3.042	0.218
	Boundary	1.418	0.492
	Post Vanguard	1.195	0.879

Table 7-2 Chi-squared values for pass/fail rates in Courses A, B and C from 2004-05 to 2008-09

7.7.1 Chi-squared analysis of pass-fail rates in Course A

Table 7-2 shows that a comparison of the pass-fail rates during ***pre-Vanguard*** years yields a chi-squared value of 0.434, which gives a significance value of 0.805. Hence we can assume that in the ***pre-Vanguard*** years the chi-squared test tells us that, as with the grade distributions, the pass-fail rates in Course A before the introduction of Vanguard Principles remained on a statistical par with each other.

Performing the same test on the ***boundary*** years (i.e. one year before and one year after the Vanguard Principles were adopted) yields a chi-squared value of 6.881 and a significance value of 0.032. Again, we can see that, as with the grade distributions for this time period, this value is below 0.05. Hence it appears that a statistically significant change has occurred that has not only had an impact on the distribution of grades, but also on the actual pass-fail rate as the course became Vanguard.

The ***post-Vanguard*** chi-squared value of 5.191, coupled with a significance value of 0.268, would again appear to suggest that the major change observed in the boundary years was largely confined to that point in time, with any changes occurring in the pass-fail rate over the following years being less statistically significant.

7.7.2 Chi-squared analysis of pass-fail rates in Course B

The comparison of the pass-fail rate in Course B during ***pre-Vanguard*** years as shown in Table 7-2 yields a chi-squared value of 2.892, which gives a significance value of 0.236. We can assume that this result indicates that the observed dip in the pass-fail rate before the introduction of Vanguard Principles was not statistically significant.

Performing the same test on the ***boundary*** years (i.e. one year before and one year after the Vanguard Principles were adopted) yields a chi-squared value of 0.062 and a significance value of 0.970. This value indicates that any differences between the data groups under comparison are negligible and no significant change has occurred in the pass-fail rate as the course became Vanguard.

The ***post-Vanguard*** chi-squared value of 0.287, coupled with a corresponding significance value of 0.866, would appear to suggest that the observed changes in the pass-fail rate over the time period have been within the bounds of expected year-on-year fluctuations and, as before, are unlikely to represent a significant response to external events.

7.7.3 Chi-squared analysis of pass-fail rates in Course C

Table 7-2 shows that the comparison of the final course grade distributions during ***pre-Vanguard*** years yields a chi-squared value of 3.042, which gives a significance value of 0.218. From this value can assume that although a seemingly large rise in the pass rate occurred in the 2005-2006 year, any observed change before the introduction of Vanguard Principles was not statistically significant.

Performing the same test on the ***boundary*** years (i.e. one year before and one year after the Vanguard Principles were adopted) yields a chi-squared value of 1.418 and a significance value of 0.492. Again, this indicates that the differences observed between the data groups under comparison (this time, a fall in pass rate across the boundary) are unlikely to be significant.

The ***post-Vanguard*** chi-squared value of 1.195, coupled with a corresponding significance value of 0.879, would appear to suggest that yet again any year-on-year fluctuations are unlikely to represent a significant response to any changes that took place in the course.

7.8 Summary of the statistical analysis of final course marks

A review of the mean, median and modal course marks combined with a visual examination and a chi-squared analysis of the grade distributions and pass-fail rates over the period studied for each subject indicated;

7.8.1 Summary of Course A

- There was little change in the grade distributions or pass-fail rates during the *pre-Vanguard* years, although the mean, median and modal course marks increased during that time

- A statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles to the following year that must be attributed to something other than "noise" or random fluctuations. There was also an observable "spike" in the mean, median and modal course marks in the 2006-2007 year, following the introduction of the Vanguard Principles. This statistically significant change was also apparent in the pass-fail rates during this time, indicating that not only did the adoption of the Vanguard Principles coincide with a non-trivial change in grade distributions, but also with a non-trivial increase in the overall pass rate

- There was no dramatic change from one *post-Vanguard* year to the next. However, the visual analysis of the grade distributions showed a gradual and continued movement to the left, reflecting an overall upward shift of grades, together with a gradual increase in pass rate during this time. This was also supported by the upward trend in both the mean and median course marks over the period of study

7.8.2 Summary of Course B

- Although there was an observed fall in the pass rate during the *pre-Vanguard* years, the chi-squared values reflected the fact that this change was not statistically significant. The mean, median and modal course marks decreased to their minimum values for the period of study in 2005-2006

- No statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles and the following year that may be attributed to something other than "noise" or random fluctuations. The mean, median and modal course marks recovered from their low point in 2005-2006 and showed a noticeable increase in the

2006-2007 year, following the introduction of the Vanguard Principles. The pass rate showed a slight but statistically non-significant decrease during this time

- There was no dramatic or statistically significant change from one *post-Vanguard* year to the next. However, the visual analysis of the grade distributions showed a slight decrease in the number of A grades together with a corresponding increase in the number of B grades during this time. Both the mean and median course marks remained stable, while the mode was seen to decrease.

7.8.3 Summary of Course C

- Although there was a slight increase in A grades in 2005-2006 coupled with an increase in the pass rate during the *pre-Vanguard* years, the chi-squared values reflected the fact that these changes were not statistically significant. The mean and median course marks remained steady during this time while a spike was observed in the modal course mark in 2005-2006

- Although in 2006-2007 the number of both B and C grades dips while the number of A grades increases., the chi-squared value indicates that no statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles to the following year, The mean and median remained steady while the mode decreased following the introduction of the Vanguard Principles. The pass rate showed a slight but statistically non-significant decrease during this time

- There was no dramatic change from one *post-Vanguard* year to the next. A visual analysis of the grade distributions showed a slight decrease in the number of A grades across these years, with no obvious trend in pass rates. Both the mean and median course marks remained stable over this time, while the mode was seen to increase.

7.9 Examining changes that may have been significant

The detailed analysis of the final course marks obtained in the three courses pinpoints specific areas where changes occurred that may not be solely attributed to the typical "natural" fluctuations that take place from year to year. The changes that were observed are summarised in Table 7-3 (overleaf).

The purpose of the study was to identify changes that, at the very least, *were coincident with the transition of each course to "Vanguard" status* – i.e. as they became early adopters of the College's Teaching and Learning Principles, and more specifically as they introduced technology-based innovations in order to support these principles. This transition took place between the 2005-06 and 2006-07 years, and hence it would be ideal to be able to make the assertion that any change in the status quo observed in the final course marks around this time may point to such changes arising directly from the adoption of the Vanguard Principles. However, there is no guarantee (in fact it is highly unlikely) that the adoption of the new Principles was done in isolation – it is entirely possible that other unrelated changes either happened or were made to or even were imposed upon the courses in question. Many of these possible changes could have had observable effects on the data, and these effects could easily mask or exaggerate any improvement due to the transition to "Vanguard". Hence if we are to establish that the use of technology to support the adoption of the Vanguard Principles had a measurable impact on the final course marks of the courses then it is imperative that we not only identify what other possible changes may have occurred but also whether or not they occurred in the time under study and what their impact, if any, might have been.

Period	Course A	Course B	Course C
Pre-Vanguard	There was little change in the grade distributions or pass-fail rates during the *pre-Vanguard* years, although the mean, median and modal course marks increased during that time	Although there was an observed fall in the pass rate during the *pre-Vanguard* years, the chi-squared values reflected the fact that this change was not statistically significant. The mean, median and modal course marks decreased to their minimum values for the period of study in 2005-2006	Although there was a slight increase in A grades in 2005-2006 coupled with an increase in the pass rate during the *pre-Vanguard* years, the chi-squared values reflected the fact that these changes were not statistically significant. The mean and median course marks remained steady during this time while a spike was observed in the modal course mark in 2005-2006
Boundary	A statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles to the following year that may be likely be attributed to something other than "noise" or random fluctuations. There was also an observable "spike" in the mean, median and modal course marks in the 2006-2007 year, following the introduction of the Vanguard Principles. This statistically significant change was also apparent in the pass-fail rates during this time, indicating that not only did the adoption of the Vanguard Principles coincide with a non-trivial change in grade distributions, but also with a non-trivial increase in the overall pass rate	No statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles and the following year that may be attributed to something other than "noise" or random fluctuations. The mean, median and modal course marks recovered from their low point in 2005-2006 and showed a noticeable increase in the 2006-2007 year, following the introduction of the Vanguard Principles. The pass rate showed a slight but statistically non-significant decrease during this time	Although in 2006-2007 the number of both B and C grades dips while the number of A grades increases., the chi-squared value indicates that no statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles to the following year, The mean and median remained steady while the mode decreased following the introduction of the Vanguard Principles. The pass rate showed a slight but statistically non-significant decrease during this time
Post-Vanguard	There was no dramatic change from one *post-Vanguard* year to the next. However, the visual analysis of the grade distributions showed a gradual and continued movement to the left, reflecting an overall upward shift of grades, together with a gradual increase in pass rate during this time. An upward trend in both the mean and median course marks over the period of study was observed.	There was no dramatic or statistically significant change from one *post-Vanguard* year to the next. However, the visual analysis of the grade distributions showed a slight decrease in the number of A grades together with a corresponding increase in the number of B grades during this time. Both the mean and median course marks remained stable, while the mode decreased.	There was no dramatic change from one *post-Vanguard* year to the next. A visual analysis of the grade distributions showed a slight decrease in the number of A grades across these years, with no obvious trend in pass rates. Both the mean and median course marks remained stable over this time, while the mode was seen to increase.

Table 7-3: Summary of observed changes in the Vanguard course marks 2004-2009

7.10 Possible reasons for change

It seems reasonable to suggest that there are four broad areas in which change is likely to take place that may have a direct or indirect impact on the final course marks in a course for any particular year. These are the nature of the students taking the course, the course itself, the way the course is assessed and changes in policy either within the department concerned or across the College or University as a whole. These areas may be broken down as follows;

- **Changes in the students**
    - Change in intake profile of students
    - Change in ability of students

- **Changes in the course**
    - Change in syllabus
    - Change in teaching staff
    - Change in course structure

- **Changes in assessment**
    - Change in assessment methods
    - Change in marking process
    - Change in marking standards
    - Change in weighting/mark adjustments
    - Change in exam/coursework split
    - Change in exam question styles

- **Changes in policy**
    - Change in marking standards
    - Change in weighting/mark adjustments
    - Change in re-sit policy

It is, of course, important to be able to eliminate these other possible causes of change if we are to reliably attribute any of the changes suggested by the statistical analysis to the shift to "Vanguard" and the use of technology in the courses (Cohen et al., 2005, p. 117).

7.10.1 Changes in the students

Attributing a change in the course marks to an educational intervention assumes a certain level of consistency or homogeneity in the student body during the period of study. Specifically, it assumes that there has been no major change in the intake profile of the students (including factors such as male/female ratios) or in the ability of those students, as might be indicated, for example, by the entry grades in a particular year. There will inevitably be a natural variation in these factors from year to year, but is unlikely that such random fluctuations would reveal themselves as *trends*. However, it is fair to assume that any significant variations are likely to have been identified by those in charge of the courses themselves.

- *Course A* – The data show that the number of students taking the course increased over time, and the Course Organiser indicated that these students were on average better qualified (in terms of secondary examination grades, primarily Scottish Higher Grades) than they were in previous years. Interestingly, there was no feeling that this was purely a result of ongoing "grade inflation". However, it is also interesting to note that, according to the Course Organiser (although data were not available), these students did *not* perform any better than their predecessors in the "standard concept test" routinely given to all first year students taking the course.

- *Course B* – The Course Organiser reported that there had been no significant changes observed in the students over the past number of years.

- *Course C* – Again, the Course Organiser reported that in recent years there has been an apparent increase in the "quality" of the student intake to the course (it is assumed that in this context the term "quality" refers primarily to the academic ability of the students taking the course), and this is, at least in part, attributed to the increase in the number of Eastern European students. These students have been observed to display a more industrious approach to study than their local counterparts.

However, the Course Organiser admitted that these were no more than postulations based on "instinct" rather than on any hard evidence that the students were, in fact, more academically able or harder-working than in previous years.

7.10.2 Changes in the course

It could also be argued that the validity of making year-on-year comparisons of marks in a course in search of effects produced by the adoption of the "Vanguard" principles and the resulting implementation of one or more technology–based innovations in the way the course was delivered also depends on the absence of any other changes occurring within the course itself. Such changes may include specific changes to the syllabus and therefore the content of the course, changes in the personnel who teach or support the course or changes in the way the course is structured, such as the balance between lectures, tutorials and laboratory sessions. However, it is here that the waters become more than a little muddied. While it is clear that such changes may indeed have an impact on the course marks obtained by students in a particular year, the changes themselves may also have directly arisen from the decision to adopt the "Vanguard" principles into the way a course was delivered. For example, a particular course may choose to move away from a didactic form of "delivery" towards a more student-centred approach, putting content and resources online and leaving more time for tutorials and laboratory work. This may even necessitate changes in the syllabus. If such changes have indeed been made during the transition period and these coincide with significant changes in students' course performance, it makes sense to highlight these changes but it would be equally wise not to discount the influence the adoption of the new principles of teaching and learning had on these decisions.

- *Course A* – The last major change to the course syllabus was made in 2003-2004, i.e. before the period considered by this study. However, the explicit adoption of the “Vanguard” principles in 2006-2007 led to the introduction of several changes in the way the course was delivered, including the replacement of traditional “labs” with tutorial-like sessions based in a technology-rich teaching space as well as the regular use of an interactive “clicker “system to augment course lectures. Teaching staff changes occurred in 2005-2006 and 2008-2009.

- *Course B* – The Course Organiser stated that the content had remained unchanged over the time period in question.

- *Course C* – All first year courses in this area were revamped in 2006-2007, which coincided with Course C becoming a “Vanguard” course. These two facts are inextricably linked – plans to introduce changes into the courses will have made it easier to also adopt the new teaching and learning principles, and these principles in turn clearly had an impact on how Course C at the very least was structured. However, it is also worth noting that although there were changes to the course in 2006-2007, these changes were, antithetically, also accompanied by a very conservative and clearly stated determination on the part of the Course Organiser *not* to “rock the boat” or to introduce any change that may have any adverse affect. There were no other changes of note made to the syllabus or course structure, and the course is still taught by the same lecturer.

7.10.3 Changes in assessment

A key consideration when comparing course marks over successive years is of course whether or not the modes of assessment have remained unchanged, or at least comparable. The way a course is assessed can have a direct impact on the marks obtained by students and so knowing that there is a satisfactory level of consistency across the years is essential if comparisons are to be made. The method (or methods) of assessment may change – for example there may be a shift away from a single end-of-year exam to more continuous assessment, or there may a change in the split between coursework and a final exam. There may also be non-trivial changes made in examinations, such as the types of question used and the way in which such questions are marked. It is also conceivable that there may be adjustments made from one year to the next in the way course marks are obtained and processed – for example, standards of marking may be loosened or tightened, or weightings that may be applied to marks before they are released may be adjusted, either for internal departmental reasons or at the request of external agencies such as external examiners to improve quality or reliability or even university bodies to encourage compliance with university-wide standards or targets.

- *Course A* – The marking processes and any procedures for weighting or adjusting marks remained consistent across the years under study. In addition, there were no changes in the balance or split between coursework and the final end-of-year exam. However, there were some changes made to the overall method of assessment, or at least new contributors to the overall assessment were introduced in 2007 and again in 2008. In 2007, the course introduced a diagnostic test, weighted as a few percent of the overall final mark. In 2008, a mid-term exam was introduced which contributed to the final mark. Question styles also seem to have evolved as described by the Course Organiser; “There has been a move in recent years to set 'compound problems' in a bid to evidence students' development of problem solving skills. A typical example might be an extended problem, worth 10-15 of the 25 marks for the entire exam question, where the student has to define the correct strategy to solve the problem, rather than have it spelt out in salami-sliced mini-problems.”

- *Course B* – There were no changes in the assessment processes reported by the Course Organiser.

- *Course C* – Again, the marking processes and any procedures for weighting or adjusting marks remained consistent across the years under study. However, in the 2006-07 and 2007-08 courses, there was a large element of continuous assessment (roughly one assessed exercise every two weeks that contributed toward the final mark). It was felt by the course team that this approach inadvertently made the students too focused on scoring marks rather than on studying the course material, and in the following year a shift was made so that these exercises became for practice only and did not contribute to the final mark.

7.10.4 Changes in policy

We have already mentioned that some changes may be introduced (or imposed) as a result of priorities that lie outside the immediate confines of the course, such as with the department in which the course resides or the wider College or University, particularly in the area of marking and standards of assessment. There may be additional policy decisions that could conceivably have an impact that may be observable as a change in the course marks obtained over a period of time. An example of such a factor would be a change in the policy that governs how re-sits are handled for those students who fail a particular course. A change that limited (or no longer limited) the final mark they could obtain in a re-sit would obviously show itself in any course data and would make it difficult to compare sets of data that may contain a number of results obtained by students who were re-sitting one or more of the exams.

- *Course A* – The Course Organiser reported that there were no major shifts in policy at a departmental, College or University level that may have affected the final course marks during this time.

- *Course B* – Again, the Course Organiser reported that there were no major shifts in policy at a departmental, College or University level that may have affected the final course marks during this time.

- *Course C* – As with Courses A and B, the Course Organiser reported that there were no major shifts in policy at a departmental, College or University level that may have affected the final course marks during this time.

7.11 Impact of changes on the course marks

Having reviewed each course in order to identify any possible changes that may have occurred in the students, course, assessment or policy, we are better placed to comment on the likelihood of any such changes having occurred in a way that would have significantly affected the final marks in each course. Table 7-4 summarises the information gathered on each possible change for each course, and highlights those categories that may have contributed to the changes in course marks outlined in Table 7-3. The colours indicate the following;

- ***Red***: a significant change "event" has occurred in the students, course, assessment or policy that may have contributed to any observed change in the statistics for that course
- ***Orange***: a significant change "event" has occurred in the students, course, assessment or policy that may have contributed to any observed change in the course statistics for that course, but the change "event" itself was likely to have been a direct result of the adoption of the Vanguard Principles
- ***Green***: no significant change "event" has occurred in the students, course, assessment or policy.

It is clear from Table 7-4 (overleaf) that there are indeed several events that could potentially have contributed to the changes observed in the course statistics for the three courses, and it is worth taking a closer look at these specific areas to see if any of these events were likely to have been *significant* contributors to any of the observed changes.

7.12 Impact of the changes on marks in Course A

7.12.1 Changes in the intake profile of the students

It is interesting that the Course Organisers of each of the courses remark on the perception that the student intake may be becoming better qualified. However, at least in the case of Course A, this observation cannot be taken in isolation. As is recorded in the following category, each Course A student was required to take a "standard concept test" on an important area of the subject. Students did *not* perform any better than their predecessors in this test, indicating that although students may be better qualified, we cannot make any assumptions regarding how well or otherwise they might perform in the subject. Hence it is unlikely that this factor will have contributed to the observed changes in the statistics over time.

7.12.2 Changes in teaching staff

Although the two changes in teaching staff that occurred during the time in question could easily have had an impact on the students and their course performance, there are no significant deviations from the overall trends observed that coincide with these changes.

<table>
<tr><th>Possible Change</th><th>Course A</th><th>Course B</th><th>Course C</th></tr>
<tr><td colspan="4">Changes in the students</td></tr>
<tr><td>Change in intake profile of students</td><td>There was a perception that students may be becoming better qualified.</td><td rowspan="2">There were no reported changes in the intake profile or in the ability of the students.</td><td rowspan="2">The Course Organiser reported that in recent years there has been a perceived increase in the “quality” of the student
It is assumed that the term “quality” refers primarily to the academic ability of the students taking the course.</td></tr>
<tr><td>Change in ability of students</td><td>Students did not perform any better than their predecessors in the “standard concept test” routinely given to all first year students taking the course.</td></tr>
<tr><td colspan="4">Changes in the course</td></tr>
<tr><td>Change in syllabus</td><td>The last major change to the course syllabus was made in 2003-2004, i.e. before the period considered by this study</td><td>There were no changes made to the course syllabus during this time.</td><td>All first year courses in this area were revamped in 2006-2007. Changes were conservative and designed not to introduce any change that may have any adverse affect.</td></tr>
<tr><td>Change in teaching staff</td><td>Teaching staff changes occurred in 2005-2006 and 2008-2009</td><td>There were no teaching staff changes during this time</td><td>There were no teaching staff changes during this time</td></tr>
<tr><td>Change in course structure</td><td>In 2006-2007 several changes were made, including the replacement of “labs” with tutorial-like sessions based in a hi-tech teaching space as well as the regular use of an interactive “clicker “system</td><td>There were no teaching staff changes during this time</td><td>There were no teaching staff changes during this time</td></tr>
<tr><td colspan="4">Changes in assessment</td></tr>
<tr><td>Change in assessment methods</td><td>In 2007, the course introduced a diagnostic test, weighted as a few percent of the overall final mark. In 2008, a mid-term exam was introduced which contributed to the final mark.</td><td>There were no changes in the assessment methods used in the course.</td><td>A large element of continuous assessment present in the 2006-07 and 2007-08 courses was removed the following year.</td></tr>
<tr><td>Change in marking process</td><td rowspan="3">The marking processes, standards and any procedures for weighting or adjusting marks remained unchanged.</td><td rowspan="3">The marking processes, standards and any procedures for weighting or adjusting marks remained unchanged.</td><td rowspan="3">The marking processes, standards and any procedures for weighting or adjusting marks remained unchanged.</td></tr>
<tr><td>Change in marking standards</td></tr>
<tr><td>Change in weighting/mark adjustments</td></tr>
<tr><td>Change in exam/coursework split</td><td>There were no changes in the balance or split between coursework and the exam.</td><td>There were no changes in the balance or split between coursework and the exam.</td><td>There were no changes in the balance or split between coursework and the exam.</td></tr>
<tr><td>Change in exam question styles</td><td>'compound problems' have been used in recent years in a bid to evidence students' development of problem solving skills.</td><td>No changes were reported in the styles of questions used in the final exam.</td><td>No changes were reported in the styles of questions used in the final exam.</td></tr>
<tr><td colspan="4">Changes in policy</td></tr>
<tr><td>Change in marking standards</td><td rowspan="3">There were no major shifts in policy reported at a departmental, College or University level</td><td rowspan="3">There were no major shifts in policy reported at a departmental, College or University level</td><td rowspan="3">There were no major shifts in policy reported at a departmental, College or University level</td></tr>
<tr><td>Change in mark weighting</td></tr>
<tr><td>Change in re-sit policy</td></tr>
</table>

Table 7-4: Summary of reported changes in students, course, assessment or policy

7.12.3 Changes in course structure

The changes made to the Course A course in 2006-2007, including the replacement of traditional “labs” with tutorial-like sessions based in a technology-rich teaching space as well as the regular use of an interactive “clicker“ system to augment course lectures, could easily have had a major impact on the students and their performance in the subject, being, as they were, focused on increasing student understanding of and engagement with the course material. Indeed, the introduction of these new innovations coincided exactly with a significant upward shift in the course statistics. However, these changes were not only sympathetic to, but are difficult (if not impossible) to separate from the adoption of the new teaching and learning principles, and their introduction formed part of the stated innovations that would indeed make this a “Vanguard” course. Hence, although it is clear that these changes may have had a significant effect on the course statistics that year, it is also clear that these changes were themselves an inherent part of the shift to “Vanguard” status.

