The Effect of Interactivity in e-Learning Systems

A thesis submitted for the degree of Doctor of Philosophy

by

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I. Abstract

The purpose of this research was to investigate whether interactivity yields a learning effect when used appropriately in e-Learning Systems, and whether this effect enhances learning. The importance of interactivity for success in learning has always been paramount; however, little scientific evidence can be found to support this importance (Sims, 2003; Leiner & Quiring, 2008). Thus, this research aims to provide evidence of the impact of interactivity on e-Learning Systems considering three main agents: the learner, the teacher and the system (educational triangle). A key element often found to be related to learning and the three previously-mentioned agents is the concept of feedback. The use of interactivity as part of a feedback mechanism for enhancing learning is well documented in this research. Three empirical studies were designed to investigate interactivity within the educational triangle. These three studies, developed to support the research hypotheses, were conducted based on the framework of positivism and action research paradigms. The first study, entitled "Interactive Pedagogical Feedback", aimed to gather evidence for how highly interactive pedagogically-designed formative feedback enhances students' memory and understanding. The two student groups to which the interactive conditions were added showed a significant difference in the post test scores. A one-way ANOVA with a Turkey HSD post hoc test for all pair wise comparisons reveals a significant difference between the transfer and no condition scenario. The second study, entitled "Interactive Audio Feedback", examined whether the speed enhancements of oral feedback improve the conditions for the production of lecture's feedback and the quality of the feedback delivered to the students. The use of the interactive condition reduces by 40 to 65% the time it usually takes to prepare feedback for final assignments, and an unpaired Student's *t*-test shows significant differences in the use of the two conditions. The final study, "Interactive Texting Feedback", took a pedagogical approach to provide formative feedback to a student audience using mobile text messages. It aimed to determine whether Interactive Texting Feedback enhances the leaning experience within the e-Learning environment. Inferential analysis demonstrated good correlations in the use and benefits obtained by the introduction of the interactive mechanism. The results indicated that interactivity is critical in promoting and enhancing effective learning. Learning theories led by the generative theory of learning (Wittrock, 1974) and the principles of multimedia learning (Mayer, 2001) provide scientific explanation for this findings.

II. Acknowledgements

I would like to take this opportunity to present my sincere thanks to all the people that have supported, encouraged, and contributed to me completing this piece of research.

I wish to express my gratitude to Dr Chris Evans, my first supervisor, who provided me with invaluable advice and insight, as well as the opportunity to do this research.

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It has been a great opportunity to have met so many amazing friends and colleagues during this process. I want to give my many thanks to all of them and show my appreciation for their support and great collaboration.

Finally, my loving thanks go to all members of my family for their silent but strong support.

III. Supporting Publications

The following publications supporting this thesis were written almost entirely on my own, but I am grateful for the guidance and support provided by my supervisor Dr Chris Evans. I also attended related international conferences to present these ideas, and these often led to cooperation with interested researchers.

Palacios, L. A., & Evans, C. (2010). Effectiveness of interactivity for enhanced undergraduate learning. In M. Siran, & T. Purnendu (Eds.), *Cases on transnational learning and technologically enabled Environments* (pp. 359-375). IGI Global. doi:10.4018/978-1-61520-749-7

Palacios, L. A., & Evans, C. (2010). Interactive self-assessment questions within a virtual environment, proc. third international. Paper presented at the *Conference on Innovations in Learning for the Future 2010: E-Learning,* Istanbul, Turkey, Istanbul Kültür University. (May 10-14)

Evans, C., & Palacios, L. A. (2011). Interactive self-assessment questions within a virtual Environment . *International Journal of E-Adoption (IJEA), 3*(2), 1-10. doi:10.4018/jea.2011040101

Evans, C., & Palacios, L. A. (2010). Feedback on student assignments: Audio as an alternative to typing. Fifth Mediterranean Conference on Information Systems MCIS 2010 Proceedings, (28)

Evans, C., & Palacios, L. A. (2010). Using audio to enhance learner feedback. Paper presented at the *International Conference in Education and Management Technology (ICEMT), 2010 International Conference on,* Cairo, Egypt. 148-151. doi:10.1109/ICEMT.2010.5657683

Evans, C., & Palacios, L. A. (2011). Interactive feedback in the classroom using SMS messages. IADIS International Conference IADIS e-Learning 2011, Rome, Italy.

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1 Chapter 1: Introduction

1.1 Introduction

Human-technology interactions rule our lives with a clear purpose such as enhancing lifestyle or supporting our present relationship with machines. Such interactions have been an important element in all human activities, from the earliest times to the present. Interactivity is tied to a long history of successful human events. Today, when interactivity is a core component of technology, this tendency has not diminished; on the contrary, it is growing at the same speed or maybe even faster than technology. In education, for example, Technology-Enhanced Learning (TEL) uses interactivity to facilitate learning practices that have become ubiquitous (Chan et al., 2006). Learners can select their educational material and study at the place, time and pace that suits them as individuals, enabling them to be active learners. The importance of interactivity for success in teaching has been seen as fundamental for a long time (Webster & Hackley, 1997). This importance is emphasised to such an extent that is claimed that students with higher levels of interaction will obtain more positive and higher levels of achievements (Fulford & Zhang, 1993).