7.12.4 Changes in assessment methods

Two non-trivial changes in assessment occurred in the post-Vanguard years – the introduction of a “diagnostic test” in 2007 and a mid-term exam in 2008. During this time, the statistics reveal an overall upward shift of grades, together with a gradual increase in pass rate during the same period. This was also supported by the upward trend in both the mean and median course marks over the period of study. Although these changes were obviously made for well thought-out educational reasons, we cannot necessarily associate them with the notion of the course being “Vanguard” and hence it is difficult to ignore the fact that such changes in the way the course is assessed (such as the beneficial impact of early opportunities for formative feedback) may well have been significant contributors to the observed changes over and above any “Vanguard” effects.

7.12.5 Changes in exam question styles

The introduction of so-called "compound problems" could also have easily had an impact on the course statistics – these problems were specifically designed to enable students not just to memorise the correct answer, but to display (and gain credit for) an understanding of the concepts involved in solving a particular problem. It is clear that the increased use of such an approach could enable some students to score better in those exam questions if they were to gain partial credit for what may ultimately be an incorrect answer. However, as with the changes in course structure, the decision to use this particular style of question was taken as part of a broader plan that was deeply influenced by, and sympathetic to, the new teaching and learning principles that were explicitly embraced as the course became "Vanguard." It is therefore difficult to argue that this particular change can be treated as a contributor to the shifts observed in the course statistics separate from the adoption of the "Vanguard" principles.

7.12.6 Conclusions regarding changes in Course A

Course A appears to be a dynamic course that is undergoing constant change or evolution in many of its aspects. There are changes that have taken place over the past number of years that clearly could have had an impact on the course results. However, it is interesting to note that all but one of these changes (the changes in teaching staff) are changes that may also be described in terms of the Vanguard status of the course – in other words, where there has been change in Course A, the Vanguard Principles have not been far behind. In addition, one of these changes (the adoption of the new tutorials) had technology very much at its heart. Hence it seems reasonable to assert that while there were a number of changes taking place that could have contributed to changes in the course statistics, these changes were closely associated with the Vanguard Principles and cannot easily be separated from the course's move to Vanguard status.

7.13 Impact of the changes on marks in Course B

Course B is conspicuous in its lack of any additional changes over the past number of years in the areas discussed as reported by the Course Organiser. However, this apparent inertia makes it much more likely that any changes observed in the course statistics may be attributed to the introduction of technology into the course as part of the adoption of the Vanguard Principles.

7.14 Impact of the changes on marks in Course C

7.14.1 Changes in the intake profile/ability of the students

Like Course A, the Course Organiser reported that in recent years there has been a perceived increase in the "quality" of the student. Although the notion of "quality" is taken to refer primarily to academic ability, it is interesting to note that this observation is based on (or at least rationalised by) the increased number of Eastern European students, who as stated before displayed a rather more industrious attitude to their studies than their local counterparts. It is easy to see how this may play out in course statistics. However, the data for Course C are notable for their *lack* of visible trends in the key statistics, with no clear shift in either direction. Hence, although we cannot contradict the notion that the change in the profile of the student intake could have had a measurable impact on the course statistics, in this case there were no corresponding changes detected in the data.

7.14.2 Changes in the syllabus

The paradox of a "revamp" that occurred in 2006-07 in the context of a concerted effort not to "rock the boat" makes it difficult to judge whether or not this constituted a change that could conceivably have had a direct impact on the course statistics. Certainly, any re-think of the material taught within the course could conceivably have had a significant effect on the course statistics following the change, although it is also clear that this work was again directly related to the idea of the course becoming “Vanguard”, occurring as it did at that specific time. However, any changes observed during this period do not appear to be significant (***see Table 1***), and this may be explained by fact that there also existed a clearly stated aim to maintain the status quo. It is worth noting that even if the change in syllabus did contribute to any change observed in the statistics, it would be difficult to separate this from the adoption of the “Vanguard” principles.

7.14.3 Changes in assessment methods

Despite the seemingly significant move away from continuous assessment in the post-Vanguard years, there were no observed changes in the course statistics (either up or down) that may have been the result of such a change. Hence we can conclude that the change in assessment methods had no visible impact on the marks studied.

7.14.4 Conclusions regarding changes in Course C

Like Course A, there were several changes reported in Course C that may have contributed to any observed shift in the course results. However, as the preceding discussion highlights, two of these changes do not coincide with any significant change, while the third (the rewrite of the course syllabus) was a direct result of the course’s adoption of the Vanguard Principles. Hence there is no strong case here for attributing any observed changes (although these were few and far between) to anything that lies outside the move to Vanguard.

7.15 Part of a bigger picture

It is clear that even the most intriguing changes discussed in this chapter are slight, and that there are more contributing factors at work to cause such changes than simply a move to introduce technology into some aspect of each course. However, even a conclusion of "*no significant difference*" may be a valid one in this context as the quantitative data, and in particular the effect of the shift to Vanguard and the introduction of technology on the final course marks, are only a small part of much bigger picture (T. L. Russell, 2001). Despite the fact that positive changes in the final course marks would have been a welcome result of the changes made to the courses, those who devised the Learning and Teaching Strategy were more focused on increasing student responsibility. It may have been possible, and even satisfactory in the eyes of those involved, for the shift to Vanguard and the associated use of technology to have had a significant impact on the courses without producing a corresponding change in the final course marks. Hence we must return to the other data sources to form a more complete picture of any changes that *did* occur in these courses.

Chapter 8. Comparing data sources – is there a story?

8.1 Introduction

At this point in the discussion, it is worth pausing to review what has been done so far. The choice of data and collection methods used during this study of the Vanguard courses was determined primarily by the Framework, on which the investigation is based. This framework, described in detail in Chapter 3, highlighted the ***Foundations*** necessary for ***transformation*** of teaching and learning to occur as well as three distinct areas in which research has indicated that such transformations may occur – ***Institutional*** transformations (those affecting overall policies, approaches or attitudes within a particular institution), ***Material*** transformations (those affecting the content of a particular course and the way it is delivered) and ***Behavioural*** transformations (those affecting the way teachers and students act and interact with each other). In addition, Chapter 7 described how quantitative data from 2004/2005 to 2008/2009 (before, during and after the transition to "Vanguard") for the courses in question were gathered and analysed in an attempt to identify any statistically meaningful changes that may have coincided with the use of new technologies. However, up to this point each group has largely been dealt with independently of the others, and it must be acknowledged that in actual fact the data sources may well be interconnected in non-trivial ways that, if considered together, could help paint a clearer picture of the backgrounds to, and the effects, of the implementations of technology in these courses. In particular, we can group the data we have gathered in two ways;

1. The data obtained from the key groups of staff involved with the courses (Undergraduate Deans, Course Organisers, Lecturers and Postgraduate Tutors) should be viewed as a whole so that any similarities or

differences between the groups and how they perceived the effects of technology on the courses can be identified and considered in terms of the impact they may have on how the data are interpreted.

2. The claims made by those directly involved in teaching the courses, particularly with regards to their perceptions of how the use of new technologies has had an impact on the performance of their students, should be viewed in the light of the quantitative data obtained for those courses. This may enable us to validate those perceptions or to clarify them as unsubstantiated opinions of those concerned.

Hence in the remainder of this chapter we will draw together the data as described above in order to identify any specific areas of corroboration or contradiction in the data and to provide a broader view of not only *where* technology may have had transformative effects but also *how* the story behind the implementations may inform what happened in the courses.

8.2 From the top down – comparing the qualitative data

A key part of the research was to gather relevant data from each of the key staff groups who were connected with each course and the transition to "Vanguard" status. At what we might consider the "top" of the group came the Deans of undergraduate teaching and learning. In addition to having overall responsibility for teaching and learning within the College of Science and Engineering, the first Dean (Dean 1) also played a pivotal role in devising and implementing the Vanguard Principles which in turn provided the impetus for the use of new technologies in many of the Vanguard courses. As such, the views and opinions expressed by the Dean could reasonably be expected to reflect the ethos behind the Vanguard courses and a perspective that focuses on what the effects of "Vanguard" should be. Dean 1 was replaced by Dean 2 in 2009, and we would naturally expect his perspective, although still that of a senior "overseer", to be different – not only was he less directly involved in the introduction of the Vanguard Principles, but his thoughts were also expressed much later in the "Vanguard" phase.

Similarly, we would expect the views of the Course Organisers to bear the hallmarks of the ideals of the Vanguard Principles, being, as they were, the trailblazing early-adopters of this new initiative. However, the Course Organisers were naturally closer to the practicalities of applying the Principles in their courses and making decisions as to where changes might be made, and where it was more important to avoid disruption. Ultimately, it was the lecturers who had to deliver the courses, and their perspectives would naturally reflect their own observations as to what worked and what didn't. It should also be clear from their comments to what degree the Vanguard Principles and the ideas behind them had been communicated to or discussed with them and what prominence they had at this level, together with the impact they may have had on the courses they were teaching. Similarly, it seems reasonable that if a course was wholeheartedly adopting the Vanguard Principles then those involved in taking tutorials, workshops or practical classes (usually postgraduates in the subject, but given a range of titles such as Teaching Assistant or Postgraduate Tutor) would have an awareness, even on a basic level, of the "Vanguard" nature of the course. Hence, reviewing the data gathered from each of these groups and comparing their perspectives and observations on the use of technology to encourage the transformation of teaching and learning may tell a story about how the Vanguard Principles were adopted and passed on at each level and how the ideals and rhetoric at the "top" were translated into reality at the teacher-student interface, as shown in Figure 8-1;

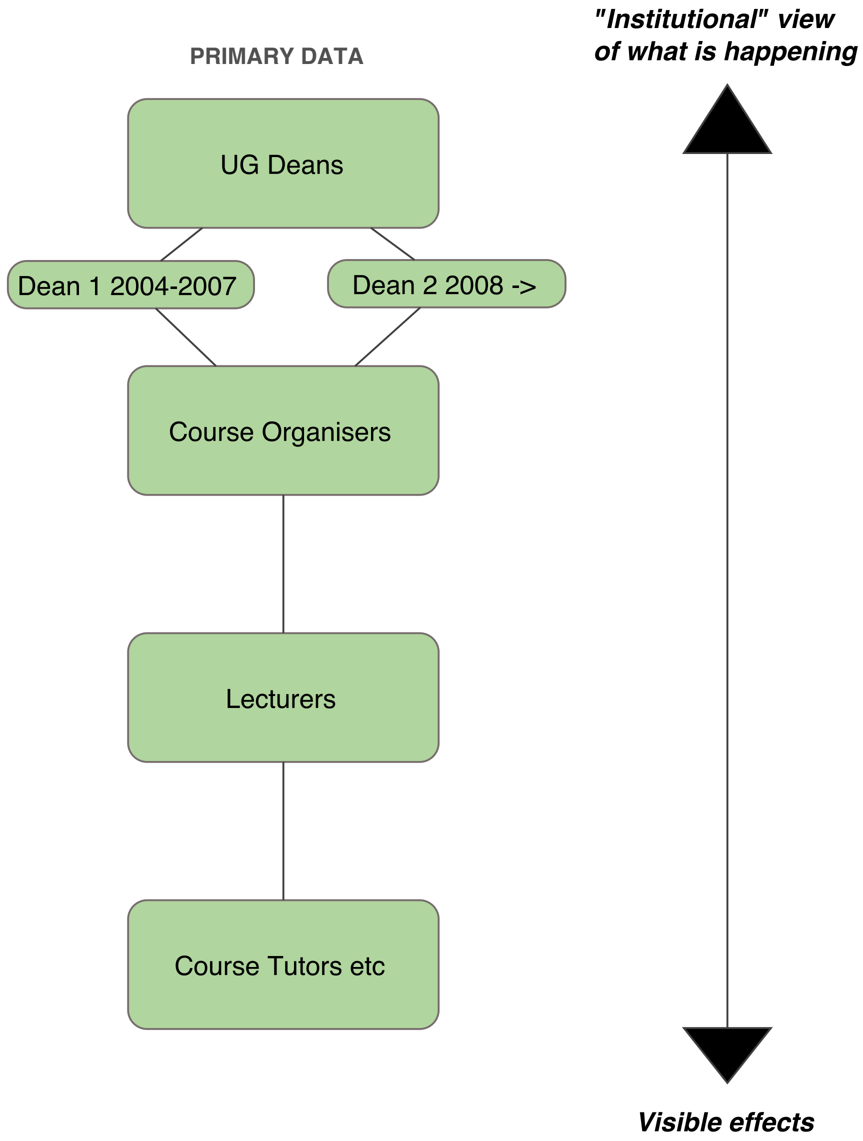


Figure 8-1 Hierarchy of data sources

8.3 Foundations for Transformation and Institutional Transformations

The elements of the ***Institutional Transformations*** framework are very similar to those in the **Foundations** framework- not only are careful planning, resourcing and professional development key foundations to the successful implementation of a particular educational technology, but the decision to use technology in this way in itself may prompt those involved to consider or rethink their approach to these areas. As a result, there is a high degree of overlap in the perspectives of the three groups regarding the ***Foundations*** in place as the Vanguard courses were introduced and the ***Institutional Transformations*** that may have resulted from the implementation of the technologies. Hence the interviews and surveys of the Deans of Undergraduate Studies, Course Organisers, Lecturers and other teaching staff were first reviewed in order to obtain an overview of the perspectives each of these groups had regarding the elements identified as the Foundations for Transformation and those that were indicative of Institutional Transformations. The results were summarised in Tables 8-1 and 8-2 and colour-coded to highlight positive views (green), views that were mixed or that contained significant qualifications (orange) and negative views (red) in relation to each of the Guiding Questions. This enabled simple comparisons to be made between the corresponding perspectives of the three distinct groups.

8.3.1 F1 – The presence of a clear rationale/ I1 – Planning educational interventions

It seems that, from the Deans' perspective, there was a clear rationale for the introduction of technology into the courses that was rooted in the Learning and Teaching Strategy and the Vanguard Principles. They also had a clear expectation that the decision to implement such technology would necessarily have an influence on how the courses were planned. Both the Course Organisers and teaching staff agreed to some extent that clear rationales existed, but they did not automatically associate these with the Learning and Teaching Strategy and the Vanguard Principles. Perhaps surprisingly, while the teaching staff broadly felt that there may have been some influence on the way the courses had been planned, the Course Organisers stated strongly that the technology had *not* had any influence over how the courses had been planned initially, although they suggested this might happen at some time in the future. This mismatch between the views of the three groups is the first indication that, while the Deans were effectively reporting what they thought *should* be happening, the Course Organisers were reporting what had *actually* happened. The fact that the other teaching staff felt there may have been some influence on the way the courses were planned may merely indicate that they themselves made some changes at "ground level" as they sought to implement the technology, even though the Course Organisers had not proactively built such changes into the courses. We see another disconnect between the views of the teaching staff and those above them regarding whether or not the use of technology had prompted a review of what was being taught. Again, the Deans had the expectation that this kind of review would naturally follow the initial implementation, and the Course Organisers broadly shared this perspective. However, the other teaching staff had little impression that any form of review of what was taught would be part of any use of technology, either in the initial stages or later on, seeing the technology as another tool in the teaching toolbox.

8.3.2 F2 – The presence of willing participants

There was an assumption on the part of the Deans that "early adopters" (those who stepped forward to be among the first of the Vanguard Courses) were, by definition, willing participants and would be the most likely to adopt the Principles and use technology in an appropriate way to support them. However, there was also an expectation that there would inevitably be a "tail" of teaching staff who would remain reluctant to change their current practices or adopt new approaches to teaching and learning. This was reflected in the views of the Course Organisers, who observed that those involved in the Vanguard Courses were a mix of innovators, followers ready to change, and those who were, at this stage, paying lip service only to the Vanguard ideals "because they were asked to" while striving to leave their courses unchanged. It was clear that those involved in teaching the courses were themselves willing participants insofar as they were, as a group, acquiescent to the decisions made by a small number of people. However, there was distinct difference in the apparent level of commitment to the technologies and their purpose from the Deans and Course Organisers at this level, perhaps again reflecting the fact that this group was more detached from the vision and ideals that lay behind the Vanguard Courses. In particular, as might be expected, teaching assistants were the least invested in the innovations.

8.3.3 F3 – The provision of sufficient resources/ I2 – Resourcing educational interventions

The Deans expressed the hope that the Vanguard courses would act as a catalyst for change throughout the College, not least of all in the way all courses are taught, and felt that it was likely that this would have consequences going forward in terms of time and other resources. The College had, as part of the broader move towards innovation in teaching and learning, secured the services of an educational technologist, but in general it was acknowledged that courses could not be resourced in terms of time or money beyond the existing provision. There was a feeling in particular that more resources would need to be provided in the future to support teaching with technology. The Course Organisers cited the provision of additional e-learning support and expertise by the College but confirmed that little else in terms of extra time or resources was available for the new initiatives. However, depending on the technology chosen (and the course) there was some disagreement as to whether the use of technology would be more demanding going forward, at least in terms of time, and therefore there was some debate as to whether or not significant changes in resourcing would be necessary. The rest of the teaching staff saw no extra provision in this area and had little to say about what the requirements might be in the future. One would expect course tutors not to be particularly engaged in this aspect due to the often temporary nature of their involvement, and the fact that they are more likely to be involved in laboratory sessions, tutorials and so on rather than in lectures where some of the technologies were most used. However, in general there was little difference between the sentiments expressed by the Course Tutors and those expressed by the lecturers in this group.

The Deans expressed confidence that the development of the Learning and Teaching Strategy has had a very visible effect on the design and provision of new teaching spaces, and technology has played a central role in this, most notably with integration of “clickers” into many of the new spaces. This provision of new teaching spaces, both traditional and technology-orientated, was widely acknowledged by the Course Organisers. These were seen largely to be a result of the changing way in which the university was thinking about teaching and learning, and about the role of technology in particular (Cobbet et al., 2012; TRIAG, 2004; UoE, 2005). Among the other teaching staff, it was generally felt that the nature of the courses and the work involved required specific teaching spaces, and there was consensus that the nature of teaching spaces was closely linked with the technologies being used, and that these were, in general, reasonably new (or newly renovated) facilities. Again, the more passive nature of this group’s statements when compared to those of the Deans and Course Organisers was evident – they made the same broad observations but did not automatically connect or associate these with the new initiatives and the use of technology.

8.3.4 F4 – The opportunity for professional development/ I3 – Professional development

The Deans emphasised that increased professional development was considered to be important and pointed to specific training that was provided to those involved in the use of the “clickers” as an example. They noted that someone had been employed who would be able to sit down with lecturers to provide technological and paedagogical support, but acknowledged that more resources would need to be provided in the future to support teaching with technology. However, the perspective of the other groups was noticeably different. Neither the Course Organisers nor the teaching staff reported any perceived increased focus on professional development in this area, although the teaching staff did acknowledge the training sessions associated with the clicker system. However, the teaching staff also went so far as to suggest that, in general, training in the technologies used was not required. This sentiment was echoed in this group’s feeling that in general they already had a reasonable level of confidence and competence with regard to the technologies in use in their subjects. It is interesting to note that this feeling was not fully shared by either the Deans or the Course Organisers. Although both groups agreed that those involved were slowly becoming more confident and competent in the use of the chosen technologies, they felt that there was a need for further work in the area of paedagogy in general with technology. It is not immediately obvious why this difference in perspective exists, but it seems reasonable to surmise that it may reflect a difference in expectations among the three groups. The Deans (and to a lesser extent the Course Organisers) have clearly expressed the fact that they see technology as a vehicle for change in the courses, and hence they have an expectation that as the technology is used to its fullest extent there will necessarily be disruption to the existing teaching practice that may well require significant adjustment in paedagogy (Armstrong, 2002; C. M. Christensen, 1997; Garrison & Kanuka, 2004; Meyer, 2010). Hence they may see the initial introduction and use of technology as the start of a process rather than the completion of one. On the other hand, the teaching staff may *not* share the expectation that the introduction of technology is part of a broader move to change the way teaching and learning is approached and may instead view the introduction and use of the technology as a much more contained event. The technology has been introduced, they have begun to use it and have gained some experience with it so that they can report, in that context, that they feel both confident and competent in their use of the technology, even though they may not yet be using the technology in the way envisaged by the Deans and hence may not yet be matching the Deans' perception of confidence and competence.

8.3.5 F5 – Ease of use and clarity of purpose

We have already seen that the Deans placed a great importance on the need for an explicit rationale for using technology. It was also evident that the Deans were acutely aware of the need for any chosen technology to be meaningful and useful to the students and that the students would be able to draw the appropriate connections between the tools they were using and the educational goals. They reported that their experience was that this was indeed the case in the Vanguard courses. In general, both the Course Organisers and the teaching staff operated under the assumption that background and information provided in the courses would ensure that the purpose of the technologies chosen would be clear to the students, and that seems to have been the case. However, there were some instances where technology-based resources were provided but no guidance was given to the students as to how they should be used, and this may have had a negative impact on the effectiveness of those particular resources. There were also some instances where inexperience with the use of the clickers, together with poor question design, led to a poor initial response from the students (Gauchago, 2008).

The perspectives of the three groups on the Foundations and Institutional Transformations present in the Vanguard courses are summarised in Tables 8-1 and 8-2 on the following pages. Positive perspectives (the corresponding Foundation or Transformation was felt to be present) are highlighted in ***green***, more non-committal perspectives are in ***orange*** while ***red*** indicates that the group concerned felt that there was no evidence that a particular Foundation or Institutional Transformation was present.

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Foundations for Transformation	Guiding Questions	Deans' Perspectives	COs' Perspectives	Teaching Staff's Perspectives
F1 – The presence of a clear rationale	*Has the introduction of technology been driven by an explicit rationale?*	*There was a very clear rationale for the use of technology expressed as part of the much larger picture of the Learning and Teaching Strategy. A deliberate choice was made not to formally include technology in the strategy, but there was a clear expectation that technology would underpin it.*	*A full spectrum of responses was evident – some courses were prompted to think carefully about how technology may support certain aspects of their course, while others chose the technology simply on the basis of speed and convenience.*	*Most members of the teaching staff were able to identify clear reasons for the introduction and use of new technologies across the courses. However, these reasons were not always explicitly related to the Vanguard Principles or the Learning and Teaching Strategy.*
	Has the decision to implement technology influenced how the course or intervention is planned?	*The Deans presented a clear feeling that it was not possible to implement technology successfully in the Vanguard courses without careful planning on the part of the courses themselves. However, there was a feeling that overall approach of the College was experimental.*	*There was little evidence that the use of technology had yet had a measurable influence on how the courses were planned, but there seemed to be broad agreement that this may happen in the future.*	*There was little agreement, either within subjects or role, as to whether or not the decision to use technology had influenced how the courses were planned. This possibly reflects the individual stances taken by those involved in teaching the courses.*
	Has the use of technology prompted a review of what is taught?	*There was no feeling that a review of what was taught was part of the implementation. However, there was an expectation that as technology use became more familiar there would inevitably be an impact on what was taught. The College was performing some high level review work on the response of the students to the new course approaches*	*Although the use of technology did not immediately precipitate any formal reviews of what was taught, following the introduction of the technology (at the mid-point or end of the course), most courses did make some attempt to review how things had gone and how the use of the technology (together with other course elements) could be improved.*	*In general, there was little feeling in this group that the use of technology had prompted any kind of review of what was being taught.*
F2 – The presence of willing participants	*Are those involved in the innovation willing participants?*	*There was an assumption on the part of the Deans that "early adopters" were, by definition, willing participants and would be the most likely to adopt the Principles and use technology in an appropriate way to support them. However, there was also an expectation that there would be a "tail" of teaching staff who would remain reluctant to change their current practices or adopt new approaches to teaching and learning.*	*The COs' perspectives reflected the fact that those involved in the Vanguard Courses were a mix of innovators, followers ready to change, and those who were, at this stage, paying lip service only to the Vanguard ideals "because they were asked to" while striving to leave their courses unchanged.*	*In general, those involved in teaching the courses were willing participants insofar as they were, as a group, acquiescent in the decisions made by a small number of people. In particular, as might be expected, teaching assistants were the least invested in the innovations.*

F3 – The provision of sufficient resources	*Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?*	*The hope was expressed that the Vanguard courses would act as a catalyst for change, not least of all in the way all courses are taught. However, there was no feeling that this could be resourced in terms of time or money beyond the existing provision. There was a feeling that more resources would need to be provided in the future to support teaching with technology.*	*There was a feeling that little extra time or resources were available for the new initiatives, although depending on the technology chosen (and the course) there was some disagreement as to whether the use of technology would be more demanding, at least in terms of time. The provision of additional e-learning support and expertise by the College was acknowledged.*	*There was little indication that there had been a change in the way courses had been resourced in response to a move towards the use of technology, and there was also little perception that extra time was available specifically for development in this area.*
	Are new teaching spaces technology-friendly?	*The development of the Learning and Teaching Strategy has had a very visible effect on the design and provision of new teaching spaces, and technology has played a central role in this, most notably with integration of "clickers" into many of the new spaces*	*The provision of new teaching spaces, both traditional and technology-orientated, was widely acknowledged by the Course Organisers. These were seen largely to be a result of the changing way in which the university was thinking about teaching and learning.*	*It was generally felt that the nature of the courses and the work required specific teaching spaces, and there was consensus that the nature of teaching spaces was closely linked with the technologies being used, and that these were, in general, reasonably new (or newly renovated) facilities.*
F4 – The opportunity for professional development	*Has the introduction of new technologies been accompanied by appropriate training?*	*Specific training was provided in the use of the "clickers". There was a feeling that more resources would need to be provided in the future to support teaching with technology. It was noted that someone had been employed who would be able to sit down with lecturers to provide technological and paedagogical support.*	*The Course Organisers did not see any increased focus on professional development in this area.*	*In general, there was a feeling that training in the technologies used was not required, with the exception of the clicker system, which did have associated training sessions.*
	Are educators both confident and competent in the use of the chosen technology?	*The provision of training provided a base level of confidence to those using the clickers, but it was clear that there was a perceived need for further work in the area of paedagogy in general with technology.*	*There was a consensus that educators were becoming more confident and competent in the use of the chosen technologies, but that this was a gradual and ongoing process with an element of trial and error rather than training.*	*In general the teaching staff felt they had a reasonable level of confidence and competence with regard to the technologies in use in their subjects.*

F5– Ease of use and clarity of purpose	*Is the educational purpose of the technology clear to teachers and students?*	*In line with the importance placed on the need for an explicit rationale for using technology, the Deans were aware of the need for any chosen technology to be meaningful and useful to the students, and their experience was that this was indeed the case.*	*In general, it was assumed that the purpose of the technology would be clear to the students, and that seems to have been the case. However, there were instances where technology-based resources were provided but no guidance was given to the students as to how they should be used. In addition, inexperience with the use of the clickers together with poor question design led to a poor initial response from the students.*	*The teaching staff assumed that the purpose of the technologies was clear to all concerned.*
	Can students easily connect the use of the technology to specific educational goals?	*There was an expectation that the technologies chosen by the courses would be suitable for the courses in question and that the students would be able to draw the appropriate connections.*	*The COs reported that in general it was felt that students could connect the use of the technology to specific educational goals. There were instances as described above were this was not the case.*	*Again, this was assumed to be the case.*

Table 8-1 Comparison of the views of Deans, Course Organisers and teaching staff on the Foundations for Transformation

Area	Guiding Questions	Deans' Perspectives	COs' Perspectives	Teaching Staff's Perspectives
I1 – Planning educational interventions	*Has the desire to introduce new technologies led the institution to explore explicit rationales for its use?*	*There was a very clear rationale for the use of technology expressed as part of the much larger picture of the Learning and Teaching Strategy. A deliberate choice was made not to formally include technology in the strategy, but there was a clear expectation that technology would underpin it.*	*A full spectrum of responses was evident – some courses where prompted to think carefully about how technology may support certain aspects of their course, while others chose the technology simply on the basis of speed and convenience.*	*The teaching staff as a whole was clear about the practical reasons behind the use of the technologies but did not naturally express the part technology had to play on any overall Learning and Teaching Strategy.*
	Has the decision to implement technology influenced how the course or intervention is planned?	*The Deans presented a clear feeling that it was not possible to implement technology successfully in the Vanguard courses without careful planning on the part of the courses themselves. However, there was a feeling that overall approach of the College was experimental.*	*There was little evidence that the use of technology had yet had a measurable influence on how the courses were planned, but there seemed to be broad agreement that this may happen in the future.*	*The group was split as to whether or not technology had had an effect on how the courses had been planned – the majority felt that it had not had a major impact, although a sizable minority could point to evidence of small changes in approach.*
	Has the use of technology prompted a review of what is taught?	*There was no feeling that a review of what was taught was part of the implementation. However, there was an expectation that as technology use became more familiar thee would inevitably be an impact on what was taught. The College was performing some high level review work on the response of the students to the new course approaches*	*Although the use of technology did not immediately precipitate any formal reviews of what was taught, following the introduction of the technology (at the mid-point or end of the course), most courses did make some attempt to review how things had gone and how the use of the technology (together with other course elements) could be improved.*	*In general it was agreed that the use of technology had not led to a review of what was taught in the various courses.*
I2 – Resourcing educational interventions	*Is there evidence that the introduction of technology is prompting the institution to rethink its approach to time and other resources?*	*The hope was expressed that the Vanguard courses would act as a catalyst for change, not least of all in the way all courses are taught. However, there was no feeling that this could be resourced in terms of time or money beyond the existing provision. There was a feeling that more resources would need to be provided in the future to support teaching with technology.*	*There was a feeling that little extra time or resources were available for the new initiatives, although depending on the technology chosen (and the course) there was some disagreement as to whether the use of technology would be more demanding, at least in terms of time. The provision of additional e-learning support and expertise by the College was acknowledged.*	*There was little indication that there had been a change in the way courses had been resourced in response to a move towards the use of technology, and there was also little perception that extra time was available specifically for development in this area.*

	Is the use of technology resulting in existing spaces being used differently or driving a need for alternative teaching spaces? Are new teaching spaces technology-oriented?	*The development of the Learning and Teaching Strategy has had a very visible effect on the design and provision of new teaching spaces, and technology has played a central role in this, most notably with integration of "clickers" into many of the new spaces*	*The provision of new teaching spaces, both traditional and technology-orientated, was widely acknowledged by the Course Organisers. These were seen largely to be a result of the changing way in which the university was thinking about teaching and learning.*	*It was generally felt that the nature of the courses and the work required specific teaching spaces, and there was consensus that the nature of teaching spaces was closely linked with the technologies being used, and that these had been equipped appropriately for the current technologies.*
I3 – Professional Development	*Has the introduction of new technologies led to a new focus on professional development?*	*Specific training was provided in the use of the "clickers". There was a feeling that more resources would need to be provided in the future to support teaching with technology. It was noted that someone had been employed who would be able to sit down with lecturers to provide technological and paedagogical support.*	*The Course Organisers did not see any increased focus on professional development in this area.*	*In general, there was a feeling that training in the technologies used was not required, with the exception of the clicker system, which did have associated training sessions.*
	Are educators becoming more confident and competent in the use of the chosen technology?	*The provision of training provided a base level of confidence to those using the clickers, but it was clear that there was a perceived need for further work in the area of paedagogy in general with technology.*	*There was a consensus that educators were becoming more confident and competent in the use of the chosen technologies, but that this was a gradual and ongoing process with an element of trail and error rather than training.*	*In general the teaching staff felt they had a reasonable level of confidence and competence with regard to the technologies in use in their subjects.*

Table 8-2 Comparison of the views of Deans, Course Organisers and teaching staff on Institutional Transformations

8.4 Material Transformations

As before, the interviews and surveys were reviewed in order to obtain an overview of the perspectives each of these groups had regarding the elements indicating Institutional Transformation. The results were summarised in Table 8-3 and colour-coded in the usual way to highlight positive views (green), views that were mixed or that contained significant qualifications (orange) and negative views (red) in relation to each of the Guiding Questions. Again, this enabled simple comparisons to be made between the corresponding perspectives of the three distinct groups.

8.4.1 M1 – Efficiency of course delivery

As might be expected, it was clear from the discussions with the Deans of Undergraduate Study that they had less insight into the effects of the use of technology to support the Vanguard Principles in individual courses than they had into the overall ethos and planning that led up to the instigation of the Vanguard Courses. As a result, they had little to say about possible effects on the efficiency of course delivery or the amount of time that may or may not have been made available for activities other than delivery of content. The Course Organisers felt that the use of technology certainly had the potential to make course delivery more "efficient", and there were comments that suggested that this had already been observed in some areas but was viewed as a longer-term goal in others. They observed specifically that the use of clickers necessarily reduced the time available during lectures for "ordinary" content delivery and was therefore forcing them to consider how to deliver the same amount of content by other means (d'Inverno et al., 2003; Gauchago, 2008; Grabe, 2005).

There was no indication that the teaching staff felt that there was any noticeable improvement in efficiency in this area, and the majority reported that there was no noticeable change in the amount of time delivering content as a result of the use of technology. However, a small number of lecturers felt that there *had* been a change – this may be a direct reflection of how those particular members of staff personally used the technology in their teaching and felt they had to make adjustments. It may also be indicative of the fact that course tutors and teaching assistants who make up the majority of this group would also have been more likely to have been directly involved in workshops, tutorials and practical classes rather than with delivery of content in lectures.

8.4.2 M2 – Means of engagement with subject matter

The Deans placed a high degree of importance on the need for courses to provide students with a range of alternative means of engagement with subject materials, and saw this as a key use of WebCT and other online platforms, and it was assumed that the courses were taking advantage of this opportunity, with some examples given. There was also a high level of agreement among the Course Organisers and the other teaching staff that the use of a range of technologies had increased the variety of means available for students to engage with the material in their courses. The Course Organisers reported that they took advantage of this variety to varying degrees, with some courses making proactive use of online resources in tandem with an increased us of the clickers in lectures, while others saw the provision of such resources simply as a bolt on to be used (or not used) as the students saw fit. The teaching staff reported that the students were benefitting from the increase in variety, although this seemed to be at least as much a result of students themselves taking advantage of the different modes as any proactive moves by the courses themselves (McConnell & McCune, 2007b).

8.4.3 M3 – Content and assessment

The Deans expressed an expectation that what was taught would evolve over time as a result of teachers becoming more familiar with what was possible with the technology, and they felt that this would lead to greater innovation as time went on.

The Course Organisers offered no direct examples of content delivered in lectures having changed as a result of the use of technology, but agreed with the Deans in that they saw this as a possibility in the future as teachers begin to see what might be accomplished, and there was a feeling that this process was already underway in the thinking of those involved in delivering the courses. The new technology-rich teaching spaces had enabled major changes to be introduced in the practical classes of one course. The “inertia” of large first-year courses (found in staff as well as in the nature of the course material) was seen by some of the Course Organisers as a barrier to change (A. Hannan, 2005; M. T. Hannan & Freeman, 1984). The teaching staff also reported little evidence or awareness of any change in the content of the courses as a direct result of the use of technology, over and above some specific examples of changes in workshop content that corresponded to the examples cited by the Course Organisers. They also expressed little vision for the future in this respect. This could largely have been because as a group they may have had less direct involvement with course planning and organization.

The Deans reported that they were aware of changes that had been made in the way courses were assessed, but the view was that these were experimental in nature, rather than being fundamental, permanent changes. They felt that a key strength of the use of WebCT in courses was in the area of formative and self-assessment, with courses having the ability to design quizzes and other assessment activities and make them available to students online. This was reflected in the Course Organisers’ perspective that technology had been reasonably widely used in the provision of formative assessment in the form of online banks of questions with feedback, as well as “clicker” questions for use in lectures. Technology did not seem to have an impact on summative assessment in the courses, although the teaching staff did highlight some instances of computer-based exams being used rather than paper ones in one particular subject. However, this group could see little other evidence of changes in the way courses were assessed as a result of the use of technology in the day-to-day teaching and learning. This may be indicative of the fact that the more holistic view of assessment as encompassing both formative and summative modes, as discussed by the Deans and Course Organisers, may not be always shared by those at the "coal face" for whom the notion of assessment may, more often than not, refer primarily to the scored elements of the courses.

The perspectives of the three groups on the Material Transformations present in the Vanguard courses are summarised in Table 8-3 on the following pages. As before, positive perspectives (the corresponding Foundation or Transformation was felt to be present) are highlighted in ***green***, more non-committal perspectives are in ***orange*** while ***red*** indicates that the group concerned felt that there was no evidence that a particular Material Transformation was present.

Area	Guiding Questions	Deans' Perspectives	COs' Perspectives	Teaching Staff's Perspectives
M1 – Efficiency of course delivery	*Has it improved efficiency of course delivery?*	*The Deans had little to say about this area as they had little insight into what happened in individual courses.*	*It was felt that the use of technology certainly had the potential to make course delivery more "efficient", and there were comments that suggested either that this was already happening in some areas or was a longer-term goal.*	*There was no indication that the teaching staff felt that there was any noticeable improvement in efficiency in this area.*
	Has it increased the amount of time available for activities other than delivery of content?	*The Deans had little to say about this area as they had little insight into what happened in individual courses. However, they did express the hope elsewhere that this would be the case.*	*The Course Organisers observed specifically that the use of clickers necessarily reduced the time available during lectures for "ordinary" content delivery and was therefore forcing them to consider how to deliver the same amount of content by other means.*	*The majority of teaching staff felt that there was no noticeable change in the amount of time delivering content as a result of the use of technology, although there were a small number of lecturers who felt that it had – this may be a direct reflection of how those particular members of staff personally used the technology in their teaching.*
M2 – Means of engagement with subject matter	*Has it increased the variety of means of engagement with the material?*	*The Deans placed a high degree of importance on the need to provide alternative means of engagement with material in courses, and saw this as a key use of WebCT*	*There was a high level of agreement that the use of a range of technologies increased the variety of means available for students to engage with the subject material*	*There was overwhelming agreement that the use of technology had increased the variety of means of engagement with subject matter.*
	Does the course take advantage of this?	*There was an assumption that the courses did take advantage of this opportunity, with some examples given.*	*The Course Organisers reported that they took advantage of this variety to varying degrees, with some courses making proactive use of online resources in tandem with an increased us of the clickers in lectures, while others saw the provision of such resources simply as a bolt on to be used (or not used) as the students saw fit.*	*The teaching staff reported that the students were benefitting from the increase in variety, although this seemed to be at least as much a result of students themselves taking advantage of the different modes as any proactive moves by the courses themselves.*

M3 – content and assessment	*Has it enabled new content to be taught or less useful/redundant material to be removed?*	*There was little mention of the addition or removal of content, but there was a feeling that what was taught would evolve over time as a result of teachers becoming more familiar with what was possible with the technology, and would lead to greater innovation as time went on.*	*There were no direct examples of content delivered in lectures having changed as a result of the use of technology, although there was a feeling that this may be a possibility in the future as teachers begin to see what might be accomplished, and there was a feeling that this process was already underway in the thinking of those involved in delivering the courses. The new technology-rich teaching spaces had enabled major changes to be introduced in the practical classes of one course. The "inertia" of large first-year courses (found in staff as well as in the nature of the course material) was seen as a limitation to change.*	*It appears that in general at this stage, there is little evidence or awareness of any change in the content of the courses as a direct result of the use of technology, over and above some specific examples of changes in workshop content.*
	Has it altered the way the course is assessed?	*The Deans were aware of changes that had been made in the way courses were assessed, but the view was that these were experimental in nature. A key strength of WebCT was in the area of formative and self-assessment.*	*The Course Organisers reported that technology had been reasonably widely used in the provision of formative assessment in the form of "clicker" questions for use in lectures and online banks of questions with feedback. Technology did not seem to have an impact on summative assessment in the courses.*	*Although there some instances of computer-based exams being used rather than paper ones in a one particular subject, there was little other evidence of changes in the way courses were assessed as a result of the use of technology in the day-to-day teaching and learning.*

Table 8-3 Comparison of the views of Deans, Course Organisers and teaching staff on Material Transformations

8.5 Behavioural Transformations

As before, the interviews and surveys were reviewed in order to obtain an overview of the perspectives each of these groups had regarding the elements indicating Institutional Transformation. The results were summarised in Table 8-3 and colour-coded in the usual way to highlight positive views (green), views that were mixed or that contained significant qualifications (orange) and negative views (red) in relation to each of the Guiding Questions. Again, this enabled simple comparisons to be made between the corresponding perspectives of the three distinct groups.

8.5.1 B1 – Amount and quality of interactions

The Deans made few assertions regarding the amount of interaction going on in particular classes, as they naturally had little sight of what happened in individual courses. However, one Dean reported how he had observed the use of clickers in one course and noted the high level of interaction between students and teacher. In general, the chosen technologies were reported by the Course Organisers to have visibly increased the amount of interaction between students and teachers both in lectures and in the online environment. However, there was a significant variation in the observed use of *online* interactions by the students from year to year. The quality of the interactions was in general thought to have improved, with students asking more questions in lectures than would previously have been the case (Gauchago, 2008; Herreid, 2006). However, the large numbers of students involved in first year courses such as these was seen again as a limiting factor to the quality of interactions that could be achieved in this context (Herreid, 2006). The teaching staff was divided regarding whether or not technology had had a positive effect on teacher-student and student-interaction from their perspective. On closer inspection it was clear that the opinions expressed were directly related to the way individual subjects chose to use the technologies rather than to the technologies themselves. Where there was a conscious effort to engage with students using technology, there was a clear feeling that interactions had been improved.

8.5.2 B2 – Paedagogy

The Principles were inherently designed to drive change, not least of all in the paedagogical approaches within courses, and the disruptive nature of technology in these courses was seen by the Undergraduate Deans to be a fundamental part of this process. They felt that the use of technology was a way of increasing openness, willingness and ability to change the way courses were taught over time among those who delivered the courses. The Course Organisers themselves offered two distinct perspectives – an overt reluctance to make any immediate changes to the way one course was delivered for fear of disrupting the current balance, and a desire to begin to make careful, well thought-out paedagogical changes in order to make the most of the chosen technologies. It was acknowledged by all the Course Organisers that the use of technology would lead to ongoing and greater changes in the longer term. The view of the teaching staff overlapped with both these perspectives to some extent, seeing the possible effects of the use of technology on teaching style and paedagogy in their courses as being dependent on the technology itself. For example - most teaching staff who had used the clickers felt that it had been necessary to make changes to the way they delivered lectures, and the design of the new technology-rich teaching spaces in the refurbished tower block had at least facilitated a shift to group based work. Interestingly, most tutors did not observe any shift in teaching styles from their perspective. Again, this may reflect the fact that course tutors and teaching assistants may be more likely to be involved in workshops, tutorials and practical classes rather than with the delivery of content in lectures where many of these changes would have been observed.

8.5.3 B3 – Student responsibility

Enabling students to take responsibility for their own learning was seen as a key focus of the Learning and Teaching Strategy and hence the Vanguard Courses themselves, and the Deans saw technology as a key way of accomplishing this, especially through the provision of additional materials and increased freedom of access to those materials. There was some uncertainty as to whether or not this had been effective, largely as a result of student responses to surveys that revealed the students themselves felt they took less responsibility later in the courses than they did at the beginning (McCune, 2007). There was a feeling among the Course Organisers that the students had been provided with a wealth of materials to enable them to begin to take more responsibility for their own learning as a result of the Vanguard initiative and the use of technology. There were mixed observations regarding how much advantage students were taking of these opportunities, with some Course Organisers feeling that there had been an improvement and others seeing the lack of use of some online resources as evidence to the contrary. There was again agreement that the size of the courses, with their inevitably wide range of levels of student motivation, made it difficult to "engage the unengaged". There was also a general consensus among the teaching staff that students had been enabled to take more responsibility for their own learning, and although it was largely felt that technology had contributed to this, a small number of staff qualified their responses by saying that they were unsure that this could be attributed solely to the use of technology.