Interactivity is changing the way we behave by increasing an individual's control over his or her own learning (Rogers, 2000). Since the introduction of the internet, information is now more in the hands of individuals, with predictable consequences. One important consequence is the elimination of the intermediary in most business, service, and even academic transactions. In business, for example, there has been a transfer of power from the advertising agency building the brand to the individual consumer (Einstein & Pollack, 2000). In the past, an agency forged a brand and delivered it to the consumer. In an unprecedented shift in paradigm, the consumer actually creates the brand over time using a variety of media resources. This shift in paradigm is not exclusive to business, but it is seen in many other areas where individuals have been empowered with tools and decision-making power that were inaccessible before.

Interactivity is everywhere these days. If you walk into a library or a museum, there will be an interactive map with guided instructions. The television set was transformed a long time ago into an interactive TV to enhance the entertainment experience (Jiang, et al, 2011). Interactivity provides the viewer with real-time interaction with the TV content production

team to guarantee the best possible entertainment experiences, and the ability to watch, participate, influence and control what they see.

1.2 Research background

In education, interactivity has changed the teacher and student roles (Rogers, 2000). The teacher-student relationship used to occur in a one-way direction, where students adopted a passive role. Today this relationship has been transformed to a bidirectional exchange where students have an active position. Educators, to adapt to these innovative events, have also changed from instructional delivery to instructional design, and this has given birth to information technologists responsible for applying information technology to the content (Anson, 1999). Instructional designers, tied to this impressive chain of events, have moved from the educational philosophical approach of behaviourism to cognitivism, and then on to constructivism, in a systematic progression toward individualised instruction (Cooper, 1993). This philosophical shift in paradigm through technology has found the appropriate environment (e-Learning) in which to demonstrate its potential and interactivity, and this is being used in an unprecedented way to enhance learning. Interactivity, as the ability to respond contingently to the learner's actions (Beauchamp and Kennewell, 2010), has been positioned as an important instrument for promoting leaning.

e-Learning, as the educational environment based on technology, is an innovative concept focused on the individual. Tavangarian et al. (2004) highlight this particular characteristic when they define e-Learning as "all forms of electronic supported learning and teaching, which are procedural in character and aim to effect the construction of knowledge with reference *to individual* experience, practice and knowledge of the learner". However, e-learning is still in its infancy and its adoption, as with the implementation of any new technology, faces issues, such as the reduced usage of technology as an instruction delivery method and the ineffective use of technology to support learning (Kahiigi et al., 2007). In addition, a related constraint that is reducing support for the constructivist approach are the needs for customization of the content and learning material, and for an interactive relationship between the learner and the content that is being instructionally defined.

Many e-learning implementations fail because they just mirror common objects from the physical world, such as books, in a digital environment, without considering the environment and contextual characteristics.

1.3 The research problems and objectives

The challenge of this research is propelled by these emerging issues in e-learning that relate to interactivity. The importance of interactivity for success in learning has always been paramount. However, little scientific evidence can be found to support such a statement. Sims (2003), for example, comments that the concept of interactivity is frequently used to refer to an inherent quality of the medium and learning environment, with an underlying assumption that the interactive characteristics of communication with other learners or content objects is beneficial to the learning process. However, he does not perceive that tangible enlightenment is presented in the dynamics of interactivity. Leiner and Quiring (2008) argue that the user's perceptions of interactivity require more research as a central aspect in the new media context.

This lack of evidence underpins the research and motivates the following question:

Can interactivity in an e-learning system enhance the learning experience?

Three main agents are identified in this process: the learner, the teacher and the system. Similar studies in the literature have called this relationship "the educational triangle" (Cumming, 1998; Wood et at, 1999). The effect of interactivity within these agents has been investigated to determine the impact on individualised learning.

An important element that also emerges from this question is related to interactivity and its ability to produce a learning effect when appropriately implemented in a particular system. Since one of the main objectives is the identification of learning as a result of the introduction of interactivity, the study of learning as a process of transferring knowledge is vital. Others effect may be present that enhance the learning experience given the reaction speed resulting from incorporating interactivity in another scenario or contextual situation.

This study will investigate the effect of interactivity within a feedback context. Bransford et al. (2000) indicates that frequent feedback is essential for deep learning. Interactive feedback offers feedback quickly and at the appropriate frequency, to help keep motivation and interest in the topic taught. Feedback increases the amount of time dedicated to learning because it engages the learner in an interactive learning process. Research indicates that the time dedicated to learning is essential because it is approximately proportional to the amount of material being learned (Singley and Anderson, 1989)

Feedback is information communicated to improve learning by changing thinking or learner behaviour (Shute, 2008). The use of interactivity as part of a feedback mechanism

for enhancing learning is well documented in the literature. Feedback is essential for learning because it is information communicated to improve learning by changing the learner's thinking or behaviour. Three empirical studies were designed to investigate the effect of interactivity within the previously-mentioned educational triangle.

The first empirical study revolves around the concept of using formative feedback pedagogically designed to enhance learner skills. It is believed that interactivity incorporated into a computer-based system in the form of formative feedback will increase learning. Knowledge about appropriately implementing and embedding formative feedback within learning environments is taking a more relevant position recently (Bell & Cowie, 2001). Information about feedback and its characteristics is also highly important; for example, immediate constructive feedback offers a valuable contribution to the learning experience, but if feedback is provided too soon it seems to block relevant mental information processing activities and thus degrades learning (Requin & Stelmach, 1991).

The second study relates to enhancing teachers' capabilities to produce effective and quicker interactive feedback using audio, as for most people speaking is a much quicker form of communication than typing. These speed enhancements of speaking rather than typing are carried over to the process of creating feedback to enhance learning-related activities. The expansion of higher education has meant that, with large numbers of students, producing feedback can be a very time consuming task. This can have a knock on effect on the length and quality of individual feedback. There is a need, therefore, to find mechanisms to ensure that the quality and quantity of feedback is sustained or even enhanced.

The final study focuses on the system. It mediates the relation between the two main agents of the educational triangle: the teacher and the learner. The empirical study uses text messages (SMS) supported by a web-based response system to provide formative feedback to a student audience after educational content has been delivered. The objective of this experiment was to determine if Interactive Texting Feedback is a valid and effective pedagogical approach to enhance the learning experience. The feedback system employed to communicate with teachers and learners is a logical and direct way to integrate technology with pedagogical practices and learning activities. Interactivity, as the essential component in technology, plays a key role in communication among the agents of this educational triangle.

1.4 The contribution of this research

The thesis contributes a conceptual framework for the understanding of interactivity in e-Learning systems, identify the important role interactivity has taken in all learning activities mediated by technology and illustrate the implications of using interactivity within the educational triangle: the teacher, the learner and the system. The information contained in the thesis is useful for academics and institutions to improve their teaching, guide the design of instructional content and the efficiency of their learning delivery mechanisms. It could also be of utility to other researchers, or those in roles that require an understanding of interactivity.

Previous studies attribute apparent success or lack of success to enhance learning by using interactivity. This research also contributes with significant evidence of the tangible effect of interactivity within the three particular agents of the educational triangle that combine in any learning experience.

The contribution of the work described in this thesis has been recognised through the peer-reviewed publication of sub-sections of it in the following journals and conferences: Cases on transnational learning and technologically enabled Environments book published by IGI Global (Palacios & Evans, 2010); Conference on Innovations in Learning for the Future 2010: e-Learning in Istanbul, Turkey, (Palacios & Evans, 2010); International Journal of E-Adoption (Evans &Palacios, 2011); Fifth Mediterranean Conference on Information Systems MCIS 2010 (Evans &Palacios, 2011); 2010 International Conference in Cairo, Egypt. (Evans &Palacios, 2011); the International Conference in Education and Management Technology (ICEMT) (Evans &Palacios, 2011); and in the International Conference IADIS e-Learning 2011, Rome, Italy (Evans &Palacios, 2011);

1.5 The overall structure of the thesis

The overall structure of the thesis is designed around the concept of interactivity and how it enhances learning in three different feedback scenarios. This Chapter has described the scope of this thesis by presenting the research background about interactivity, identified the research problem, the significance of this research, and the methodology to be followed to answer the research questions and to test the proposed hypotheses, and explained the overall structure of the thesis.

Chapter 2 reviews the literature in the areas of e-Learning, interactivity, feedback delivery and the theoretical background to support the research. Major philosophical approaches are explained in this literature review to support these different perspectives of how people

learn and how teachers educate. These teaching strategies vary across disciplines and they are conceived as pedagogical information that help students overcome difficulties and guide them through a typical path in order to achieve understanding.

Chapter 3 describes in general the methodology followed to provide validity and reliability to the research.

The following three chapters describe the experiments designed to test the effects of interactivity within feedback mechanisms embedded in the context of the educational triangle. Chapter 4 is about Interactive pedagogical feedback. It focuses on the learner and how interactivity enhances his/her cognitive abilities. This empirical study is conducted to test the first hypothesis that interactivity in the form of retention and transfer ISAQs incorporated in a computer-based system increases learning.

Chapter 5 is about Interactive Audio Feedback for Enhancing Learning. Teachers' capability to produce quality feedback is enhanced by producing it in half the time that it takes to produce normal feedback. The Interactive Audio feedback study was designed to test the two following hypotheses: that "creating feedback in audio form is quicker than creating feedback in typewritten form" and "that feedback received in audio form is better quality than feedback received in written form".