8.5.4 B4 – Knowledge and understanding of subject matter

The Deans expressed a general feeling that the effects of the implementation of new technologies into the Vanguard Courses on the perceived level of knowledge and understanding achieved by students had so far been positive, but it was also acknowledged that there were so many factors at work that it was difficult to identify which had contributed to any such perceived improvements. The Course Organisers shared this view, explaining that the technology had enabled lecturers to "*get things across*" better, and this was reflected in a perception that students had a better grasp of the subject matter. One Course Organiser attributed a large increase in the pass rate for his course to the changes made as a result of the course's transition to "Vanguard" status, including the use of technology. It was acknowledged that in general it was difficult to quantify this type of improvement or attribute it to any single factor. A number of teaching staff commented that while they had a perception or feeling that there had been a comparative increase in knowledge and understanding of the subject matter, this perception was generally subjective with little supporting evidence. There were some instances of greatly improved examination marks that were attributed partly (but not solely) to the impact of the new technologies.

The perspectives of the three groups on the Behavioural Transformations present in the Vanguard courses are summarised in Table 8-4 on the following pages. Again, positive perspectives (the corresponding Foundation or Transformation was felt to be present) are highlighted in ***green***, more non-committal perspectives are in ***orange*** while ***red*** indicates that the group concerned felt that there was no evidence that a particular Behavioural Transformation was present.

Area	Guiding Questions	Deans' Perspectives	COs' Perspectives	Teaching Staff's Perspectives
B1 – Amount and quality of interactions	*Has it increased the amount and quality of teacher-student and student-student interaction?*	*The Deans made few assertions regarding the amount of interaction going on in particular classes, as they naturally had little sight of what happened in individual courses. However, one Dean reported how he had observed the use of clickers in one course and noted the high level of interaction between students and teacher.*	*In general, the chosen technologies were reported to have increased the amount of interaction between students and teachers both in lectures and in the online environment. However, there was a significant variation in the observed use of online interactions by the students from year to year. The quality of the interactions was in general thought to have improved, with students asking more questions in lectures than would previously have been the case. However, the large numbers of students involved in first year courses such as these was seen again as a limiting factor to the quality of interactions that could be achieved.*	*The teaching staff was divided regarding whether or not technology had had a positive effect on teacher-student and student-interaction. On closer inspection it was clear that the opinions expressed were directly related to the way individual subjects chose to use the technologies rather than to the technologies themselves. Where there was a conscious effort to engage with students using technology, there was a clear feeling that interactions had been improved.*
B2 - Paedagogy	*Has the introduction of particular technologies forced, inspired, enabled or otherwise caused a shift in teaching styles and approaches?*	*The Principles were inherently designed to be drive change, not least of all in the paedagogical approaches within courses, and the disruptive nature of technology in these course was seen to be a fundamental part of this process. The technology was felt to be a way of increasing openness, willingness and ability to change the way courses were taught over time.*	*There were a two distinct perspectives offered – an overt reluctance to make any immediate changes to the way one course was delivered for fear of disrupting the current balance, and a desire to begin to make careful, well thought out paedagogical changes in order to make the most of the chosen technologies. It was universally acknowledged that the use of technology would lead to ongoing and greater changes in the longer term.*	*It was felt that this was dependent on the technology, for example - most teaching staff who had used the clickers felt that it had been necessary to make changes to the way they delivered lectures, and the design of the new technology-rich teaching spaces in the refurbished tower block had at least facilitated a shift to group based work. Most tutors did not observe any shift in teaching styles etc from their perspective.*
B3 – Student Responsibility	*Does the implementation enable the student to take more responsibility for his or her own learning?*	*Technology was seen as a key way of enabling students to take responsibility for their own learning, through the provision of additional materials and increased freedom of access to those materials. There was some uncertainty as to whether this had been effective, largely as a result of student responses to surveys that revealed the students themselves felt they took less responsibility later in the courses than they did at the beginning.*	*There was a feeling that students had been provided with a wealth of materials to enable them to begin to take more responsibility for their own learning. There were mixed observations regarding how much advantage students were taking of these opportunities, with some COs feeling that there had been some improvement and others seeing the lack of use of online resources as evidence to the contrary. There was again agreement that the size of the courses, with their inevitably wide range of levels of student motivation, made it difficult to "engage the unengaged".*	*There was general consensus that students had been enabled to take more responsibility for their own learning, and although it was largely felt that technology had contributed to this, a small number of staff qualified their responses by saying that they were unsure that this could be attributed solely to the use of technology.*

B4 – Knowledge and Understanding of Subject Matter	*Has it facilitated a comparative increase in knowledge and understanding of the subject matter?*	*There was a general feeling that the effects had so far been positive, but it was also acknowledged that there we so many factors at work that it was difficult to identify which had contributed to any perceived improvements.*	*There was a general feeling that the technology had enabled lecturers to "get things across" better, and this was reflected in a perception that students had a better grasp of the subject matter. One Course Organiser attributed a large increase in the pass rate for his course to the changes made as a result of the course's transition to "Vanguard" status, including the use of technology. It was acknowledged that it was difficult to quantify this type of improvement.*	*A number of teaching staff reported that while they had a perception or feeling that there had been a comparative increase in knowledge and understanding of the subject matter, this perception was generally subjective with little supporting evidence. There were some instances of greatly improved examination marks that were attributed partly (but not solely) to the impact of the new technologies.*

Table 8-4 Comparison of the views of Deans, Course Organisers and Teaching Staff on Behavioural Transformations

8.6 Summary of the comparison of qualitative data

The colour-coding in Tables 8-1 to 8-4 reveals some interesting differences in perspective across the three groups. There appear to be noticeable differences in opinion regarding the state of the Foundations for Transformation and the Institutional Transformations that may or may not be occurring (Tables 8-1 and 8-2), particularly between the Undergraduate Deans and the teaching staff. In Table 8-1, clear differences exist in three of the five areas (*the presence of a clear rationale*, *the provision of sufficient resources* and *the opportunity for professional development*), while some differences are visible in the other two (the presence of willing participants and ease of use and clarity of purpose). In Table 8-2, clear differences arise in all three areas (*planning educational interventions*, *resourcing educational interventions* and *professional development*). In general, it seems fair to observe that the Deans presented a clear vision of how the College in general was positioned in terms of the Foundations and how these would support the introduction of the Vanguard Courses and the use of technology to support the Learning and Teaching Strategy. However, when we look at the discrepancies between these views and those of the Course Organisers and in particular the teaching staff, it is clear that the view from the top often represents the theory rather than the practice as experienced by those involved in delivering lectures, tutorials and so on. It must be acknowledged that this will be at least partly due to the fact that, by nature of their positions, the teaching staff (and especially the tutors) are not always privy to the discussions of ethos, policy and direction that the Deans will inevitably be embroiled in and hence their focus is unlikely to be on noticing gradual changes of mindset, but rather on what they see happening around them. Both *Foundations for Transformation* and *Institutional Transformations* are, by their very nature, much more focused on what is going on behind the scenes than on what is happening day by day in the lecture theatre or laboratory, and hence it is perhaps unsurprising that there is a noticeable “gradient” of opinion as information, and perhaps vision, filters from one group to the next.

Both *Material Transformations* and *Behavioural Transformations* focus much more on what is going on in individual courses, and as such the Deans were often a little more circumspect in their responses, although what they did express was often their hopes, expectations or assumptions about what should be happening in the courses from the perspective of the Vanguard Principles. It is interesting to note the high degree of overall agreement that exists between the Deans and the Course Organisers in their views on *Material Transformations* as shown in Table 8-3. Both groups indicated that they did not necessarily see *Material Transformations* within the courses as a key focus to begin with, although the Course Organisers sometimes pointed to examples where such transformations may already have begun. However, they were clear about the fact that they saw these as an inevitable consequence of the use of technology in the courses in the future. These perspectives seem generally to be in contrast to those expressed by the teaching staff, who again put forward views that do not reflect or draw on a perception of where the course will be at some stage in the future, but who rather report on how they see the situation at present. The most notable exception to this is in the area of *means of engagement with subject matter*, where all three groups were in agreement (a rare thing indeed) and felt strongly that the use of technology had increased the variety of means of engagement available to the students. This seems first and foremost to be recognition of the *potential* of the chosen technologies and as such agreement on this point is merely an indication that all three groups acknowledge that students can now access materials in different ways because of the technology. However, there was also some level of agreement that the courses were taking advantage of this increased variety, although again, there was some tension between the Deans' unqualified positivity and the more cautious responses of the Course Organisers and the teaching staff.

In contrast to the *Foundations for Transformation*, *Institutional* and *Material Transformations,* the colour-coding in Table 8-4 paints a picture of tentative agreement across the groups with regards to most areas of *Behavioural*

Transformation. As before the responses of the teaching staff tended to err more on the side of caution than those of the other groups, although any differences in opinion were less marked than in the other areas of transformation. The Course Organisers were a little more enthusiastic than the teaching staff in their belief that the use of technology had increased the amount and quality of teacher-student and student-student interaction, and that the use of technology was prompting a shift in teaching styles. It is interesting to note that these two areas are primarily related to the delivery of course materials, and it seems reasonable to suggest that the Course Organisers may have felt that they had the most influence over them in their courses, and hence viewed them as key to the "Vanguard" nature of the courses. In general, it is striking that the area of *Behavioural Transformations* is the one that yielded the highest level of agreement among the three groups, when it must also be the one that is most difficult to quantify and measure. In particular, it yielded the highest level of agreement between what we might reasonably expect to be the Deans' idealistic view of improvements in student learning and the more realistic view from the lecture theatre and laboratory. However, while the Deans expressed views that were clearly influenced by the aims of the Learning and Teaching Strategy, the Course Organisers and teaching staff reported observations and perceptions that the Deans' hopes were being realised, at least to a small extent. The accuracy of these observations and perceptions is, of course, difficult to determine, and it is always possible that wishful thinking can prevail in the absence of physical evidence. However, it has to be acknowledged that in other areas, the teaching staff have not been unwilling to state opinions that are contrary to what the Deans may think and so we must attach at least some value to the consensus that exists across the groups in these areas.

8.7 Conclusions on the comparison of qualitative data

The Undergraduate Deans have largely presented a picture of the Vanguard courses that is in line with the ideals of Learning and Teaching Strategy and that reflects their hopes and expectations of how this will play out in the Vanguard courses. The Course Organisers views were broadly sympathetic with those of the Deans with some notable exceptions in the areas of *course planning* and *professional development* (**F1** and **F4** in Table 8-1 and **I1** and **I3** in Table 8-2). The most frequent and noticeable differences occurred between the views of the Deans and those of the teaching staff. This may at least partly be a result of the differing roles of the two groups in relation to the courses – the Deans represent the "big picture" and the ideas that gave birth to the notion of the Vanguard courses, while the teaching staff are ones who deal with the day to day reality of delivering the courses and observing the students and their interactions with the courses. However, the prevalence of a left-to-right progression in the tables, indicating an increasing disconnect in the perspectives as we move from the Deans to the Course Organisers to the other teaching staff is demonstrated quite clearly in Table 8-5;

	Deans expressed a more positive view than teaching staff (%)	Deans expressed a more positive view than COs (%)	COs expressed a more positive view than teaching staff (%)	Teaching Staff expressed a more positive view than COs or Deans (%)
Foundations for Transformation	70	50	40	40
Institutional Transformations	86	43	43	43
Material Transformations	83	17	67	0
Behavioural Transformations	25	0	50	0

Table 8-5 Decreasing positive perspectives on observed Foundations and Transformations: Deans -> Course Organisers -> Teaching Staff

Hence it could be suggested that in addition to the fact that different roles will inevitably lead to a difference in perspectives based on the primary concerns of those roles - a dilution of the "message" (the reason, drive or focus behind the Vanguard courses and the underlying push to use technology in order to aid transformation in the teaching and learning in those courses) is taking place as we move from the meeting room to the lecture hall. It appears that the teaching staff don't necessarily share the vision for the future or connect it with the day-to-day operation of the courses when given the opportunity to do so. This may make the few areas where some agreement *was* apparent (such as in M2 in Table 8-3) even more worthy of note in that it may be in these areas where we can be most confident that transformation may be taking root.

8.8 Comparing qualitative and quantitative data from the Vanguard courses

Although the bulk of the information necessary in order to construct a picture of what was happening in the three courses was obtained in the form of qualitative data, quantitative data, primarily in the form of final course marks spanning the period before and after the introduction of the Vanguard courses, were also analysed in order to inform in particular those areas which relate to the performance of students before and after the introduction of the Vanguard Principles. In addition to providing information as to the relative performances of students in the end-of-year examinations, these data may also enable us to perform a check on any claims or assumptions made by those involved with the courses. Hence the purpose of this section is to pitch *what was said* against *what actually happened*, identifying and highlighting any such assumptions or claims made in the interviews and survey responses and to view them in the light of the quantitative data, allowing us to conclude whether such statements can be supported and are likely to be based on an accurate view of what was happening in a particular course, or must be treated as merely the unsubstantiated wishful thinking (or otherwise) of those concerned (Cohen et al., 2005, p. 121).

8.9 The claims

Area of Transformation	Sub-Area Identifiers	Guiding Questions
Material Transformations *Transformations in what is taught and how it is presented to students*	M3 – content and assessment	*Has it enabled new content to be taught or less useful/redundant material to be removed?* *Has it altered the way the course is assessed?*
Behavioural Transformations *Transformations in the "normal" day-to-day activities of teachers and students*	B3 – Student Responsibility	*Does the implementation enable the student to take more responsibility for his or her own learning?*
	B4 – Knowledge and Understanding of Subject Matter	*Has it facilitated a comparative increase in knowledge and understanding of the subject matter?*

Table 8-6: Areas of transformation that may be informed by the numerical data

The interview transcripts and survey data were first analysed in detail to search for any comments that related directly to any area of the Framework also informed by the examination data and the related statistical analysis. The relevant framework areas were as shown in Table 8-6 (above). These comments were then filtered to identify only those that contained specific but unqualified claims or statements relating to these areas that should be able to be verified or otherwise through the quantitative data. The statements were typically either of the form *x caused y* or *students are doing better at y since we changed x*. In addition, any statements that suggested it was *not* possible to draw a connection between x and y were also examined, as the data may in fact refute such a proclamation, if only by showing a negative relationship. The claims and statements that were identified are summarised in Table 8-7 (overleaf), which also shows the source of the claim together with the possible framework areas to which each statement may be related. The source of each claim refers to the role of the claim maker – CO – Course Organiser; L – lecturer; T – tutor, teaching assistant etc.

Source	Details of Claim	Framework Area
Undergraduate Dean	"Yes, I think students will learn better"	B3, B4
Undergraduate Dean	"So we think we've had some effect but it's much more difficult to translate into pass rates and why they occur"	B4
Course C (T)	Do you think there is any evidence that the use of technology has increased student learning? Yes - good students certainly know where to find extra material. Not much has changed for the others, though.	B4
Course C (T)	The exam is now computer-based, which has dramatically changed the types of answers we get.	M3
Course B (L)	Do you think there is any evidence that the use of technology has increased student learning? Yes, there's more thinking during the lectures	B4
Course B (L)	I think it has improved student learning, but hard evidence is difficult to find	B4
Course A (CO)	as much as we could control some of the many variables that will exist between last year and this year, I think we demonstrated pretty clearly that the change that we made, along with the other improvements to the course, had a huge impact on their learning and understanding, and so we can even quote that the pass rate for the course went up 15%, from 75% to 90%.	M3, B4
Course A (CO)	And in that circumstance you were able, in marking that, to give students partial credit for partially correct answers, and that had a huge effect on … the average mark on that section of the paper compared with previous years, had a huge impact on the over all pass rate and a huge impact on the student view of the end of course assessment.	M3, B4
Course A (L)	Student learning is improving, but not necessarily because of the technology	B4
Course A (T)	I think it does encourage students to take more responsibility for their own learning as it provides them with much easier and more portable access to course materials. This makes it easier for students to manage their studying and fit it around part-time work and other activities.	B3
Course A (T)	Students are taking more responsibility but it's difficult to attribute this solely to the technology	B3

Table 8-7: Claims made during interviews that may be informed by the numerical data

The next step was to review the claims in the context of the course to which they referred – first, to get a feel for how representative these claims were of the views of all those connected with the course in any sort of teaching capacity, and second to see if the claims may be supported or refuted by anything found in the analysis of the numerical data for that particular course.

8.9.1 Course A

The claims made regarding Course A are summarised in Table 8-8:

Source	Details of Claim	Framework Area
Course A (CO)	as much as we could control some of the many variables that will exist between last year and this year, I think we demonstrated pretty clearly that the change that we made, along with the other improvements to the course, had a huge impact on their learning and understanding, and so we can even quote that the pass rate for the course went up 15%, from 75% to 90%.	M3, B4
Course A (CO)	And in that circumstance you were able, in marking that, to give students partial credit for partially correct answers, and that had a huge effect on … the average mark on that section of the paper compared with previous years, had a huge impact on the over all pass rate and a huge impact on the student view of the end of course assessment.	M3, B4
Course A (L)	Student learning is improving, but not necessarily because of the technology	B4
Course A (T)	I think it does encourage students to take more responsibility for their own learning as it provides them with much easier and more portable access to course materials. This makes it easier for students to manage their studying and fit it around part-time work and other activities.	B3
Course A (T)	Students are taking more responsibility but it's difficult to attribute this solely to the technology	B3

Table 8-8: Claims made regarding Course A

The Course Organiser of Course A made some bold claims regarding changes in assessment and their impact on exam results, and the specificity of the claims suggest that they were at least partly based on an analysis of the data that we will also be using. Hence it should be a simple matter to validate these accounts or otherwise. The assertion of one of the course lecturers that "student learning is improving" seems equally as unequivocal, even though he or she questions the source of that improvement. Indeed, two thirds of the teaching staff agreed to some extent, responding that they *did* think there was evidence to show that learning was improving and that this might at least partly be related to the use of technology. Again, assuming that there is an implication that this improvement must somehow be reflected in the results of the course's final marks, the quantitative data should indicate whether or not such claims might be supported.

Statements made regarding the increase or otherwise of the amount of responsibility that students are taking for their learning were common, with only 1 out of the 6 teaching staff who responded stating that they did *not* believe that students were taking more responsibility for their own learning. Unfortunately, these statements are also more difficult to deal with, not least of all because there is not necessarily an automatic link between responsibility and the *amount* of learning as may be evidenced in the course data. Just because a member of the teaching staff (in this case a tutor) suggests that a student is taking more responsibility for their learning does not mean that the tutor also believes that the student will do better in the exam. However, one of the tutors did qualify their statement with the observation that technology "*provides them with much easier and more portable access to course materials. This makes it easier for students to manage their studying and fit it around part-time work and other activities*." It does not seem a stretch to assume that in this case the implication exists that if students are able to manage their studies better in this manner then there can indeed be an expectation that they may be able to do better in assessments (Condie & Livingston, 2007; R. Hall, 2002; Twigg, 2003). Hence any evidence in the numerical data that shows an increase in student performance would, while not proving the claim, at least lend weight to the idea that this may be a contributory factor to increased student performance.

The results and conclusions of the analysis of the available numerical data for Course A spanning the years before, during and after the adoption of the

Vanguard Principles are discussed in detail in Chapter 7. These can be summarised as follows;

- There was little change in the grade distributions or pass-fail rates during the *pre-Vanguard* years, although the mean, median and modal exam marks increased during that time

- A statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles to the following year that must be attributed to something other than "noise" or random fluctuations. There was also an observable "spike" in the mean, median and modal exam marks in the 2006-2007 year, following the introduction of the Vanguard Principles. This statistically significant change was also apparent in the pass-fail rates during this time, indicating that not only did the adoption of the Vanguard Principles coincide with a non-trivial change in grade distributions, but also with a non-trivial increase in the overall pass rate

- There was no dramatic change from one *post-Vanguard* year to the next. However, the visual analysis of the grade distributions showed a gradual and continued movement to the left, reflecting an overall upward shift of grades, together with a gradual increase in pass rate during this time. This was also supported by the upward trend in both the mean and median exam marks over the period of study

From these conclusions, we can see that *something* has had a non-trivial impact on the exam results in Course A, and this impact is not evident before 2006-2007, implying that the trigger may lie in this academic year. Of course, this also coincides with the course becoming "Vanguard". Ignoring any transient spikes, from 2006-2007 onwards, the upward trend in the mean, mode and median marks suggests that for whatever reason, students scored better each year in the examinations during the period under study, and this would certainly be concomitant with claims that student learning is improving.

Perhaps the most striking feature of the examination data (besides the quantum leap that apparently occurs between 2005-2006 and 2006-2007) is the steady upward shift towards the higher grades, indicating that the increases in exam marks for the students were significant enough to produce corresponding shifts across the grade boundaries. This pattern would fit with what we would expect from a student body who were, as a whole, taking more responsibility for their own learning – rather than, for example, only the good students gaining higher scores (which would raise the mean, mode and median but would not cause a shift in grades across the board). Such a shift suggests that students at all levels were able to improve their scores and again, this is certainly in sympathy with the claims made by the staff.

Of course, the existence of such statistics does not *prove* any of the claims, and there are many possible contributors to the improvement in the exam results observed, not least of all the changes to the way the course was assessed. These other contributing factors are discussed in more depth in Chapter 7. However, technology is seen as playing a role (but not necessarily a solo role) in the improvement by several of the staff. Whatever the cause, the fact remains that in the case of Course A, the claims made by the teaching staff appear to be plausible at the very least.

One last question that might be worth asking is why, in the case of Course A, it seems that there may be a direct relationship between an observation of improved student learning and student performance in exams, when there is no such apparent relationship in other subjects that made, on the surface at least, many of the same changes? It could simply be, as already discussed in section

7.10 of Chapter 7, that other factors may have had an influence in the case of Course A. However, it is also interesting to consider the possibility that the changes in assessment mentioned previously have not simply enabled students to score higher, but may also (perhaps inadvertently) have been exactly the kind of changes needed to enable students to display their "improved learning" in ways that other examinations do not (R. Hall, 2002). If that was indeed the case, then the numerical data would indeed be convincing evidence that student learning was improving.

8.9.2 Course B

In this case, both claims identified Course B were made by lecturers, as shown in Table 8-9 (below), with the Course Organiser and tutors seemingly more guarded in their statements regarding student learning. The assertion that "there's more thinking during lectures" (referring primarily to the effect of the use of "clickers" in class) seems to be a particularly bold one, and again one that few others involved in delivering the course are prepared to echo, with 4 out of 6 respondents stating that they did *not* think there was any evidence that technology had increased student learning. Of course, "more thinking" does not necessarily mean the same thing as "more learning". However, it follows that if the technology has enabled students to "think more" in the best sense of the phrase, then there should be some evidence to support this in the numerical data. Similarly, if no such evidence exists, then that may indicate that "thinking more" is not enough.

Source	Details of Claim	Framework Area
Course B (L)	Do you think there is any evidence that the use of technology has increased student learning? Yes, there's more thinking during the lectures	B4
Course B (L)	I think it has improved student learning, but hard evidence is difficult to find	B4

Table 8-9: Claims made regarding Course B

The second statement raises a number of interesting side-questions, implying as it does that the lecturer concerned is confident enough to state an opinion, but does not claim any basis for that opinion, whether through simple honesty or doubt of his or her own position. It is fair to assume that had the lecturer had any reasoning in mind he or she would have offered it as an explanation. Again, the analysis of the quantitative data may inform our view of this statement, whether it confirms the lecturer's hunch and provides the elusive indicators of improved learning or simply confirms the lack of evidence and consigns his or her instincts to nothing more than wishful thinking.

The results and conclusions of the analysis of the available numerical data for Course B spanning the years before, during and after the adoption of the Vanguard Principles are discussed in detail in Chapter 7. These can be summarised as follows;

- Although there was an observed fall in the pass rate during the *pre-Vanguard* years, the chi-squared values reflected the fact that this change was not statistically significant. The mean, median and modal exam marks decreased to their minimum values for the period of study in 2005-2006

- No statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles and the following year that may be attributed to something other than "noise" or random fluctuations. The mean, median and modal exam marks recovered from their low point in 2005-2006 and showed a noticeable increase in the 2006-2007 year, following the introduction of the Vanguard Principles. The pass rate showed a slight but statistically non-significant decrease during this time

- There was no dramatic or statistically significant change from one *post-Vanguard* year to the next. However, the visual analysis of the grade distributions showed a slight decrease in the number of A grades together with a corresponding increase in the number of B grades during this time. Both the mean and median exam marks remained stable, while the mode was seen to decrease.

It is clear that the data in this case point to statistically insignificant variations only, with no visible trends or patterns and no dramatic changes. From these conclusions we must assume that, at the very least, any increase in student learning brought about by the introduction of technology into the course as part of the Vanguard initiative has had no visible effect on the final course marks. Of course, at no time did the lecturers concerned claim that the technology had improved the assessment performances or results. Instead, the focus of their statements was on the visibility of the students' thinking – they *looked* like they were paying the material more attention during lectures, perhaps not least of all because they were being asked to consider questions for themselves at certain points in the lecture. They *appeared* to be thinking more about what was being taught. There could be two possible explanations for the absence of any obvious mark-based evidence of increased student learning despite the observations of the lecturers. First, it could suggest that any observed increase in "thinking" observed by the lecturers was at best transient – a fleeting thing that occurred only for a short time during the lecture but did not result in any deeper learning, understanding or retention of the material such as might reveal itself in an assessment situation (Papert, 1971; Wallace & Mutooni, 1997). Alternatively, it may merely reflect the fact that the assessments in their current form were poorly aligned to the "new" learning and teaching (R. Hall, 2002; Mayer, 1997). In other words, they may have been an inadequate way of revealing or measuring any such increased learning or understanding such as may be acquired during a lecture that uses clicker-based questioning techniques, whether due to the types of assessment used or even the fact that at least part of the assessment occurred several months after the completion of the course! Either way, there is no evidence to be found in the numerical data to support the claims made by the Course B lecturers.

8.9.3 Course C

The claims made regarding Course C are as follows;

Source	Details of Claim	Framework Area
Course C (T)	Do you think there is any evidence that the use of technology has increased student learning? Yes - good students certainly know where to find extra material. Not much has changed for the others, though.	B4
Course C (T)	The exam is now computer-based, which has dramatically changed the types of answers we get.	M3, B4

Table 8-10: Claims made regarding Course C

It is interesting to note at the start that these claims were both made by tutors or teaching assistants, with none provided by more senior full-time staff. This may simply be indicative of a more cautious group of lecturers than in the other subjects. However, across the board tutors were generally less keen to express opinions on these issues simply because they felt they were not in a position to do so. Hence, the claims may reflect the fact that in this particular practical-based subject the tutors felt that they had enough contact with students to be in a position to offer firm opinions, or they may merely be indicative of the presence of two tutors who were more confident in expressing their opinions than would generally be the norm.

Whatever the case, it is clear that not all teaching staff involved in Course C shared the tutors' confidence that there is a noticeable degree of improvement in any particular area. In answer to the question “do you think there is any evidence that the use of technology has increased student learning?” 3 of the teaching staff responded with a definite “Yes”, 5 responded with a definite “No” while 6 thought it was “difficult to say”. The statement made by the tutor implies that the use of technology has enabled good students to do better. If that is the case, the numerical data should offer some sense of this.

The second claim was made in response to the question “Do you think the technology used has changed the way the course is assessed?” One might expect that claims in this area may not be directly addressed by an analysis of numerical data alone. However, it is striking that many respondents drew their own connection between changes in assessment and student performance in exams. In this case, 4 respondents thought that technology had changed the way the course was assessed while 5 thought that it did not. However, only one respondent stepped out and implied that there was some kind of positive effect on student learning as a result of this change. If the implication is that the change to computer-based exams has enable students to answer questions better, then this should be detectable in the quantitative data.

The results and conclusions of the analysis of the available numerical data for Course C spanning the years before, during and after the adoption of the Vanguard Principles are discussed in detail in Chapter 7. These can be summarised as follows;

- Although there was a slight increase in A grades in 2005-2006 coupled with an increase in the pass rate during the *pre-Vanguard* years, the chi-squared values reflected the fact that these changes were not statistically significant. The mean and median exam marks remained steady during this time while a spike was observed in the modal examination mark in 2005-2006

- Although in 2006-2007 the number of both B and C grades dips while the number of A grades increases, the chi-squared value indicates that no statistically significant change occurred from the year immediately preceding the adoption of the Vanguard Principles to the following year, The mean and median remained steady while the mode decreased following the introduction of the Vanguard Principles. The pass rate showed a slight but statistically non-significant decrease during this time

- There was no dramatic change from one *post-Vanguard* year to the next. A visual analysis of the grade distributions showed a slight decrease in the number of A grades across these years, with no obvious trend in pass rates. Both the mean and median exam marks remained stable over this time, while the mode was seen to increase.

From these conclusions, we can see that there is little in the quantitative data to suggest that there has been an increase in student learning (assuming, of course, that the course assessments are intended to be a measure of this) or that there has been a dramatic change in the quality of the answers provided by students in the new computer-based exams that has translated into higher marks. Indeed, the only trend confirmed by the statistics is one of no statistically significant change from one year to the next. The consistent increase in the modal (or most frequently achieved) mark each year is interesting and may in isolation imply that some students are doing better that in previous years. However, the fact that all other statistical measures point to little change from year make this conclusion unlikely. Hence we can see that there is little in the examination results to support the claims made by the tutors.

8.10 A means to an end

So, the comparison of the qualitative data sources carried out in this chapter has enabled us to gain a feel for the context in which the comments made by those sources sit – from the Deans' views of how things *should* be, through the Course Organisers' hope of what *could* be to the teaching staff's views of what was *actually* happening. The analysis of specific claims made by those involved, particularly with regard to student performance, in the light of the quantitative data allowed us to comment on the possible accuracy or otherwise of such claims. In addition to providing insight into the "back-story" of what was happening behind the scenes as the Vanguard courses came into being, this filtering of the data (and placing it onto a more transparent footing) sets the scene for conclusions to be drawn regarding the Foundations that were in place as the courses became "Vanguard" and, ultimately, any transformations that arose as a result of the use of technology in those courses.

Chapter 9. Transformative effects of technology in learning and teaching in the Vanguard courses - ubiquitous, rare or mythical?

9.1 Introduction

Clark suggested that technology was just another "*mere vehicle*" for delivering education (2001), but can it actually have a transforming effect on what is being delivered? Does technology by default have a significant impact on teaching and learning when it is introduced into a course, so that transformation will always be present with it? Or is the possibility of transformation nothing more than a nice idea with little evidence to support its existence in reality? At the beginning of this thesis I defined key research questions that would form the central focus of the study;

- **Is technology having a transformative effect on teaching and learning?**
  - *What areas of teaching and learning can be transformed by technology?*
  - *What is the evidence for this in literature?*
  - *In what areas of teaching and learning can transformative effects be observed? Can these transformative effects convincingly be attributed to technology or its use?*
  - *Is there a discrepancy between the rhetoric about the choice and use of technology in the Vanguard courses and the reality of the implementation?*

In order to address these questions, an in depth review of existing literature was conducted in Chapter 2 to identify the areas of teaching and learning which theory suggests may be affected by the use of technology or in which some kind of transformative effect has actually been observed. In Chapter 3, the evidence gleaned from the literature was then used to synthesize what could be described as a simple framework or a lens through which any implementation of educational technology could be viewed as a way of "exposing" the areas of teaching and learning in which transformation was likely to be occurring to a greater or lesser extent. Three first year courses in a well-known UK university that were in the process of using technology as a vehicle for change as part of the broader implementation of a new Learning and Teaching Strategy were selected for study using the Framework. This Framework was used to construct a series of interviews and online surveys, which were then used to gather the perspectives and perceptions of those involved in the courses; from the Dean of Undergraduate Study who had at least some responsibility for the introduction of the new Learning and Teaching Strategy (which in turn had resulted in the implementation of new technologies into these Vanguard courses), to the Course Organisers, lecturers and teaching assistants who took part in the actual delivery of the courses themselves. The data obtained were analysed to identify the areas in which the interviewees felt that some level of transformation had been observed. The final course marks obtained by the students in these courses during the period under study were also analysed in an attempt to identify any observable changes or shifts as the courses introduced the new technologies, and the numerical data were then compared with the qualitative interview data to highlight any areas or agreement or otherwise. Finally, the perspectives of the three groups of staff (the Deans of Undergraduate Studies, the Course Organisers and the other teaching staff) were compared with each other. This was again done with the aim of identifying common themes or observations that would perhaps corroborate any statements that were made, as well as highlighting any contradictions or disconnects that might exist between the views at the "policy" level as represented by the Deans through the middle ground of the Course Organisers to the teaching staff who spend most time at the course-student interface. The overall approach is summarised in Table 9-1 (overleaf);

	Research Question	How it was Addressed
Is technology having a transformative effect on teaching and learning?	What areas of teaching and learning can be transformed by technology can be transformed by technology? What is the evidence for this in literature?	Literature review and development of the "framework"
	In what areas of teaching and learning can transformative effects be observed? Can these transformative effects convincingly be attributed to technology or its use?	Use of the Framework to conduct and analyse interviews and online surveys with Deans, Course Organisers, lecturers and teaching assistants. Use of numerical data to corroborate claims.
	Is there a discrepancy between the rhetoric about the choice and use of technology in the Vanguard courses and the reality of the implementation?	Comparison of the perspectives of the three key groups (Deans of Undergraduate Studies, Course Organisers and Other teaching staff.

Table 9-1: Approach to addressing the research questions

The development of the Framework has already been discussed in detail in Chapters 2 and 3, as have the results of the various stages of its application to the selected courses. This chapter takes those results and discusses them as a whole in the light of the research questions and hence to highlight the conclusions that may be drawn from the study regarding the transformative effects of technology on teaching and learning in the Vanguard courses.

9.2 Were the Foundations for Transformation in place?

In Chapter 6, the interviews and surveys that were carried out with the Course Organisers and the teaching staff of the three first year courses under study were first analysed in detail in order to identify the Foundations for Transformation that were in place (Table 9-2). In the table, ***green*** indicates those areas in which the Course Organisers and teaching staff agreed that they felt that there was convincing evidence that the corresponding Foundation was in place, or that transformation could be observed. ***Orange*** indicates areas in which they may have offered some evidence but that could at best be described as "emerging".

Course	Foundations in place
Course A	*F1a - The introduction of technology was driven by an explicit rationale*
	F1b- The decision to implement technology influenced how the course was planned
	F2 - Those involved were willing participants
	F3b - Some new teaching spaces were technology-oriented
	F4b – educators were both confident and competent in the use of the chosen technology
	F5a - the educational purpose of the technology was clear to teachers and students
	F5b - students easily connect the use of the technology to specific educational goals
Course B	*F1a - The introduction of technology was driven by an explicit rationale to some extent*
	F3b - Some new teaching spaces were technology-oriented
	F5a - the educational purpose of the technology was clear to teachers and students
Course C	*F5a - the educational purpose of the technology was clear to teachers and students*
	F5b - students easily connect the use of the technology to specific educational goals

Table 9-2: Foundations for transformation as perceived by all teaching staff

For each course, it is important not only to review the Foundations as reported or implied by the Course Organisers and teaching staff as highlighted in Table 9-2, but it is also vital that we consider whether these reflect an accurate view of what was in place or one which may have been idealised, influenced or otherwise distorted (no matter how unwittingly) by those involved.

9.2.1 Foundations in Course A

Table 9-2 highlights the fact that the staff involved in Course A were confident that many of the Foundations desirable for the successful use of technology in education were already in place to a greater or lesser extent when the course became a Vanguard course. It was eminently clear from the discussions with the Course Organiser that, not only did he personally subscribe to the ethos behind the Learning and Teaching Strategy, but he was already passionate about exploring and furthering innovative teaching and learning within his department *before* the shift to Vanguard. Although there is often a certain amount of rhetoric offered in this area (Moore, Fowler, & Watson, 2007; Nichol & Watson, 2003), it was also obvious that the needs of the course and the possibilities offered by specific technologies had indeed been carefully considered and discussed before implementation, and it seems reasonable to concur with those involved that this Foundation (F1a) was in place.

Interestingly, the Course Organiser and Staff were less convinced that the decision to implement technology had influenced how the course was planned (F1b). It is important to remind ourselves that this element does not mean that there is an expectation that courses should be changed solely to accommodate new technologies, but rather that once the decision is made to use specific technologies, it may be necessary to plan ahead how to get the best from those technologies in the context of a particular course (Young, 2004). However, it must also be acknowledged that there may be occasions where this is not necessary, either due to the nature of the technology or the context into which it is placed. In the case of Course A, the staff involved (and the course itself) were no strangers to innovation and seemed to be genuinely comfortable with the mechanics of using the technologies in their teaching (F4b), and the shift to Vanguard was a natural part of an existing trajectory which they were willing to follow (F2). Hence, although the feeling that there had been little influence on the way the course was planned may reflect the fact that the Course was not yet in a position to make those kind of changes, it (together with the general willingness and level of comfort with the innovations already mentioned) may also simply be a reflection of the fact that these kind of changes had already been in progress and the technology actually sat comfortably into the existing course environment.

Course A had an improved infrastructure in place in terms of the teaching spaces available, although neither the Course itself, nor the existence of the Vanguard courses could be credited as being the sole motivation for the development of these spaces by the University. The Course Organiser asserted that the course, and the School's whole approach to teaching and learning, nonetheless had a direct impact on the way the renovations took shape. He felt that the correlation between the teaching styles employed and the design and equipping of the new teaching spaces reflected the fundamental change in thinking that was being stimulated by these innovations in teaching and learning, and in particular, those which are built on the use of technology. This seems to be a fair representation of his and the Course's role in ensuring that the appropriate teaching spaces are in place to support the delivery of technology-rich courses (F3b).

There was clear agreement among those involved that the educational purpose of the technology was clear to teachers and students and that the students could easily connect the use of the technology to specific educational goals (F5). There seems to be little to argue with here – the staff themselves were given the opportunity to discuss anonymously how they felt about the chosen technologies and the response was overwhelmingly positive. Usage figures and feedback responses from students regarding the use of web-based resources and the "clickers" during lecture time were presented as evidence of how the students had responded to the use of the tools, and so, assuming these were representative, it seems safe to accept that there were few barriers to the successful use of the particular technologies chosen for this course.

Hence, there is little to suggest that the perspectives of the Course Organiser and teaching staff of Course A are anything other than a fair indication of the Foundations that were laid preceding the introduction of the new technologies. The staff and even the students appear to have been well prepared for the innovations, and the innovations themselves appear to have been born out of a conscious and carefully considered approach to teaching and learning within the department.

9.2.2 Foundations in Course B

The discussions with the Course Organiser and teaching staff of Course B revealed that, although those involved were generally sympathetic to the ideas behind the Learning and Teaching Strategy, the shift to Vanguard, and hence the implementation of new technologies, was a cautious one. Those involved expressed less confidence both about what they were doing and the way they were doing it. Some of this reflected an acceptance of the fact that they were at the beginning of a learning curve as far as teaching with that particular technology was concerned. However, it was also indicative of the fact that, although the Course Organiser was aware of the educational benefits of the tools, the technology was chosen, at least in part, because others (such as Course A) were already using it and it seemed a sensible direction in which to go (F1a).

Hence, although it was clear that the use of technologies was much more than simply a blind or unthinking attempt to squeeze it into the course, the approach as described by the Course Organiser and teaching staff suggests that with the exception of F3b (the course has taken advantage of the existence of some teaching spaces that are equipped with the clicker systems), the Foundations were either absent (F1b, F1c, F3a, F4b, F5b) or at an emergent stage. Despite having reported an initially bad experience with the technology, the staff (some of whom were initially reluctant to take on new things) were beginning to show a willingness to make the “clickers” work in lectures (F2) as they began to consider how the technology might best be used and seek to develop new and more effective questions (F5a). Indeed, the conversations with the Course Organiser indicated that he felt that the Foundations would, in many ways, gradually be built as he and his staff became more experienced with the use of the technologies in delivering their course materials.

9.2.3 Foundations in Course C

Course C stood out among the three courses studied as the only one in which the technology was, in the eyes of the Course Organiser at least, an afterthought – effectively bolted on in an effort to tick the appropriate box without causing disruption to the existing infrastructure as the course became Vanguard at a relatively late stage. There seems little reason to doubt the Course Organiser’s point of view in this respect – whether or not those involved would have liked to, there was little time to think ahead about what technology might be able to accomplish in this context and to plan accordingly; the technology was simply chosen because it was available and would not have an impact on the way the course was run (F1). While it may be a little unfair to describe the staff as *unwilling participants*, the nature of the implementation was such that their role was effectively reduced to observers – watching with passing interest to see if students would make use of any of the online resources (F2). Resources and even professional development (F3 and F4) were not an issue simply because the technology was not expected to be used by the staff in their teaching – rather it was put in place in the hope that students would use it in their own time and in their own way. Indeed, the Foundations that may have been present in an emergent state were dependent solely on the staff and the students (F5). It could be argued that these emergent Foundations are, in fact, only an accidental by-product of the subject - we may reasonably expect teachers and students in Course C to be unperturbed by new technologies and to be able to grasp their use in new contexts, Hence, it may be that even these loosely placed cornerstones may be a fortuitous coincidence in the case of Course C rather than the result of any deliberate preparation for technological innovation.

9.2.4 Common Foundations

It may be worth pausing at this point to consider the fact that although the elements we consider as Foundations for Transformation can certainly be laid within individual courses, at least some of them may also have their roots in decisions made or attitudes held at a higher level such as the School, College or even the University (Boyd-Barrett, 2002; Cornford & Pollock, 2003, pp. 3-7). Perhaps the most obvious of these are found in F3 and F4:

F3 – The provision of sufficient resources	*Have the time and other resources provided for the teacher and students by the institution been augmented or adjusted in response the new teaching and learning methods and tools?*
	Are new teaching spaces technology-friendly?
F4 – The opportunity for professional development	*Has the introduction of new technologies been accompanied by appropriate training?*

Table 9-3: Foundations for Transformation common across courses

Responsibility for the provision of sufficient resources may well lie outside the immediate influence of any single course – many (if not all) resources are likely to be shared across courses and so Schools may take a subject-wide view of allocations of time, equipment and money, leaving individual courses with little ability to make any adjustments. A similarly broad view is also likely to be taken towards the area of professional development in its strictest sense – it seems more likely that a formal professional development programme would address issues that were pertinent to a large number of staff involved in a wide range of courses. Course- specific discussions may well be more informal in nature, involving as they would a smaller group of staff, and may even happen as one of many items in a regular meeting and hence may not even be seen as professional development in the strictest sense. For example, although there were obviously informal discussions and plans made at an individual course level, it does not appear that there were many training sessions specifically organised at department or College level for those Vanguard courses which were going to use the clicker systems in their courses for the first time (Gauchago, 2008). Finally, although personnel involved in particular courses may be influential in the decision-making processes, the provision of new technology-friendly teaching spaces is unlikely to happen because of, or be solely geared towards, a specific course. Indeed, demand for such spaces across a wide range of courses (thus implying a potentially high level of usage) may even be a factor in securing the release of the necessary finances to fund such developments (Cobbet et al., 2012; TRIAG, 2004; UoE, 2005).

It is interesting to note that from the perspective of each of the courses, only one of these Foundations was considered to be fully in place. There was no evidence of any recognition of the need for any adjustment in resources from outside the courses. Opinion varied as to how important this was in each context, but it seems that this particular Foundation gained little attention during the implementation of the Vanguard courses. In the same way it was clear that, although the College had made some investment in providing support staff, little had been done to provide *paedagogical* training in the use of technology in teaching and learning for the staff that were to be involved in the Vanguard courses – the implication perhaps being either that staff would already know how best to teach with the new resources or that they would acquire that knowledge as they went along.

The existence of the clicker-equipped lecture halls and the other new teaching spaces in the newly-renovated teaching block meant that Courses A and B at least could point to tangible evidence that this Foundation had been addressed, albeit from outside their particular courses. However, Course C was not in a position to refer to this evidence as it did not choose to make use of the "clickers". The technology chosen for the course (the online environment) did not place any constraints on where the course was taught and hence, from their perspective, this Foundation had not been addressed. It could be argued that the "clickers" *could have been* available if the course had chosen to make use of them (indeed, all the commonly used teaching spaces in the newly-renovated teaching block where the course was taught were already equipped with clicker base stations), and hence although the course itself had no perceived need of this element and felt it had not been addressed, the Foundation was still in place had it been needed, as it was for the other courses.