The next chapter (Chapter 6) is more related to the mediator system in the pedagogical triangle. The Interactive Texting Feedback study uses action research methodologies to determine the effectiveness of interactivity in this context. It responds to the final hypothesis that interactive texting feedback is an effective approach to enhance learning practice.

The final chapter (Chapter 7) embrace a general discussion of the results found in the three experiments designed to test the effects of interactivity. It generalise the findings and relates to the appropriate theories to explain the phenomenon. Then, it addresses the limitations of this study and suggests directions for future research. Finally the conclusion is presented.

2 Chapter 2: The Effect of Interactivity in e-Learning Systems

2.1 Introduction

The present section considers the relevant literature relating to the effects of interactivity in different e-learning systems or TEL mechanisms. TEL refers to the support of any learning activity through technology (Manouselis et al., 2011) and is usually used synonymously with the term e-learning, although they do differ as TEL focuses largely on the technological support of any pedagogical approach that utilises technology. Although the utilisation of TEL is new, research on the subject has spanned three generations (Hakkarainen, 2009): the first generation studied computer-assisted learning from a cognitive perspective; the second-generation research focused on analysing patterns of participation (social view) in computer-assisted learning; and the third generation of research aimed to overcome the disparity between the cognitive (knowledge acquisition) and socio-cultural (participation) perspectives.

e-Learning is a term that encompasses all forms of TEL, but tends to focus on pedagogy (Watkins, 2010). Indeed, e-learning is predicted to be the mechanism by which future students and organisations can facilitate learning practices that are independent of time, place and pace (Palacios & Evans, 2010a; Zhang et al., 2004). For example, educational technologies empower individuals in gaining international access to the academic resources of countries in which self-directed study and student autonomy are emphasised (Ziguras, 2001). Learners can select educational material and study in accordance with their own style and pace, enabling them to be active learners. The flexibility provided by these interactive technologies does not constrain the learner in terms of location or time. Furthermore, it facilitates a more active role and personal development, and generally involves the support of any learning activity by means of technology. These learning activities are organised with the intention of improving students' knowledge, skills and competence.

According to Stergioulas (2004), there is a need to improve and consolidate the professional learning of the current learning systems that are seen in research policies and road maps designed for e-learning Technologies in Europe. In this context, e-learning is seen as a tool that minimises the time needed to prepare for future jobs in order to improve the current knowledge base and expertise and transform the process of continuous professional development.

Interactivity is a distinctive component within the modern world of technology, and, as an educational tool, it is perhaps the element that offers the best guarantee in education (Domagk, Schwartz & Plass, 2010). People have been interacting with their environment, absorbing knowledge or creating new experiences on top of previous ones from an early age (Hofer & Pintrich, 1997). Learning is considered the transformational process of increasing abilities to obtain goals (Washburne, 1936), and thus people and technology interaction are relevant within the process of learning. The extension and the type of effect these interactions has in learning are no well known. In addition, the effect of interactivity is vaguely registered in the literature from an academic perspective.

Since the focus on learning alternatively shifts from technology to human cognition in order to take into account our ability to assimilate knowledge (Zuga, 2004), it is sensible to study several theories and concepts of learning in order to gain a better understanding of these issues and to support this research. Moreover, there is a paradigm shift (Rogers, 2000) from "teaching" to "learning" promoted by technology that has been evolving in recent decades. Fantuzzo (1992), for example, described the use of behaviour analysis in education to indicate that a teacher-centred approach was the cornerstone of resolving the educational challenges of that generation. In contrast, Geelan (2001) advocated the notion of 'student-centred learning' as a popular and influential approach for students to control and develop own educational activities in a more constructivist framework. Interactivity seems to be at the centre of this parading shifting.

A great variety of learning theories have enriched the realm of education and other disciplines, but these overlap and coincide in their final outcome of learning (Guild, 1997). Learning theories moved into the psychological and sociological processes a long time ago, in the search for general ways to explain how we learn and how to do it more effectively (Zito & Schout, 2009). A learning theory is a method that describes how people learn and the complexity of the process of learning (Leonard, 2002). There are three main philosophical approaches (Cooper, 1993) presented in this section that encompass a huge body of learning theories: behaviourism, cognitivism and constructivism (See Figure 1). These approaches follow a natural path of evolution from an emphasis on the environment (behaviourism) to an emphasis on the internal complexities of human learning (cognitivism and constructivism).

Behaviourism largely focuses on the observable changes of learner behaviour, while cognitive theories go beyond behaviour and explain mind-based learning. Constructivism

considers learning as a phenomenon in which the learner actively constructs or builds new ideas or concepts.