9.3 In what areas of teaching and learning were Transformations observed?

The interviews and surveys that were carried out with the Course Organisers and the teaching staff of the three first year courses under study were also analysed in detail in order to identify the areas in these courses in which the interviewees felt there was some evidence of transformation as shown in Table 9-4 (overleaf). As before, green indicates those areas in which the Course Organisers and teaching staff agreed that they felt there was convincing evidence that the corresponding Foundation was in place, or that transformation could be observed. Orange indicates areas in which they may have offered some evidence but that could at best be described as "emerging".

For each course, it is clearly important to try to determine whether or not the perspectives of the Course Organisers and teaching staff were reliable indicators of the existence or otherwise of some form of transformation in teaching and learning or simply wishful thinking or uncorroborated claims

Course	Areas in which transformative effects may have been observed
Course A	*I1a - the desire to introduce new technologies led the institution to explore explicit rationales for its use*
	I1b - the decision to implement technology influenced how the course or intervention is planned
	I2b - the use of technology is driving a need for alternative teaching spaces
	I3b – educators are becoming more confident and competent in the use of the chosen technology
	M1 – technology has improved efficiency of course delivery i.e. it has increased the amount of time available for activities other than delivery of content
	M2a – It has increased the possible variety of means of engagement with the material
	M2b - the course takes some advantage of this
	M3a – Technology has enabled some new content to be taught or less useful/redundant material to be removed
	B1 - it has increased the amount and quality of teacher-student and student-student interaction
	B2 - the introduction of particular technologies has begun to cause a shift in teaching styles and approaches
	B3 - the implementation enables the student to take more responsibility for his or her own learning to some extent
Course B	*I1a - the desire to introduce new technologies led the institution to explore explicit rationales for its use*
	M2a – It has increased the possible variety of means of engagement with the material
	M2b - the course takes some advantage of this
	M3b - *it altered the way the course is assessed*
	B1 - it has increased the amount and quality of teacher-student and student-student interaction
Course C	*M2a – It has increased the possible variety of means of engagement with the material*
	B3 - the implementation enables the student to take more responsibility for his or her own learning to some extent

Table 9-4: Areas of observed transformation as perceived by all teaching staff

made in hope or desperation. However, it is also important to look more closely at the transformations that may have occurred in order to ascertain if it seems reasonable or plausible to attribute at least part of that transformation to the use of the chosen technologies, or if those transformations would have been likely to occur anyway in the absence of any technological intervention.

9.4 Transformations in Course A

9.4.1 Institutional Transformations

As has been mentioned several times, those involved with Course A were no strangers to innovation, and in previous years the course had explored many different ways of enhancing and modifying the way the course was delivered as well as the way the students interacted with the subject material. We have already seen that such innovations seemed to be built on explicit and educationally valid rationales as the team, and in particular the Course Organiser, was inspired by the "peer instruction" method (Crouch & Mazur, 2001; Mazur, 1997). However, despite the fact that solid foundations were already clearly in place in this area, it seems fair to say that the "institution" (in this case, referring to the course and those involved) did not rest on its laurels. There was the implication that when a particular technology was brought to the table, they considered carefully how it could change teaching and learning in this particular course (I1a, I1b). It is worth noting that the Course Organiser and teaching staff indicated that they took the same approach each time they considered *any* innovation - they took the time to consider what it brought to the course and what it might enable them to accomplish. Hence it seems reasonable to suggest that if there were some signs of transformation in this area (where those involved are more likely to consider explicit educational rationales for use than they might otherwise have been) this may be a result of *all* the educational innovations encountered in the course, not just technology.

Course A has certainly made strong use of the new teaching spaces that were completed and ready for use as the course became Vanguard, and did claim some influence over how these spaces were planned and developed. It is clear that, just as with I1a, this area (I2b) has a certain ambiguity about it, in that not only did the existence of the teaching spaces provide part of the foundation for the successful use of technology, but also the increased use of technology in teaching and learning had driven the need for them in the first place. Assuming that the Course Organiser did indeed have an influence over the development of the new teaching spaces, then it seems fair to accept that the use of technology in Course A may have been beginning to have a transformative effect on the space around it, and as an indirect result, on what other courses may have been able to achieve in the new environments.

9.4.2 Material Transformations

The desire to use innovative teaching methods within Course A, coupled with the lack of availability of any additional contact time with students, would obviously have presented certain challenges to the course team. As we have seen before, they sought to re-allocate many mundane aspects of traditional course delivery, particularly the giving of notes, to a time and place outside the limited contact time with staff. Hence, as the course made its transition to "Vanguard" status an element of transformation was clearly already underway as the course made a deliberate choice to make use of appropriate technologies as an alternative means of delivering content, thus increasing the amount of time available for activities other than delivery of content (M1) and the possible variety of means of engagement with the subject material (M2a). However, would these transformations have happened in the absence of the chosen technologies? That these transformations were already underway *before* the course officially became "Vanguard" is a reflection of the ongoing innovation that was taking place. Technology was clearly not responsible for the teaching staff's desire to be innovative – indeed, we discussed previously how the course developed its own student response system using coloured pieces of card long before the "clickers" became available. However, the desire to use a fixed amount of lecture time for interactive question and answer sessions necessitated the search for supplementary means of delivery for course notes and other materials. Some of these materials could have been supplied as traditional paper-based "handouts" and if this had been the sum total of the steps taken then some transformation could have occurred without the need for any technology (Grabe, 2005; Grabe & Christopherson, 2005; Grabe et al., 2005). While Course A did make use of the online environment to provide access to lecture notes for students, it is clear that the teaching staff were also taking advantage of the affordances of the medium to provide students a with a wide range of learning materials such as tutorial-style animated explanations, simulations and questions with immediate feedback that would be difficult to envisage being supplied using any other mode. Course Organiser A recognised that this was a work in progress and that the Course had not yet made the most of this area (M2b), but it was obvious that this was something that the Course took seriously. Hence, although the technology did not drive the desire to innovate, it clearly enabled Course A to make the most of that desire within existing constraints and made a significant contribution to the transformation that was taking place.

Course Organiser A and the rest of the teaching staff reported that *potential* existed in the course. Small steps had begun to be taken to use the new-found freedom provided by the available means of engagement and the technology-equipped teaching spaces to review and expand what was being taught, and perhaps even to introduce content which had been inaccessible in the past (M3a). Hence they seem confident that the course was seeing the initial signs of transformation in this area, and there is little to suggest that this was an over-optimistic view of the situation, especially given the staff's willingness to change and innovate when and where appropriate. However, the interconnection between some of the technology used and the teaching spaces that facilitated its use renders it difficult to determine with confidence the degree to which the technology was a key contributor in and of itself. Although the staff of Course A clearly associated technology with the teaching spaces, much of the evidence provided in support of the fact that transformation was underway centred around the introduction of the workshop scenarios to support laboratory work, and these were not necessarily dependent on specific technology. If transformation was beginning to occur in this area, it seems reasonable to suggest in this case that although the new teaching areas were very much "high-tech", it appeared to be more dependent on the use of the space itself and so may have happened irrespective of the tools used within that space.

9.4.3 Behavioural Transformations

It is clear that from Course Organiser A's perspective, the use of technology such as the "clickers" during lecture time and wikis in the online environment had a transformative effect on both student-teacher and student-student interaction (B1). Indeed, it would be difficult to argue against the notion that these technologies could have had a positive impact on the *quantity* of interactions taking place between these groups (Chickering & Ehrmann, 1996; d'Inverno et al., 2003; Sivin-Kachala et al., 1997; Somekh, 2000). However, it is more difficult to determine whether or not any claims of transformation in the *quality* of interactions taking place is justified. In the first instance, the term "quality" can mean different things to different people (Harvey & Green, 1993), and we need to be clear about what we mean by the term *quality* in this context: In this case, the term "quality" is used to refer specifically to the nature and content of the interactions and their ability to achieve their purpose. So, for example, if the quality of a particular student-teacher interaction "improves", then it will be more likely to provide the teacher with a clearer idea of a student's grasp of a particular concept, and the student with the opportunity to express his or her understanding (or lack thereof) regarding that concept. The teaching staff pointed to the use of the "clickers" and the ability to provide instant feedback to the students regarding their responses, as well as the opportunity for the teacher to revisit topics or change the direction mid-lecture depending on the student responses, as evidence of higher quality interactions. Obviously, in this instance, the interactions are between the "class" (as opposed to individual students) and the teacher, and yet the possibility that a lecturer could be informed about his students' misconceptions and take the opportunity to address them at that moment is clearly a departure from the normal routine of the traditional lecture. It would be naïve, of course, to accept blindly that this happened every week in Course A, and the flexibility and confidence required of the teacher to be able to make this kind of unexpected diversion mid-lecture must not be underestimated. However, in reality, this kind of thing happened frequently enough in Course A that it was also observed by staff from other courses who were auditing Course A in order to gain some experience of what it would be like to use the "clickers" in their own lectures. Representatives of those courses admitted that they were not yet confident enough to display the kind of flexibility evident in Course A. Hence, in that respect, it seems reasonable to conclude that the use of the "clickers" *was* having an observable transformative effect on both the quantity and quality of interactions taking place in this course.

From our previous discussions in Chapters 5, 6 and 8, there can be little doubt that Course A was (and had been for some time before the Vanguard courses) exploring "new" teaching styles. Although the course still revolved around a lecture- and practical-based format it was certainly evolving and there were definite signs that transformation was beginning to take place in this area (B2). The role of technology in this shift is not clear. Conversations with the Course Organiser confirmed that the decision to make such changes was made outside of any consideration of technology, and yet by the same token, he admitted that some of the changes would have been difficult, if not impossible, to support without the technological tools used in the course. However, all told, the inter-relatedness of technology and paedagogy in this case cannot be assumed to be the same as the *dependence* of paedagogy *on* technology (Salomon, 2002; D. M. Watson, 2001). The use of the technology enabled the desired paedagogy to be enacted in a broader manner but it was *not* the key driver of paedagogical change in Course A, and it is likely that the course would have adopted the same paedagogical approach in the course (albeit perhaps in a more limited manner) if no technology had been used.

We have seen that the increased engagement and interaction discussed previously in this section was viewed by the Course Organiser and the teaching staff as *potentially* an indication of the kind of responsibility highlighted by the Learning and Teaching Strategy, and they felt that students were beginning to take advantage of such opportunities on a more regular basis. Again, it is difficult to distinguish between technology as a *driver* or *facilitator* in this emerging transformation. Certainly, the use of the “clickers” has driven increased interaction, and the use of the online environment has made it easier for students to independently gain access to learning materials over and above the lecture notes. However, the interaction alone cannot be considered to constitute “student responsibility”, and there would be other ways of providing students with materials they could work on outside class that did not involve technology. Hence in this case technology appears to be playing more of a supporting role and there was little to suggest that it was a critical element in this area.

9.5 Transformations in Course B

9.5.1 Institutional Transformations

The evidence gathered from those involved in Course B suggests that the shift to becoming a Vanguard course produced at least some reflection on how teaching and learning were approached in the course. Although the course team was certainly not at the cutting edge in terms of innovative teaching or uses of technology, it is clear that the move to Vanguard (and the natural association with technology this seemed to have in most peoples’ minds) prompted the team to begin to evaluate how teaching and learning might evolve in this context. Despite the fact that the initial stimulus for this evaluation evidently came from the course's involvement in the Vanguard programme, the decision to take a closer look at, and ultimately implement, the clicker system in their lectures also seems to have sparked an awakening of sorts. Those involved with Course B first observed Course A "in action" with the "clickers" and then introduced them into their own lectures. This introduction was, by their own admission, fairly inauspicious, and yet there was enough awareness among the course team of the potential of the tool that this led to a certain amount of re-evaluation of what they might be able to achieve with it. Hence, it seems reasonable to suggest that the use of technology (in this case, the "clickers") disrupted the "norm" in Course B enough to precipitate a slowly growing desire within the course to think about what could be accomplished with the tools at their disposal (I1a).

9.5.2 Material Transformations

We have already seen that from the perspective of the teaching staff, there were several transformations that could be observed in course B, but there was a clear sense that some of these were felt to be *emerging* rather than complete or even in full flow. There is no reason to doubt the assertion that the use of WebCT was responsible for a definite increase in the means of engagement with the subject matter (M2a) – students had more points of access to the content in different forms than was previously possible before the use of the online environment and they seemed to be making use of at least some of these materials. It was equally clear that the course itself had really only *begun* to consider how it might take advantage of this change in the future (M2b), choosing to support their current teaching through light use rather than revolutionise it through total integration, and so the perception that transformation in this area was at a very early stage seems to be justified.

A similar picture exists with regards to the impact that technology may have had on how the course was assessed (M3b). One has the impression of a group of staff which was aware that it had access to a potentially powerful set of teaching tools and yet were, at times, unsure about how best to use them and even apprehensive about doing so and the impact that may have on their current practice. It is evident that the introduction of the "clickers" and WebCT *was* beginning to bring about changes in the modes of formative assessment used in the course and that these changes would not have occurred in the absence of the technology, but these changes had not yet matured into a fully fledged, new direction of travel for the course and the staff who delivered it.

9.5.3 Behavioural Transformations

We saw in Chapter 6 that Course Organiser B felt that although some efforts had been made to increase student-student and student-teacher interactions in the course (B1), he felt that any observable transformative effects precipitated by the use of technology were only *beginning* to emerge. It seems fair to acknowledge that progress *had* been made in this respect as a result of the use of the "clickers" and that, while the teaching staff as a group were (at least initially) reluctant to move forward into new territory, some degree of will existed to refine current approaches in future iterations of the course. This was evident in the fact that, although the first run of the course with the "clickers" did not appear to accomplish the desired level of interaction between teacher and class, the staff "regrouped" after the first run of Course B in its Vanguard guise to evaluate the use of the "clickers" and design a new set of more effective questions for use during lectures in the light of what they had learned from this experience. So, the leap to highly interactive lectures had not yet been made, but the principle had been established in the minds and attitudes of the staff, and they had accepted that this was the direction in which the course was now headed. The "clickers" and their use in Course B were unquestionably the catalyst for this subtle, and ongoing, transition to commence.

9.6 Transformations in Course C

9.6.1 Institutional Transformations

The Course Organiser and teaching staff of Course C told a very different story from that of Course A and Course B. The computer-based nature of the course set it apart from other Vanguard courses in that many teaching spaces were already technology-orientated, and the staff involved were technologically literate, so it was understandably difficult for the teaching staff to identify how the use of WebCT may have had any impact on these aspects. A late entry to the Vanguard concept, coupled with concerns about upsetting the balance between the different elements of the course resulted in what innovation there was in the field of teaching and learning being almost suppressed - behind, but not touching, the existing course so that transformations in how the course was planned, resourced and accommodated were, to all intents and purposes, deliberately avoided. Course Organiser C did express some optimism regarding where the course could be headed in future iterations, but despite this it is clear that introduction of technology had virtually no impact on the “institutional” aspect of the course.

9.6.2 Material Transformations

It is perhaps surprising that Course Organiser C felt able to report that the technology *had* produced an observable transformation in the variety of means of engagement with subject matter (M1a), despite the fact that he is also on record as having made a conscious effort not to advertise the availability of those materials to the students or to actively include the use of those resources in the course. However, the Course Organiser’s claim seems to be justified, at least in terms of the numbers of students accessing the materials as recorded by the WebCT platform itself, and this is corroborated by the rest of the teaching staff. What exactly led the students to access the materials is not clear, but the fact that such a passive (and hidden) implementation of WebCT was seen as useful and desirable by a significant proportion of the course cohort cannot be ignored (Grabe, 2005; Grabe & Christopherson, 2005; Grabe et al., 2005). Similarly, it must be acknowledged that the students in this iteration of the course had an opportunity that previous cohorts did not and this was solely the result of the use of WebCT, and *despite the fact that the course staff made little attempt to take advantage of the tools on offer as they delivered the course*. As a result, there seems to have been spontaneous and palpable change in the way the students engaged with the course.

9.6.3 Behavioural Transformations

It is interesting to note that the only transformations reported by the teaching staff involved in Course C seem to be very closely linked, and focused on the responses of the students to the introduction of WebCT and the associated online resources. Despite the reluctance to cause any form of disruption to the course, the Course Organiser stated that his key aim in the introduction of WebCT was that of providing students with the opportunity to take more responsibility for their learning (B3) and to move away from a model where learning was perceived as a passive absorption of knowledge transmitted from teacher to student. As we have already discussed, the implementation (perhaps surprisingly) appears to have been a relatively successful endeavour in this respect, with students making significant self-initiated use of the resources, and this may have been less likely to occur in the absence of the technology. Whether the implementation encouraged students to take *more* responsibility for their own learning, or simply provided them with the means to demonstrate a willingness that already existed is difficult to ascertain. Perhaps the most responsible students would have searched online or gone to the library to seek or work through relevant notes and questions, but the use of WebCT in this case made such materials much more readily available. It seems reasonable to assume that the provision of course-specific online resources is much more in sympathy with the lifestyle of today's students, who, in every aspect of their lives, are often more likely to seek information online than in a book, let alone a library with limited opening hours (Tapscott, 1998, 2009). So, there is no evidence to suggest that the technology has somehow *produced* a new attitude of responsibility towards learning. However, providing online resources that can be accessed in a form that suits the students themselves seems to have acted as an *enabler* for those with at least *some* desire to supplement what they received in the lectures (Pearce et al., 2011). Did more students access the online resources than would have gone to the library? Instinct says this might be the case but there is no evidence one way or the other. The course was not suddenly overwhelmed with the sense that it was populated with a new breed of responsible student, and there was a dip in the pass rate that year, with a corresponding spike in the fail rate, although there is always the possibility that this reflected some level of destabilizing that the students had yet to come to grips with. What *is* clear is that simply providing access to a range of online resources through the WebCT platform had an impact on how the teaching staff saw the students engage with course, at least superficially – not only did the students have a wider range of ways provided for them by the course in which to engage with the subject matter, but an additional route now existed, that was not available before, that enabled students to visibly take a little more responsibility for their own learning in a way that was not reported in the other courses.

9.7 Did the Foundations matter?

In Section **9.2**, the Foundations for Transformation were discussed in relation to each course, and Table 9-5 below summarises which of those Foundations can reasonably be assumed to have been in place at the time of the Vanguard initiative and the introduction of the new technologies as part of that process;

Course	Foundations in place
Course A	*F1 - The introduction of technology was driven by an explicit rationale*
	F1- The decision to implement technology influenced how the course was planned
	F2 - Those involved were willing participants
	F3 - Some new teaching spaces were technology-oriented
	F4 – educators were both confident and competent in the use of the chosen technology
	F5 - the educational purpose of the technology was clear to teachers and students
	F5 - students easily connect the use of the technology to specific educational goals
Course B	*F1 - The introduction of technology was driven by an explicit rationale to some extent*
	F3 - Some new teaching spaces were technology-oriented
	F5 - the educational purpose of the technology was clear to teachers and students
Course C	*F5 - the educational purpose of the technology was clear to teachers and students*
	F5 - students easily connect the use of the technology to specific educational goals

Table 9-5: Foundations deemed to be in place at the time of the Vanguard initiative

It is clear from Table 9-5 that Course A was by far the most advanced of the three courses in terms of the Foundations that appeared to be in place, and it is striking that it was also the course that had made defendable claims on the largest number of observed transformations as a result of the use of technology, as shown in Table 9-7. A similar picture is visible with Course B and Course C –

Course B has fewer Foundations and fewer observed transformations than Course A, while Course C has both the fewest Foundations and fewest observed transformations. Can we read anything into these apparent correlations – did the Foundations that were in place have an effect on the specific transformations that were observed?

When taken as a group, it is clear that a close relationship exists between the Foundations and the appearance of any Institutional Transformations. This seems to be reasonably intuitive – after all, the Foundations focus on the general state of readiness of a particular course to introduce and make the most of technological innovation in teaching and learning. Ingrained in this is the assumption that the course will also have reached a state in which there is an ongoing acceptance of change that may result from any new innovation (Brzycki & Dudt, 2005). In turn, Institutional Transformations reflect the changes that may occur within a course, department or broader organizational structure as a result of a new use of technology. Foundation F1 relates to the explicit consideration given to the implementation of the technology by the course or department. Course A had a long history of this kind of careful thinking and planning, and in a way, these Foundations were so well established in the course that I1 transformations were already in place and were therefore possibly considered less worthy of note. Course B had not travelled so far in this direction, and it seems plausible that with fewer firm F1 Foundations in place, there was room for the technology to begin to act as a catalyst for further thought as it was implemented and thus show some signs of I1 transformation. F2, F3 and F4 could be taken as broadly referring to the "starting" position of the staff involved in the implementation, and taking into consideration their willingness and preparedness to use the new tools in their teaching in addition to the appropriateness of their surroundings into which the technology is introduced. Course A had all of these Foundations in place and showed some signs of transformation in I2 and I3, reflected in the attitudes to (and ability to embrace) change shown by the staff despite the absence of much in the way of formal training. Course B had only F3 in place by virtue of the fortuitous availability of the new teaching spaces in the newly-renovated teaching block, but their cautious, sometimes hesitant, approach provided too much resistance to change for any transformations to occur in this area. Course C provided no evidence of Foundations F1, F2, F3 or F4 having been in place, and interestingly showed no signs whatsoever of Institutional Transformation.

Foundation F5 seems to sit slightly apart from the other Foundations in that it deals primarily, not with the “institution” or the staff, but rather with the choice of technology itself and how its usefulness is perceived by those involved (Ebner et al., 2007; Lave & Wenger, 1991; Suchman, 2007). It is therefore tempting to suggest that F5 may be most closely related to those transformations that have to do with how students react or respond to the technology. This may cover a range of both Material and Behavioural Transformations – in particular, M2, B1 and B3. It is also interesting to note that this Foundation was deemed to be present to some degree *across all three courses*. Course A, who had thought long and hard to ensure that there was a clear match between the tools they chose and their educational goals, saw clear transformations both in the ways students could engage with the subject matter and interact with the staff and each other. Course B also reported meaningful change in student engagement with the subject matter and the beginnings of transformation in student interactions, although elements of their implementation had not been as clearly thought out and proved to be a hindrance at times rather than a help. Even Course C, who had *no other Foundations* in place, saw the technology (albeit chosen at a relatively late stage and, by their own admission, implemented without much thought) enable their students to engage with subject matter in new ways and so begin to take responsibility for their own learning in ways not visible before, indicating that in this instance, the possibility for transformation lay largely in the appropriate choice of technology alone rather than in any external preparation.