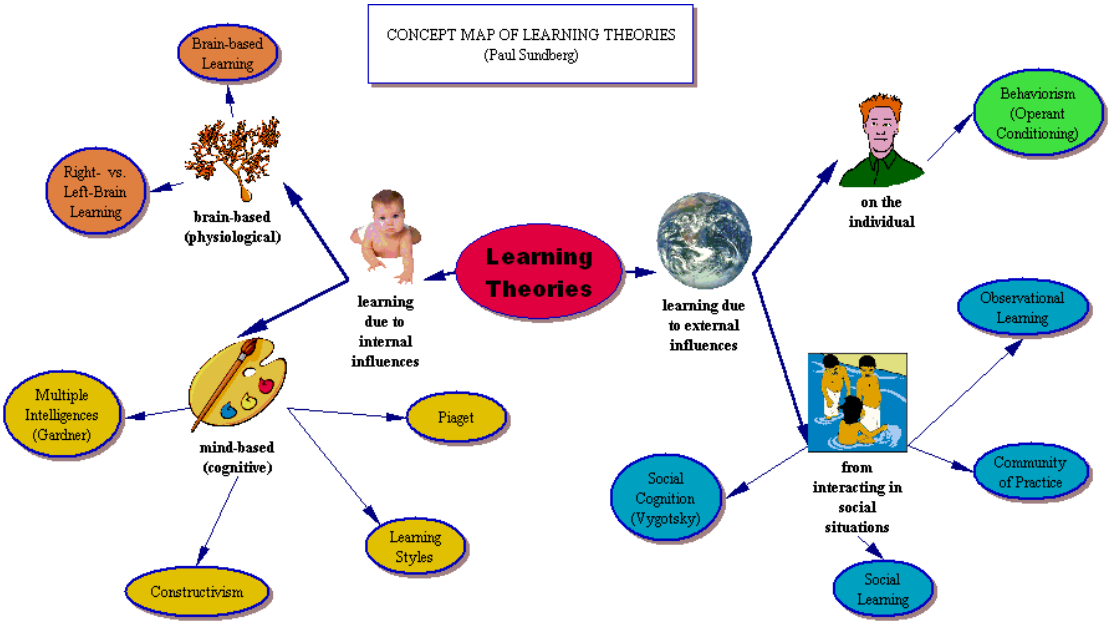

Figure 1: Concept Map of Learning Theories (Sundberg, P., 2003).

2.2 Learning as Behaviour

Behaviourists concentrate on observing changes in behaviour (Skinner, 1953). Indeed, behaviourism is a theory of learning that mainly focuses on the observable changes in learner behaviour and discounts mental activities. Behaviour theorists consider learning as nothing more than the acquisition of new behaviour, and Skinner (1953) was influential in defining behaviourism. The theory identifies conditioning as the main element of the learning process and, according to Skinner (1953), classic conditioning and behavioural or operant conditioning are the two different types of conditioning.

Classic conditioning occurs when a physiological reaction is triggered by a stimulus. Pavlov (1906) highlights how one can change the stimulus part of a stimulus-response pattern (such as salivation) to something neutral (such as turning on a light), and yet generate the same response. Pavlov observed that the dogs started to salivate as soon as they saw the person who usually brought the food, enabling him to demonstrate that any neutral stimulus could be associated with food and thus elicit the food response, even when no food was present. The original stimulus and response to this stimulus are the "unconditioned stimulus" and the "unconditioned response", with the introduced neutral stimulus and learned response known as the "conditioned stimulus" and the "conditioned response", respectively. Pavlov's work on the accumulation of information and classical

conditioning has been continued, but Bitterman (2006) considers there has been little conceptual progress. From the classical conditioning perspective (Pavlov, 1906), learning activities and the context in which they are performed should create or promote pleasant emotions, such as enthusiasm, excitement or enjoyment. These emotions will motivate the learners in the completion or better performance of any learning task and will ensure that they actively participate in the experience. Another educational implication of behaviourism relates to measuring the impact of changes on behaviour. Thus, evaluation plays a fundamental role in determining that learning has taken place. Behavioural or Operant Conditioning occurs when a response to a stimulus is reinforced and operant conditioning can be considered a feedback system: if the presence of a reward or reinforcement follows the response to a stimulus, then the response becomes more probable in the future. Skinner (1953; Skinner, 2009) used reinforcement techniques to teach pigeons to dance and bowl a ball in a mini bowling-alley. Behaviourism has been used for a significant period of time to encourage positive behaviour and deter negative behaviour (Ormrod, 2004).

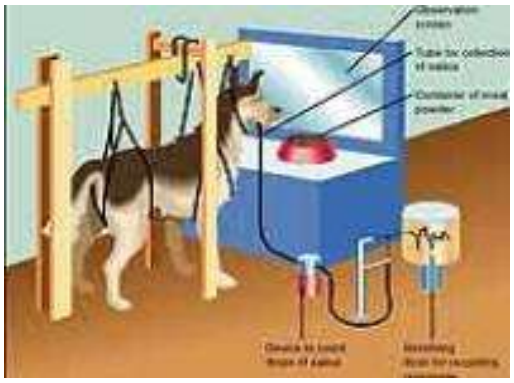

Figure 2: Classic Conditioning

In terms of *operant conditioning*, cultivating good habits through the repetition of stimulus-response exercises is part of normal classroom activities: the use of reinforcement and punishment constitutes a fundamental component in contemporary education and is derived from the practice of behaviourism. Rewards that reinforce positive behaviour in order to increase the probability of a response, such as publicly praising students' skills and the recommendation of special projects, are the hallmarks of a good teacher. Positive reinforcement involves the presentation of the stimulus after the response, while negative

reinforcement is employed to prevent or avoid an adverse condition; for example, submitting all assignments on time results in the lowest grade being avoided. This increases a response through the removal of the stimulus, which is usually an adverse or unpleasant one: for example, the removal of anxiety can be a very important negative reinforcer. Although positive and negative reinforcement increases learner responses, punishment decreases the responses expected; this is due to the fact that punishment involves presenting a strong stimulus that decreases the frequency of a particular response. Thus, punishment is quite useful in quickly eliminating undesirable behaviours; an example of this is late assignments being given a zero grade.

Interactivity is connected to the behaviourist concept and Skinner's (1953) idea that information should be presented in small amounts has had a profound impact on educational software in which reinforcement plays a fundamental role: increasing the frequency of reinforcement by reducing the size of the information presented yields more effective results (Sims, 1996). In fact, early authoring tools for programmed instruction modules were originally designed in line with behaviourist principles. Corrective feedback, consistently used by behaviourists, is also a fundamental component of multimedia design. According to Hartsell (2006), interactivity is implemented in tutorials, using corrective feedback, in order to reward learners who accurately answer questions with audible comments. Gagne's (1962) work with the military strongly influenced the design of instructional materials and the development of instructional software. Through his work, Gagne stated how the interaction only allowed students to respond to questions posed by the instructor.

However, the application of behaviourism principles fails to address two important concerns in instructional design (Chase, 1985). The first is the lack of effective implementation of technology tools, such as computers and interactive media. To overcome this, realistic educational implementations had to be developed. The other is the production of low-level skills programs that are unable to represent complex conceptual behaviour.

2.3 Cognitive Theory

Cognitive learning theory describes how people or animals learn by understanding their mental processes and how they organise, store and relate old and new information, scripts and schema (Sweller & Chandler, 1994). Cognitive theory refuses to accept behaviourism as the only explanation for the human acquisition of knowledge, believing that

behaviourism reduces complex human behaviour to simple cause-and-effect. In their quest to present the insufficiencies of behaviourism, gestalt psychologists (Köhler, 1927) demonstrate the pitfalls of the behaviourist concept of learning in their experiments to show that people are simply not programmed entities that respond to environmental stimuli; they are rational beings that require active participation in order to learn and their actions are a consequence of the processes developed in their minds. Behaviour is a manifestation of what takes place in the learner's mind. The shift from behaviourism to cognitivism occurs gradually, and Hartley (1985) based it on the short- and long-term memory paradigm.

In order to understand a wide range of cognitive functions, the constructs of working memory (WM), short-term memory (STM) and long-term (LTM) memory are central to the cognitive learning theory. However, there is a lack of consensus in the literature in what these constructs represent and how to distinguish them from one another. Terms such as "memory" and "storage capacity" are part of the cognitive vocabulary and are part of the computer jargon terminology. In the computer industry, memory is a part of a computer in which information is stored for immediate use by the central processing unit. Storage capacity is related to the maximum number of bits, bytes, words, or items that can be held in a memory system (Collins, 2000). "Memory" and "storage capacity" usage is similar in a cognitive context. People's memory is determined by the limit in the duration for which an item can remain active in STM without rehearsal (Cowan, 2001). Although memory capacity to storage is seven chunks (Miller, 1956), depending on people's differences this can increase or decrease by two chunks. Chunking, in psychology, is a phenomenon whereby individuals group responses when performing a memory task.

In addition, storage capacity is time-limited rather than capacity limited (Cowan, 2001). Rose et al. (2010) attempted to differentiate these constructs by comparing the effects of depth of processing on WM and LTM using a levels-of-processing (LOP) span task procedure that involved processing to-be-remembered words based on their visual, phonological or semantic characteristics. Rose et al. concluded that WM involved retrieval from LTM memory and that it is affected by the match (or mismatch) between initial processing and subsequent retrieval.

The term working memory implies a system for the temporary holding and manipulation of information during the performance of a range of cognitive tasks, such as comprehension, learning and reasoning (Baddeley, 1986). Indeed, the term is used interchangeably to describe what is also called STM, primary memory, immediate memory, operant memory

or provisional memory. WM emphasises the notion of the manipulation of information rather than passive maintenance (Atkinson & Shiffrin, 1968) and can be considered a more dynamic and complex STM construct (Baddeley & Hitch, 1974). Recently, Baddeley suggested that WM may be considered as an interface between STM and LTM, and thus he modified his original model by adding a new component, the episodic buffer, in order to accommodate the way in which WM and LTM interact.