Hence, we can tentatively propose a mapping between the Foundations that are in place and the Transformations that therefore might reasonably be expected to occur, based on these three courses as shown in Table 9-6 below;

Foundations	Connected Transformations
F1 – The presence of a clear rationale	**I1** – Planning educational interventions
F2 – The presence of willing participants	**I2** – Resourcing educational interventions
F3 – The provision of sufficient resources	
F4 – The opportunity for professional development	**I3** – Professional Development
F5– Ease of use and clarity of purpose	**M2** – Means of engagement with subject matter **B1** – Amount and quality of interactions **B3** – Student Responsibility

Table 9-6: Foundations and connected Transformations as observed in Courses A,B and C

9.8 Technology-driven transformations

Table 9-7 summarises the transformations identified that could reasonably be attributed directly to the use of the chosen technologies in each course as discussed in Sections **9.4** to **9.6**.

Course	Areas in which observed transformative effects are likely to have been driven by the technology
Course A	*I2b - the use of technology is driving a need for alternative teaching spaces*
	I3b – educators are becoming more confident and competent in the use of the chosen technology
	M1 – technology has improved efficiency of course delivery i.e. it has increased the amount of time available for activities other than delivery of content
	M2a – It has increased the possible variety of means of engagement with the material
	M2b - the course takes some advantage of this
	B1 - it has increased the amount and quality of teacher-student and student-student interaction
Course B	*I1a - the desire to introduce new technologies led the institution to explore explicit rationales for its use*
	M2a – It has increased the possible variety of means of engagement with the material
	M2b - the course takes some advantage of this
	M3b - *it altered the way the course is assessed*
	B1 - it has increased the amount and quality of teacher-student and student-student interaction
Course C	*M2a – It has increased the possible variety of means of engagement with the material*
	B3 - the implementation enables the student to take more responsibility for his or her own learning to some extent

Table 9-7: Areas of observed transformation likely to be driven by technology

It is clear that Course A encountered some level of transformation in more areas than either Course B or Course C, and we have also discussed how the transformations that were observed may have been catalyzed by the Foundations that were in place at the time. On the face of it, it appears that Course A was fertile ground for transformation to take root while Course B was perhaps rougher but still potentially productive soil. Course C may have been the ground that had not been considered for planting until the last minute. However, such comparisons do not give us any indication of how these courses fared in comparison with other similar courses in other universities who were making similar changes in their approach, many of whom were at least partly relying on the same technologies as vehicles for change.

The National Center for Academic Transformation provides an excellent source of courses for comparison (http://www.thencat.org/). The Center grew out of Dr. Carol Twigg's work to show that it was possible to improve the quality (and reduce the cost) of higher education courses using technology. "*NCAT furthers its mission of creating lasting change in higher education through a number of initiatives designed to provide research-based solutions, expertise and support to educational systems interested in improving quality, increasing access, and using resources more effectively*" (Heterick & Twigg, 2003). Hence we will look at three NCAT-supported courses that were similar in content to courses A, B and C.

Course X (Simon, 2009), at a large public university in the US, was similar in content and focus to Course A. It appears to have followed a more traditional path than Course A and had a larger failure rate at the time of the "intervention". The course was redesigned to incorporate a number of innovations that paralleled remarkably with Course A; an online platform was used to give students access to online activities and assessments, a classroom response system was introduced into lectures and students were put in small groups to work "*in an inquiry-based atmosphere to solve real physical problems*" (Simon, 2009). The report noted a number of observations on how impact these changes had on the course, as shown in Table 9-8 (overleaf). As can be seen, there appears to be a significant amount of overlap between the observations made regarding Course X and the transformations that were underway in Course A (indeed, as discussed in Chapter 7, if we were to look only at the "first run" of Course A as a Vanguard course, then we may also have reported a significant shift in final course marks at that time. However, further analysis suggested that this was a "spike" rather than a continuing trend).

Transformations in Course X	Related Transformations in Course B
As a result of the online materials, class time was used to deal with misconceptions, subtleties, connections, applications and summarizing content.	***M1*** *– technology has improved efficiency of course delivery i.e. it has increased the amount of time available for activities other than delivery of content*
	M2a *– It has increased the possible variety of means of engagement with the material*
	M2b *- the course takes some advantage of this*
The use of a classroom response system made the course more interactive and had a positive impact on class attendance – "clickers" were used to pose conceptual questions, which students answered after consulting with a small group of peers.	***B1*** *- it has increased the amount and quality of teacher-student and student-student interaction*
Students outperformed students in the previous run of the course: in two items students by 4%; in three items by 8%; and in one item by 16%.	

Table 9-8: Comparison of transformations observed in Course X with Course A

There were, of course, some fundamental differences in the conditions under which the implementations were made – Course A is one with a pedigree of ongoing innovation, while Course X appeared to be stuck in somewhat of a "traditional" rut. Hence, where the changes in Course A were part of an ongoing process, Course X experienced a more dramatic shift in approach. In addition, the report on Course X gives little indication of the Foundations that were in place before the course redesign, nor of the attitudes of those involved in the course to the changes that were being made. Despite these differences, the similarities in the observations regarding the impact of the technology are striking, and one could certainly argue that there is evidence that the same technologies have produced similar transformations in the two courses.

Another example, **Course Y** (Gutberlet, 2009), at a medium-sized public university in the US, was similar in content and focus to Course B. The target audience was similarly diverse, with a mixture of specialists and those who were perhaps adding an element of variety to their studies. "*The course enrolls a large number of students each semester and commands a large amount of faculty resources. The faculty involved in the course note a general lack of student engagement with the course material as it is currently taught*" (Gutberlet, 2009). Hence a number of innovations were implemented in 2008 to address these issues – in particular, the use of WebCT to deliver online resources and the use of "clickers" during lectures. The final report noted a number of changes, or transformations, that were attributed to the innovations that took place, as shown in Table 9-9:

Transformations in Course Y	Related Transformations in Course B
Students spent more time outside of class working on course material. Surveys and end-of-course evaluations suggested that students spent more time reading the textbook and doing additional coursework (online learning modules).	*M2a – It has increased the possible variety of means of engagement with the material*
	M2b - the course takes some advantage of this
Student engagement was greatly improved in the redesigned course. Students showed greater interest in class, asked good questions, made thoughtful comments, and—according to surveys—found the course material both interesting and relevant to their lives.	*B1 - it has increased the amount and quality of teacher-student and student-student interaction*
Students in the redesigned course asked a greater number of content-related questions (both inside and outside the classroom) than students in traditional sections. The questions themselves and the discussions surrounding them also suggested greater mastery of the material by students in the redesigned course.	
Students in the redesigned course outperformed students in the traditional course on common exam questions. The average percentage correct for the traditional students was 74% whereas for the redesigned students, the average was 82%.	

Table 9-9: Comparison of transformations observed in Course Y with Course B

Two important observations can be made from Table 9-9. The first is that there is clearly some overlap between the transformations observed in Course Y and Course B as they implemented the same technologies with similar goals in mind.

The second is that Course Y reported at least one transformation that was not visible in Course B. There could, of course, be several explanations for this, and we must obviously be careful about drawing too many conclusions based on comparisons of what are different courses in different universities in different countries. However, the report on Course Y highlighted three notable differences in the implementation that may indicate that the Foundations for Transformation may have been more established than those of Course B, thus setting the scene for more transformations to occur;

- Release time was provided for the course coordinator
- Stipends were provided for the summer work conducted by the redesign team
- *Instructors* took the opportunity to discuss and update the content of the course. The topic sequence was revised, and the lab manual was rewritten. This work reversed course drift, facilitated sharing of ideas and fostered positive interactions among the course instructors.

It is not possible to determine from the information available in the Final Report precisely which of the Foundations would have been in place for the beginning of Course Y. However, it does seem that Course Y was provided with some additional resources that Course B was not, and that changes were made to the substance of Course Y and the way it was delivered that were much more radical than anything that was done in Course B. It is possible that these far reaching changes enabled the course to take fuller advantage of the technologies that were introduced so that the impact on learning was much more dramatic and noticeable (for example in the increase in exam results). Indeed, given the similarities in the courses and the technologies that they implemented, and the differences in the way these technologies were introduced and used, it may not be too much of a stretch to suggest that Course

Y provides an indication of where Course B might be if (or when) it becomes more aligned with Course Y's overall approach.

Course Z (Popyack, 2003) was offered by a highly respected private university in the US, and its subject area was similar, but not identical, to that of Course C. The Course Z redesign focused on the use of an online environment much like WebCT. However, the implementation was as revolutionary to the course as Course C's was perhaps over-cautious. Instead of merely adding the online environment as a silent partner to the existing modus operandi, Course Z made the bold decision to move all of its content delivery online as a replacement for lectures and focusing face-to-face time on group work. "*The plan for the redesigned course increased hands-on participatory learning experiences by replacing the lecture format with interactive, Web-based modules that enabled students to self-schedule learning each week*" (Popyack, 2003). The results of this somewhat extreme implementation of technology into what seems to have been a traditionally delivered university course were noted in the final reports and are summarised in Table 9-10 (overleaf).

As with Courses Y and B, we can see that two observations can be made here – first, despite the great differences in the implementation, the same transformations that were noted in Course C were also reported in Course Z, suggesting that these might be common occurrences when this kind of technology is introduced into any course. The second observation is that more transformations were reported in Course Z than in Course C. As with the other courses, the Foundations that existed prior to the redesign are not clear from the final report, although there was evidently a realization of the level of support and preparation necessary to ensure that the technology was used appropriately and successfully as the course recognised that "*a formal training system with follow-up monitoring was needed for new faculty, teaching assistants, and laboratory assistants so they could fully adapt to the course redesign*" (Popyack, 2003).

Transformations in Course Z	Related Transformations in Course C
A dedicated computer laboratory containing five clusters, each with five wireless-networked laptop computers and a projector that could be switched from one computer to another, was built to facilitate group work.	
Routine course activities were automated and/or moved online	
The plan for the redesigned course increased hands-on participatory learning experiences by replacing the lecture format with interactive, Web-based modules that enabled students to self-schedule learning each week.	*M2a – It has increased the possible variety of means of engagement with the material*
The faculty noted that the students participating in the redesigned course were more enthusiastic and alert during class time and appeared to be learning more than students in the traditional course.	*B3 - the implementation enables the student to take more responsibility for his or her own learning to some extent*
The classroom dynamic improved as a result of the group work	
Students seemed to be less inhibited about asking questions and stating opinions through online mechanisms than in person.	

Table 9-10: Comparison of transformations observed in Course Z with Course C

It is certainly clear that Course Z took the opportunity to dramatically change its way of doing things, and they were obviously willing to revolutionise the way the course was delivered. They used the technology in a way that enabled them to move away from traditional lectures, hand the responsibility for learning to the students via the online weekly modules and devote the time to workshop-style classes were students worked together in groups on real-life problems. In some ways, it is tempting to suppose that this is what Course C *should* have done had it been more serious about using the technology to address issues of student responsibility, and had it done so it also tempting to assume that it would have seen further transformations. However, it would also be naïve to consider these courses devoid of context – the reason behind the cautious approach taken by Course C was steeped in politics and an unwillingness to cause any disruption to the status quo with other courses in the School and we cannot discount the possibility that this was an entirely legitimate decision. Had they made the sweeping changes seen in Course Z, it may also have resulted in ill feeling or some kind of disconnect between courses in the School. In fact, Course Z seems to have suffered its own fair share of dissent, as hinted at in the final report; "*The desire to go back to old ways of doing things had to be overcome by both faculty and students*" (Popyack, 2003). Suffice to say that it does appear that, on the surface at least, Course Z seems to have reaped dividends when compared to Course C as a result of its more determined use of an online management platform to transform teaching and learning.

Hence, from this cursory glimpse into some comparable courses introducing similar technologies into their teaching regimes we may be able to infer that the same technologies appeared to produce some of the same transformations when used in similar courses. In addition, the *number* of transformations that were reported seemed to be influenced by many factors. The comparison between Courses A, B and C and Courses X, Y and Z at the very least provides some food for thought, for Courses B and C in particular, in terms of what they may have accomplished had their implementations been more thorough, and perhaps more adventurous.

9.9 How might the Framework have helped?

Up to this point, we have considered the Framework as a tool (or a set of tools) that has been designed and used to analyse the implementation of new technologies into three specific courses as part of a wider attempt to improve reaching and learning. However, it may also be useful to briefly consider what might have happened in these courses had they been given access to the research-based Framework *before* they began to consider how they might use technology in this way. A clue as to one possible outcome may lie in what happened in Courses X, Y and Z. Although we have little insight into how prepared or otherwise these courses may have been before the changes were made, each course had an advantage that Courses A, B and C did not – a dedicated team who planned the interventions based on their knowledge and expertise in this area. Hence Courses X, Y and Z effectively had a team who came in and put the Foundations in place for them – a sort of pre-fabricated form of this part of the Framework that ensured that the innovations introduced into the courses had the best chance of working. Had Courses A, B and C been able to use the Framework in order to consider their state of readiness for their innovations, they would certainly have been more aware of the kinds of Foundations that may need to be in place for an implementation of technology in teaching and learning to reach its full potential, and the courses may even have been able to put more of those Foundations in place.

In addition, the Framework may have enabled the courses to focus more clearly on what they wanted to achieve and how technology might enable them to achieve it, particularly in the area of Material and Behavioural Transformations. For example, providing students with an increased variety of means of engagement with subject matter was a common aim that courses had with a view to enabling students to take more responsibility for their own learning. However, some courses (and Course C in particular) did not appear to take the time to consider how they might make the most of these additional modes within the course, and at worst left the students to decide for themselves how, and what, to use. Had the courses been given the Framework to help guide their thinking, the explicit nature of the guiding question "Has the course taken advantage of this increased variety of means of engagement with the subject matter" would at least have prompted them to consider what this might mean in their context and may even have challenged the courses to be a little more adventurous in their approach in order to make full use of the opportunities presented by the new technologies.

9.10 Lessons to be learned

There are four broad lessons that can be learned from this study that could, in the future, help this and other institutions to more consistently implement new technologies in a way that transforms learning and teaching in the desired manner. These lessons may be summarised as follows;

1. The Foundations are critical to the success or otherwise of any initiative to introduce new technologies into learning and teaching. This study showed the close relationship between the Foundations that were in place and the transformations that could be observed. Whether those Foundations evolve naturally or are established over time (as with Course A), or are put in place through a radical overhaul (as was the case with Courses X, Y and Z), seems to make little difference. The key is the presence or otherwise of those Foundations. The more Foundations that are in place, the more likely it is that the use of technology achieves the purpose for which it was chosen. Neglecting or ignoring those Foundations may make the implementation of new technologies less disruptive in the short term, but it may also make the innovation less likely to succeed.

2. Central to this is the issue of communication. We have already discussed in Chapter 8 how this study exposed a dilution of the "message" (the reason, drive or focus behind the Vanguard courses and the underlying push to use technology in order to aid transformation in the teaching and learning) that took place as we moved from the meeting room to the lecture hall, reflected in the fact that the teaching staff did not necessarily share the vision for the future or connect it with the day-to-day operation of the courses. This kind of disconnect inevitably has an impact on some of the Foundations on which a particular implementation is built, most notably the need for willing participants and the existence at all levels of a clear rationale for the use of technology in the first place. An institution that does not pay appropriate

attention to disseminating the purpose behind an innovation runs the risk of inadvertently introducing a possible barrier to the success of that innovation.

3. There does seem to be, as might be expected, a direct correlation between the types of technology used and the transformations that may be observed. In this study, the majority of tools chosen were primarily communication tools, and hence the majority of transformations observed were in the way students interacted with the course, its content and each other. Institutions or departments would do well to consider the types of transformation they expect or desire and allow this to inform the choice of technology. This did happen, to some extent, in the College of Science and Engineering, in that the developers of the Learning and Teaching Strategy made a conscious choice *not* to include technology so that the focus remained on the changes required. However, this focus seemed to get lost in some of the courses, where tools were, at times, chosen simply because they were available. Conversely, it also makes sense that institutions or departments should also be aware of the kind of transformations that are possible with the tools they have at their disposal to enable them to make informed and effective choices.

4. It must be acknowledged that, from time to time, simply making technology *available* is enough to trigger some kind of transformation in a particular context as observed with Course C. However, it is abundantly clear that this is the exception rather than the rule and the more *deliberate* its introduction, or the more the technology is *integrated* into the fabric of the course, the more likely it is that the technology will produce the desired transformative effects. Although this has some of its roots in the existence of solid Foundations as already discussed, it should primarily point to the importance of allowing the technology to be as

disruptive as possible. The study showed clear examples of the use of new technologies in contexts that underwent change to ensure the best use of the technology (resulting in several observed transformations) as well as an example where the technology was effectively buried so that nothing required change or adaptation (resulting in very little observable transformation). An awareness of this would help institutions, and courses in particular, to match their approach to introducing new technology with their expectations.

It seems reasonable to suggest that with this increased awareness of the importance of solid Foundations, good communication, the close relationships between types of technology and transformation and the need to embrace the disruptive nature of new technologies, institutions will surely be much better placed to see technology-related transformation as a result of their carefully planned innovations.

9.11 Making use of the Framework in future courses

In general, there are three key ways in which the Framework might be used to support courses as they use new technologies in teaching and learning. These are;

Evaluative **–** Courses may use the Framework to review existing uses of technology in order to identify possible transformations as well as possible reasons why desired effects are not visible. This is, of course, similar to the approach taken with the Vanguard courses, and would likely involve the following steps;

1. Gathering of relevant course data (this might include interview and survey data as well as assessment results)
2. Investigation of the Foundations present in the course

3. Identification of any Institutional, Material and Behavioural Transformations observed

Predictive – Courses may also use the Framework to identify what transformations they may expect to see if a particular technology was introduced in a particular manner. A course wishing to gain some insight into the effect of their intended use of technology might take the following steps;

1. Analysis of the course and the context in which it sits in order to identify the Foundations that are currently in place
2. Review of the Institutional, Material and Behavioural Transformations as outlined in the Framework and consideration of how they might apply in this context

Formative – The Framework may be used as a reference by courses before or during an implementation to help make the most of the opportunities presented by the technologies concerned. Use of the Framework in this manner might entail the following steps;

1. Analysis of the course and the context in which it sits in order to identify the Foundations that are currently in place and those that may need to be put in place
2. Review of the Institutional, Material and Behavioural Transformations as outlined in the Framework and alignment with the goals of the implementation
3. Review and amendment of the plans for implementation in the light of the Framework
4. Use of the Framework on an ongoing basis to evaluate progress and refine implementation as necessary

Hence the Framework would be a useful addition to the toolbox of any such course that was interested in how the use of technology might affect teaching and learning. In addition, it can form the basis of a structured approach to the thoughtful planning, implementation and evaluation of such innovations, either in isolation or as part of a larger effort to change the way such courses are delivered in the twenty-first Century.

9.12 The nature of technology-driven transformations

This study has identified the broad areas in which technology-driven transformation might occur in general, and could be observed in the three Vanguard courses that were the focus of this study. The transformations that were observed in these courses were also compared with those identified in similar courses by other studies. At the beginning of this chapter, the question was asked – "*Transformative Effects of Technology in Learning and Teaching in the Vanguard courses - ubiquitous, rare or mythical?"* The reality revealed in this study and others is that transformation driven by technology lies somewhere between *ubiquitous* and *rare.* If anything, it may best be described as *shy* - a little like a creature that does not appear on demand but nonetheless can be teased out of its burrow should the right conditions arise.

So how does this sit with Clark's assertion that technology is a "*mere vehicle*"? In one sense, there is a certain amount of vindication of Clark's position. It is clear that technology *is,* at times, a type of vehicle – a means of carrying teaching to the learner. The evidence clearly shows that simply slotting technology into a course, whether it is a successful, well-organised course or one that is struggling to meet its goals, will not *automatically* produce the desired transformation. In that sense, the ability for technology to transform some element of teaching and learning is clearly dependent on the context into which it is placed. It is, as we have seen, possible that transformation *can* occur almost inadvertently, even when introduced in a haphazard or less-than-serious manner. However, Clark's use of the word "*mere*" implies that the vehicle is *always* insignificant and inconsequential and therefore has no impact on what it is carrying. In that sense, this thesis suggests that Clark has perhaps underestimated the importance of the "*vehicle*". Used in the right way and under the right conditions, the vehicle *can* make a difference. Transformation is far more likely to occur if the proper Foundations have been put in place first, and the technology forms part of an implementation that is *well thought-out* by the organisers, *well supported* by the powers-that-be and *well accepted* by all those who will engage with it. If these things are in place, the elusive beast of meaningful and lasting educational change will have every chance of seeing the light of day as Institutional, Material or Behavioural Transformations.

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Appendix A – Question bank for open-ended interviews and online surveys

The interviews and online surveys used in this study were conducted using a bank of questions that was constructed using the Framework as a template. It is important to note that there is some duplication in the questions, and as such not all questions were asked in each interview or survey – where there was duplication, the most appropriate question for the interviewee or potential respondent was selected. The codes beside each question refer to the elements of the Framework and are indicative of the areas that the questions were expected to cover. However, this was highly dependent on the respondents, and it is possible that each question may have elicited responses that informed other parts of the framework.