It is important to emphasise that the interaction between storage and processing is controlled by selective attention to the subset of elements in working memory that may be manipulated at any moment. The mind's ability to direct its inner awareness upon a particular target in WM has been the predominant focus of attention (Cowan, 1995). Cowan (1995) and other researchers (Baddeley, 1986) believe that WM is activated information along with central executive processes. Therefore, they have developed a framework that integrates attention and memory. The focus of attention capacity has a limit of about one element (Garavan, 1998); however, it can be expanded to four elements with practice (Oberauer, 2006). Interactivity plays a fundamental role in this practice, as demonstrated in the experiment developed by Verhaeghem (2005). Within this framework, WM consists of three embedded components: the activated part of long-term memory, the region of direct access and the focus of attention.

Working memory is used as an area for the storage of short-term information, including separate auditory and visual working memories (Baddeley, 1986). In later research, Baddeley (1992) asserted that the working memory is organised into a visual-spatial sketch pad for visual image manipulation and the phonological loop, which handles speech-based information.

Short-term memory, however, is used to retain information for short periods. WM and STM are considered different constructs, but are highly related (Engle et al., 1999). In fact, the two constructs have been used synonymously for so long that many of the tasks depicted in the literature as working memory tasks reflect a common construct. The short-term store has a working memory component, a sort of mental notepad that is used to manipulate information in consciousness. STM refers to the activated elements in this memory model, whereas WM is a larger component that incorporates the activated elements and the executive processes.

STM is related to the current contents of consciousness, while LTM is comprised of memories previously encoded in the remote past that must be brought back into consciousness through the retrieval process (Atkinson & Shiffrin, 1968). LTM has no known limit in its capacity to store information, and verbal elements are normally coded in terms of their semantic characteristics (Craik & Lockhart, 1972). Thus, information stored in the LTM is very sensitive to the depth to which memory items are processed when they are initially encoded. Structural memory items, such as phonological or visual elements, usually lead to lower levels of retention than semantically processed memory items such as concepts (Craik & Lockhart, 1972). Long-term memory is the resident knowledge and skills acquired and held in a permanently retrievable area.

In summary, a cognitive model of learning (Sweller, 1988) is built based on three memory types: sensory memory, working memory, and long-term. These memories have limited capacity. Sensory and working memory holds much less information than long-term memory, which is considered a huge reservoir for data accumulation. Interactivity seems to play an important role in connecting knowledge stored in LTM with information in sensory and working memory.

Cognitive learning theory focuses on the internal processes of the human brain. Mental processes, such as thinking, memory, knowing and problem solving, are portrayed as schemas (plural: schemata) that are considered symbolic mental constructions (Anderson, 1982). A schema is an active organization of past reaction or past experiences (Anderson & Pearson, 2002) that can be modified to accommodate new mental information. Thus, learning is a change in the learner's schemata. These intellectual processes, categorised as 'information processes', bear a resemblance to computer operations and thus the terminology used is the same whether applied to psychology or computer science. The learner, in this theory, is considered an information processor and is analogous to a computer.

As learning theories have proliferated to encompass different ways of learning in recognition of the fact that no-one learns in the same way, cognitive theory has diversified to explore our inner mind and tackle other specific situations. Thus, the cognitive load theory (Chandler & Sweller, 1992), the dual-coding theory, the generative learning theory and the theory of multimedia learning are approaches that must be mentioned, as they are related to this work.

Feinburg and Murphy (2000) defined cognitive load theory as 'the amount of mental energy' required for processing a given amount of information. As the amount of information increases, so does the cognitive load on our mental resources. If the amount of information and instruction surpasses the capacity and limitations of our mental resources, learning does not take place and our sensors become distorted.

Paivio's (1986) dual-coding theory establishes that verbal and non-verbal information are represented in different mental systems. These systems use working memory to process the received information, as words and pictures activate independent visual and verbal codes. When information is highly imaginable, a learner can encode the information into long-term memory (LTM), using both a verbal and visual trace. This redundant encoding increases the probability of future retrieval, because if one memory trace is lost (whether visual or verbal), the other is still available (Rieber, 1990).

One important concept related also to constructivist views of learning explaining the investigation in this research is the generative learning theory. Wittrock (2010; 1974) indicates in this theory that learning is the result of concrete associations which the learner generates between his prior experience (stored in LTM) and the stimuli. It's the process of constructing relationships between new and old knowledge that supports the individual's understanding how new ideas fit into his mental web of known concepts. He emphasized that the learner is not a passive recipient of information but an active participant in the learning process working to construct meaningful understanding of information found in the environment. Interactivity in this context interactivity take a relevant role in the generation of the schemata mentioned previously that explains how new conceptual understanding is formed.