1. How were the Vanguard courses chosen? (I)
2. How did this course become a Vanguard course? (I)
3. What are the key differences between last year's course and the Vanguard Course? (I1, M1, M2, M3)
4. What is the general format of the course? (M)
5. What technologies were implemented in the Vanguard course? (I, M)
6. How much of a contribution does technology make (how much of the course depends on the tech)? (I3, M, B)
7. What were the main reasons behind the choice and use of the technologies? (I1)
8. Was there a review of what would be taught in the "Vanguard" course?
9. Have there been any changes in what is taught in the course as a result of being "Vanguard"? (M2)
10. Have there been any changes in what is taught in the course as a result of the use of technology? (M2)
11. Did the choice of technology influence how the course was designed or taught? (I1)

12. Is there a perception that change was needed? In what respects? (I, M)
13. Has this played out – have changes been made? (I, M)
14. What were the main expectations of the new courses and the tech in particular on the part of those organising the courses? (I2)
15. Have these been met so far?
16. What were your main aims as far as this Vanguard course was concerned this year? (I1)
17. Do you think these aims were met? (I1, M, B)
18. How do you measure the degree to which you meet these aims – what will it look like if the vanguard courses are "working"?
19. Looking back, what do you think the key differences were between this year's course and previous years? (I1, M1, M2, M3)
20. How do you think these key differences contributed to the success (or otherwise) of the course, particularly with regard to the aims you expressed earlier?
21. Do you think all of these differences arose as planned, deliberate, conscious decisions, or were some of them unplanned at the outset? (I1)

22. How is the teacher resourced for the teaching the course (time, pd etc)? (I2)
23. What are the main implications of the introduction of the technology for teachers? (M, B)
24. What key differences are there for the teacher and how they deliver the course or interact with the students? (M, B)
25. Do teachers have to change any aspect of how they teach or lecture? (B2)
26. Has the format of the lectures changed? (M1)
27. Has any of the content moved out of lectures to other formats such as online? (M1)
28. Do you think the technology is responsible for this? (B2)

29. Do you think all of these differences arose as planned, deliberate, conscious decisions, or were some of them unplanned at the outset? (Specifics) (M, B)

30. How have the new courses been received by the students?
31. What do you think the key differences in the course were from the students' perspective? (M, B)
32. Do you think all of these differences arose as planned, deliberate, conscious decisions, or were some of them unplanned at the outset? (I, M, B)
33. What are the main implications of the introduction of the technology for students? (M, B)
34. Have any changes been made to the way the course is assessed? (M3)
35. Did the move to Vanguard affect the way the course is assessed? (M3)

36. Have the changes made it easier for students to gain access to or engage with subject matter? (M2)
37. Does the technology make it easier for students to gain access to or engage with subject matter? (M2)
38. Does the course make formal use of this? (M2)
39. Do students make use of this? (M2, B3)
40. Is there evidence that the changes made have improved student engagement with the subject matter? M2, B1, B3)
41. If so, what is the nature of the evidence?
42. Is there evidence that the technology has improved engagement with the subject matter? (M2, B1)
43. If so, what is the nature of the evidence?

44. In general, do you think the technology has had an effect on the level of teacher-student and student-student interaction? (B1)

45. How do you think the technology has affected the level of teacher-student and student-student interaction? (B1)
46. In general, do you think the technology has had an effect on the quality of teacher-student and student-student interaction? (B1)
47. How do you think the technology has affected the quality of teacher-student and student-student interaction? (B1)

48. Are any of the changes intended to help students take more responsibility for their own learning? (B2, B3)
49. Do any of the changes help students take more responsibility for their own learning? (B2, B3)
50. Does the technology used help students to take more responsibility for their own learning? (B2, B3)

51. Is there any evidence that the changes made have facilitated learning? (B3, B4)
52. Do the students show any signs that their learning or competency with the subject has improved when compared to previous years? (B4)
53. If so, what are these signs?
54. Is there any evidence that the technology has facilitated learning? (B4)
55. If so, what is the nature of the evidence?

56. Has the technology contributed to course being "Vanguard"? (I, M, B)
57. *How* has the technology contributed to course being "Vanguard"? (I, M, B)
58. What would you say the technologies have achieved so far, above and beyond what happened previously in the classroom? (M, B)
59. Based on this year's experiences, what are the plans for next year? (I, M)
60. Are the changes that have been made permanent? (I, M)
61. Will there be further changes in the future? (I, M)
62. How are the courses being (going to be) evaluated? (I, M)

Appendix B – Categories for text analysis

This Appendix contains a summary of the categories used in NVivo to study the interview data. Each interview was analysed in a number of passes so that each statement or comment could be allocated to the appropriate terminal statements.

Nvivo Categories (Nodes)				
I Institutional Transformations and Foundations for Transformation	I1 planning educational interventions	F1 Rationale	clear rationale for tech general no clear rationale for tech	
		Course Planning	general tech integral to course planning tech not integral to course planning	
		Review and Evaluation	general tech did not prompt review tech prompted review	
		F2 Staff Attitudes and Expectations	became more negative became more positive no change no strong feelings about tech use positive feelings about tech use reluctance or resistance	
		F2 Student Attitudes and Expectations	attitude to subject became more negative became more positive expectations about tech no change no strong feelings about tech use	
			strong feelings about tech use	negative positive
			use of tech	
	I2 Resourcing Educational Interventions	F3 Time and Resources	Limitations resources made available resources not made available	
		F3 Teaching Spaces	New teaching spaces not specifically tech-orientated New teaching spaces tech-orientated tech due to new teaching spaces tech independent of teaching spaces tech not due to new teaching spaces use of space	
	I3 Professional Development	Educators confident and competent Educators not confident or competent need for support or pd no training or support provided Some educators confident and competent training or support provided		
	F4 Transparency of the Technology	tech does not get in the way tech gets in the way tech purpose clear tech purpose explained to users tech purpose not clear tech purpose not explained to users		

Nvivo Categories (Nodes)			
M Material Transformations	M1 Efficiency of Course Delivery	Improving Efficiency	improved not improved unclear
		Use of Available Time	General time not used for new things time used for new things
	M2 Means of Engagement with Subject Matter	decreased the variety increased the variety Need for more not increased the variety The course does not take advantage of any increase of variety The course takes advantage of an increase of variety	
	M3 Content and Assessment	Limitations	
		New Content or Skills	tech enabling new content or skills to be taught tech not enabling new content or skills to be taught
		Old Content	Tech enabling material to be removed Tech not enabling material to be removed
		Assessment	assessment changed, but not due to tech General tech changed assessment tech not changed assessment

Nvivo Categories (Nodes)				
B Behavioural Transformations	B1 Interactions	Amount	Teacher-Student	decreased the amount increased the amount no noticeable effect
			Student-Teacher	decreased the amount increased the amount no noticeable effect
			Student-Student	decreased the amount increased the amount no noticeable effect
			Teacher-Teacher	decreased the amount increased the amount no noticeable effect
		Quality	Teacher-Student	decreased the quality increased the quality no noticeable effect
			Student-Teacher	decreased the quality increased the quality no noticeable effect
			Student-Student	decreased the quality increased the quality no noticeable effect
			Teacher-Teacher	decreased the quality increased the quality no noticeable effect
	B2 Pedagogy	barriers to change need for change potential to change teaching style changed but not due to tech tech changes teaching style tech does not change teaching style		
	B3 Student Responsibility	aspirations		
		Opportunity	tech does not give more tech gives more	
		Action	more but not due to tech more due to tech no more	
		lack of		
	B4 Knowledge and Understanding	inconclusive tech attributed with increase tech not attributed with increase		

Appendix C – Population and exemplar quotes for each NVivo node

The following pages show the number of references allocated to each NVivo category or node, together with an example reference for each category, as a result of the analysis of the interview data.

Nvivo Categories (Nodes)					References	Exemplar quotes
I Institutional Transformations/ Foundations for Transformation	I1 planning educational interventions	F1 Rationale	clear rationale for tech		24	with a very clear focus to support the face-to-face teaching, not to try and replace it, you know, that's what we decided at the outset. (CO A)
			general		7	We've felt for the last few years in our college that we needed to take a more strategic view of learning and teaching, particularly to deal with the issues that are larger than individual programmes. (Dean 1)
			no clear rationale for tech		2	It's all experimental. Actually, we don't know what we're doing. (Dean 1)
		Course Planning	general		6	The curriculum changes a bit in the normal course of events but basically they're previous courses with some changes. (Dean 1)
			tech integral to course planning		12	for everybody to make full use of the clickers they need to provide the students with alternative ways of getting involved in the content. So if we're going to decrease the amount of material we present in a lecture then we've got to allow them to go off and learn by themselves, so more detailed reading lists and things we can give them or we can put information on the website.
			tech not integral to course planning		4	so what we're doing in the first year essentially is duplication and redundancy. (CO C)
		Review and Evaluation	general		11	we only had very limited resource, actually to attempt to gather evidence and provide metrics about how successful the project had been, and we tend to focus on, I suppose, the students' experience perhaps more than what the staff attitude was (Dean 2)
			tech did not prompt review		4	We don't have any plans for evaluation. Future decisions will continue to be made on intuition. (CO C)
			tech prompted review		3	when we first introduced the PRS system we started doing focus groups – I've never done focus groups before, we'd always just sort of relied on the "happy sheet", you know, the end of course questionnaire (CO A)
		F2 Staff Attitudes/Expectations	became more negative		0	
			became more positive		6	Yes, yes, definitely. More openness to innovative ways of doing things and the need to do it, you know, to introduce concepts and ideas in ways that actually promote student learning in a different way. (Dean 2)
			no change		0	
			no strong feelings about tech use		5	We really had very few expectations on the impact of the technology (CO C)
			positive feelings about tech use		4	I've had a lot of comments from, particularly younger members of staff, but not only, about how important they see this as being and how exciting it is and how interesting (Dean 1)
			reluctance or resistance		19	I think there is, because I think there's a lot of resistance to it – I think it does have the potential to improve things, but it's very, very difficult to convince anyone else, so there really is a reluctance to adopt something new unless there is very clear evidence that it will actually do something. (CO B)
		F2 Student Attitudes/Expectations	attitude to subject		8	There's just an incredibly broad range of students; you get very, very enthusiastic hard working students who love it and engage with everything and you get people who are barely turning up to anything and getting 8% in the exam at the end of the year and absolutely everything in between.(CO B)
			became more negative		4	But they're not using it, they're not engaging with it, they're not even trying the questions. (CO B)
			became more positive		0	
			expectations about tech		8	we don't know what the technology will be but students will want to make more choices, they will want to learn at a different time, in a different way, in different ways and that's what we have to support, I think. (Dean 1)
			no change		0	
			no strong feelings about tech use		3	You know the majority of them are just slightly apathetic. (CO B)
			strong feelings about tech use	negative	2	Some of them just don't like the technology, other kids are quite happy with chat rooms and this kind of thing, and some of them just don't get it. (CO B)
				positive	9	Karen asked them a lot of questions about the use of the clickers in the course questionnaire at the end but we get very poor return on course questionnaires, about twenty-five percent of them respond at all, but most of them are very positive. I don't know how typical that is, but of those who respond a lot of them say really quite positive things about the clickers and they find them helpful, (CO B)
			use of tech		2	What seemed to happen with WebCT was that it took a little while to pick up, and I think that was possibly because the students were just concentrating on the lectures (CO C)

Nvivo Categories (Nodes)				References	Exemplar quotes
I Institutional Transformations/ Foundations for Transformation	I2 Resourcing Educational Interventions	F3 Time and Resources	Limitations	4	The real difficulty is how you allow staff to have time to make a set of structured interventions in their own courses which aren't just one thing but are multiple different things simultaneously. And they almost have to have time to step back from the course and devote a lot of time to that, rather than a lot of time to other things. (Dean 2)
			resources made available	4	we've recently employed somebody on funding from the Principal's E-Learning fund, who has just started a week or so ago and she comes from a pedagogical background, and she does use technology. (Dean 1)
			resources not made available	5	the strategy was always, or our approach in the implementation has always been whatever we do cannot consume more resources than what we were doing before, you know, the system can't deliver more resource (Dean 2)
		F3 Teaching Spaces	New teaching spaces not specifically tech-orientated	2	We've realised that actually, a lot of what people do doesn't need such a high technical spec and actually you can provide something which provides quite innovative patterns of learning but without the same level, necessarily, of really high technical spec. (Dean 2)
			New teaching spaces tech-orientated	7	There's been a refurbishment of that which we had quite a lot to do with because they put this PRS system in all the lecture theatres (CO A)
			tech due to new teaching spaces	5	Technology has actually driven some changes in the way that the University thinks about space and teaching space. (CO A)
			tech independent of teaching spaces	0	
			tech not due to new teaching spaces	0	
			use of space	5	There are people who just use it like they use any other teaching space and either present or do tutorials, have not really adapted, they're just using the space as a mechanism to deliver what they've always done. Then there are people who basically have really thought hard about it and who have said, this is completely new, we'll write whole new activities (Dean 2)
	I3 Professional Development	Educators confident and competent		4	by having slightly better training and staff recognising that actually they need to give a bit more thought to it, I think largely we've mitigated against the worst of the bad clicker experiences now (Dean 2)
		Educators not confident or competent		1	we might ultimately get to that kind of level but we're not really there yet – it's not easy with this kind of course. (CO B)
		need for support or pd		9	I think we need advice about … pedagogy. I think we need advice and support in the use of technology. (Dean 1)
		no training or support provided		0	
		Some educators confident and competent		2	So there's a real learning curve with these. So we do get better, but we've found very much that this business of making the technology available does encourage people to change. There's no doubt that it does that, but it can be quite a while before they really get good at it. (Dean 1)
		training or support provided		4	We had a good sort of training programme, and good continued support for using the clickers and making sure people can use them, and mainstreaming them. (Dean 2)
	F4 Transparency of the Technology	tech does not get in the way		4	What we've tried to do is we've tried to get the educational aims right and then look for a way for technology to help us in achieving those aims. (CO A)
		tech gets in the way		1	there have been ongoing problems with the software and stuff which turns it into a bit of a palaver and that puts people off (CO B)
		tech purpose clear		2	we've always tried to do is to wire it in on a par with the sort of educational aspirations, not to bolt it on, and not to have it, not to have that tail wagging the dog, really. (CO A)
		tech purpose explained to users		1	this year I've tried to convince them that this is really for their benefit and they really gain from it. (CO B)
		tech purpose not clear		0	
		tech purpose not explained to users		1	The only difference I made this year was to "sell" the PRS system to them in a different way – last year, ... they didn't see that they were getting any value from it, (CO B)

Nvivo Categories (Nodes)				References	Exemplar quotes
M Material Transformations	M1 Efficiency of Course Delivery	Improving Efficiency	improved	**5**	A couple of years ago we got these handsets which we now dish out to all the students. So, the technology changes and certainly the handsets make it a lot faster, a lot better, feedback's instant, you know I don't have to look at the class and say, well, that's about 30% red and 40%... the students can see that immediately. (CO A)
			not improved	**1**	so what we're doing in the first year essentially is duplication and redundancy. (CO C)
			unclear	**1**	In practice that has the potential to save time because you can answer a question once on a discussion board instead of 12 e-mails or something, it also has the potential to be something that if I have to look at it every day and interact with it every day as against just seeing students once a week or something (CO B)
		Use of Available Time	General	**3**	If there's a downside, it's that we have to cover a lot of information – and there's 32 lectures or something, and they're only 50 minutes long, and if you start taking 5 minutes out to have this break in the middle then there's a loss of time to deliver material. (CO B)
			time not used for new things	**0**	
			time used for new things	**1**	these PRS questions, are now becoming, you know, they're a real focal point of every lecture. It's getting to the point where some lectures are entirely built around. - the notes are there and you get the notes, you get a skeleton on paper, you get the online notes - but that's not what we use the lecture time for. (CO B)
	M2 Means of Engagement with Subject Matter	decreased the variety		**0**	
		increased the variety		**17**	So that fulfils the principle of, well, a kind of vanguard principle that people can access learning in multiple different ways and at different times in quite free ways. (Dean 2)
		Need for more		**6**	I think we may need to truly facilitate students in making choices between learning in one way or another way so that, to see a website or textbook, say, or one or the other, as truly being an alternative to going to lectures, which is what I feel some students already view it as (Dean 2)
		not increased the variety		**0**	
		The course does not take advantage of any increase of variety		**1**	We purposefully didn't make any changes to the lectures (CO C)
		The course takes advantage of an increase of variety		**8**	We've tried to get much more student engagement in a very active way in the learning process, rather than simply say, we'll stand and talk for fifty minutes and then do that, repeat that twenty-two times, and then test you on it. (Dean 2)
	M3 Content and Assessment	Limitations		**7**	These big courses have a gigantic momentum, so it's very difficult to change anything – it's difficult to convince people to change things, and big changes have to go through boards of study and so on and it takes a long time. (CO B)
		New Content or Skills	tech enabling new content or skills to be taught	**17**	Then there are people who basically have really thought hard about it and who have said, this is completely new, we'll write whole new activities based on what we can do and really sort of innovated (Dean 2)
			tech not enabling new content or skills to be taught	**4**	The technology had no influence on what was taught – it might, however, in the future (CO C)
		Old Content	Tech enabling material to be removed	**2**	I think the positive things are that it really gets the lecturers thinking about the stuff they should be delivering and how they're delivering it,
			Tech not enabling material to be removed	**5**	this stuff doesn't change very much... Tweak it slightly, but it'll be pretty much the same thing … (CO B)
		Assessment	assessment changed, but not due to tech	**10**	So many courses have fewer assessments than they might otherwise have had, or have changed the assessment pattern and have sort of replicated …so they're doing things like self-tests, pre-tests, other ways of peer and self assessment. (Dean 2)
			General	**7**	One of these is, for example, assessment, the relationship between learning and assessment and the feeling that we really over assess the students. I think that's still true now. Certainly in the past we've over assessed the students and we've tended to use assessment without a very … covering a range of different motives, if you like.
			tech changed assessment	**5**	So it's something which is a technological advance that is actually permitting something more deep seated about the nature of the student reflecting on their own work and using that reflection to provide more feedback to other things. (Dean 2)
			tech not changed assessment	**0**	

Nvivo Categories (Nodes)					References	Exemplar quotes
B Behavioural Transformations	B1 Interactions	Amount	Teacher-Student	decreased the amount	0	
				increased the amount	4	the technology does allow us to introduce this type of interaction with the audience in a way that we probably wouldn't have done any other way. (CO B)
				no noticeable effect	1	the WebCT doesn't because the staff are not really in the habit of using it or looking at it and a lot of the students don't (CO B)
			Student-Teacher	decreased the amount	0	
				increased the amount	5	we have an extraordinarily active first year discussion board and they all use it – they all engage with it and the staff use it and that works (CO B)
				no noticeable effect	1	the WebCT doesn't because the staff are not really in the habit of using it or looking at it and a lot of the students don't (CO B)
			Student-Student	decreased the amount	0	
				increased the amount	3	I sat in one of the lectures and it really, to me, looks really superb. You really get the students engaged. He got them working as a … they use it partly as a tool to help the students engage and to test their understanding, but also partly to promote group work, so what's your answer, A, B, C or D? Now, talk to your neighbours and see whether you come up with a different answer. Persuade each other, sort of thing. So they use it in different ways. So that's quite technology rich. (Dean 1)
				no noticeable effect	2	what it's not doing is helping us engage the unengaged students. (CO B)
			Teacher-Teacher	decreased the amount	0	
				increased the amount	0	
				no noticeable effect	0	
		Quality	Teacher-Student	decreased the quality	0	
				increased the quality	2	you can have written comments but what the student actually sees is they see somebody scrolling through their work and maybe highlighting things in real time, and scribbling on things as they talk about it and then they get the audio commentary. ... if they want to revisit the next time they do the essay they can revisit where they went wrong because of the feedback, they can go back and revisit the lecturer's commentary. So the students quite like it and they tend to find they get five or six to ten minutes of talking, as against a few scribbled comments that they get for the feedback. (Dean 2)
				no noticeable effect	1	We can make these things available to them, but it does create work for us and I'm not utterly convinced of the benefit to the students. (Co B)
			Student-Teacher	decreased the quality	0	
				increased the quality	3	this year – I never encouraged this, or not explicitly anyway, but I would have people from the back of the room calling out questions in the lecture, and they were valid questions, and you know I'd never said "you can stop me any time and just ask questions,", (CO A)
				no noticeable effect	0	
			Student-Student	decreased the quality	0	
				increased the quality	1	He got them working as a team... so what's your answer, A, B, C or D? Now, talk to your neighbours and see whether you come up with a different answer. Persuade each other, sort of thing. So they use it in different ways. So that's quite technology rich. (Dean 1)
				no noticeable effect	0	
			Teacher-Teacher	decreased the quality	0	
				increased the quality	0	
				no noticeable effect	0	

Nvivo Categories (Nodes)				References	Exemplar quotes
B Behavioural Transformations	B2 Pedagogy	barriers to change		4	a lot of academics feel themselves to be basically self-employed researchers who do a bit of teaching because they have to. They're not really interested in what the university thinks about the way they should teach, what they should teach or anything else. This is a minority. But there are such people. (Dean 1)
		need for change		5	The clearest thing that comes out of the strategy, and indeed it's one of the principles, is that we have to become more professional teachers. In other words, traditionally at university level we're expert, I hope, in our subjects, but we seem to be quite content to be amateur educators. (Dean 1)
		potential to change		14	I think it has the potential to bring about change, but I think it's too early to say what will happen… (CO B)
		teaching style changed but not due to tech		14	We've realised that actually, a lot of what people do doesn't need such a high technical spec and actually you can provide something which provides quite innovative patterns of learning but without the same level, necessarily, of really high technical spec. (Dean 2)
		tech changes teaching style		19	I think the technology makes the teachers think a little bit about how they're delivering and what they're delivering. (CO B)
		tech does not change teaching style		10	So, what we decided to do was to keep the lectures, keep the practicals as they were, because to break that would be saying, you know, sometimes you'll be doing something which is radically different and sometimes you'll be doing this other thing, which could be confusing, (CO C)
	B3 Student Responsibility	aspirations		8	what you're trying to do is sort of influence the character and improve the nature of the learning experience for the majority in the middle, who, by encouraging them to be a little bit more independent about their own learning (Dean 2)
		Opportunity	tech does not give more	2	we need to force them to take more responsibility for their learning but I don't know how you do that. I mean, they just fail, they don't engage, (CO B)
			tech gives more	12	So it's something which is a technological advance that is actually permitting something more deep seated about the nature of the student reflecting on their own work and using that reflection to provide more feedback to other things. (Dean 2)
		Action	more but not due to tech	0	
			more due to tech	2	I believe the last time I looked it was about a third of them were using WebCT a bit. I think that was because – again, intuition – they were using it to try and fill in the gaps, thing that they weren't sure of in the lectures, because on WebCT there were plenty of little quizzes and so on that they can tackle – the quizzes are pretty directly oriented at the things they need to know in order to get through (CO C)
			no more	17	the technology is available to them but they're not taking advantage of it because they're not engaging with the course at that level. (CO B)
		lack of		9	I guess a lot of them just don't take very much responsibility. (CO B)
	B4 Knowledge and Understanding	inconclusive		14	It's very, very difficult to evidence that – it's really difficult. The only instrument we've got is the end of course exam, and, you know, the cohorts change each year, so it's not necessarily an exact comparison from one year to the next. (CO A)
		tech attributed with increase		5	I think we demonstrated pretty clearly that the change that we made, along with the other improvements to the course, had a huge impact on their learning and understanding, and so we can even quote that the pass rate for the course went up 15%, from 75% to 90%. (CO A)
		tech not attributed with increase		0	