Furthermore, the theory of multimedia learning (Mayer, 1997) implies that meaningful learning takes place when relevant information in each store is digested into a coherent representation and makes connections between corresponding representations in each store. Web-based multimedia e-learning systems are ideal tools for complementing or replacing the traditional delivery of teaching and e-learning and may be defined as a combination of technology and the pedagogical approaches required for presenting and teaching a particular subject. e-Learning systems are key delivery components in communicating the educational message through the use of text and visual images. However, the heuristic of using text and visual images is simply one element in a series of design principles whose implementation improves the effectiveness of teaching through the use of web-based

multimedia e-learning. The theory of multimedia learning is based on three main assumptions, namely: there are two separate channels (auditory and visual) for the processing of information; there is limited channel capacity; and learning is an active process of filtering, selecting, organising and integrating information (Mayer & Moreno, 1998a; Mayer, 2001; Moreno & Mayer, 1999).

According to Mayer (2001), in the multimedia theory of learning, information is presented in more than one mode (for example, as words or pictures), with all modes facilitating learning. Mayer asserted that meaningful learning occurs when learners mentally select relevant information and build coherent mental connections, and he developed a series of research-based learning techniques in which information is integrated and proportionally distributed into the auditory and visual channels, in order to maximise the learner's working memory, because people learn better when multimedia messages are designed in a way that is consistent with how the human mind works.

2.4 Constructivist Learning Theory

Constructivism is the tag given to a group of theories that argue that humans generate knowledge and meaning from the interaction between their experiences and their ideas. The core theory of constructivism was established by Vygotsky (1978), who emphasised that social interaction is the principal factor in the cognitive progress. Vygotsky's work has been the foundation of developmental cognition and constructivist theories for the past 50 years. Constructivism proposes that the learner is much more actively involved in interacting with the teacher in generating new meanings. Constructive learning takes place when meaningful mental representations are constructed on top of previous knowledge-creating schemas; therefore, learning is the active, contextualised process of constructing rather than a passive acquisition of knowledge, and instruction is the process of supporting the knowledge constructed by the learners rather than the mere communication of knowledge (Duffy & Cunningham, 1996; Honebein, Duffy, & Fishman, 1993; Jonassen, 1999).

The two views of the theory distinguish between cognitive constructivism and social constructivism (Vygotsky, 1978). The former focuses on how learners acquire knowledge as a result of developmental psychology and learning styles and considers that knowledge incites further cognitive development, while the latter attempts to explain learning acquisition and how understanding is generated through social interaction. Social

interaction and social context are essential in cognitive development, particularly when progressing from childhood. A child's cultural development is first established on a social level, as a result of interaction with people (inter-psychological) and later on an individual level, within the child (intra-psychological). All the higher functions originate as actual relationships between individuals. For example, Vygotsky (1978) found that children interacting with older individuals were able to perform better.

There are two important aspects in understanding how Vygotsky's (1978) work is relevant to this research, as they define how people's interactions underpin their learning acquisition. These are the More Knowledgeable Other (MKO) and the Zone of Proximal Development (ZPD). These concepts are used in the experiments as part of the theoretical background to support the research.

The MKO refers to someone (peers) or something (a computer system) that has a better understanding or a higher level of ability level than the learner, in terms of a particular activity, procedure or concept. Concerning Vygotsky's original view, the notion of the MKO refers to school children. Thus, one can infer that the MKO is a teacher or an older adult; however, a child's peers could constitute individuals with more knowledge or experience. However, the term is often used in the literature in different contexts, such as peers as learners (Van Lier, 2000) and does not have to refer to a person. Indeed, it may allude to a learning content management system that supports employees in their learning process: computer-assisted tutors have been used in educational settings, in order to facilitate and guide students through the learning process.

The Zone of Proximal Development (ZPD) is the difference between what a learner can do individually and what the same learner can do with the help of the MKO. Vygotsky's (1978) research determined that intelligence can be measured by comparing individual learning skills in solving or understanding a problem with the same learner skills used to solve problems with the assistance of someone who has mastered the concepts previously. The idea of using unique means to measure learner intelligence goes against the concept of ZPD, which rejects the application of standardised tests (Berk & Winsler, 1995a; Berk & Winsler, 1995b).

Vygotsky's (1978) research focuses on how children's functions (such as attention, memory and perception) develop and are individual to the learner. Children can do and understand more with the help of adults who provide apprenticeships in acquiring skills

than they can do on their own. This is apparent in the classroom, where the teacher, as the most knowledgeable member of the class, has a fundamental role in employing a variety of tools and scaffolds to support the development of academic activities; e.g., reading and writing (Gallimore, Goldenberg & Weisner, 1993). Therefore, the range of skills that children may develop usually surpasses what they could attain on their own. Further investigation has exposed that the quality of learning through mediation is attributed to human beings. It can be said that, in a variety of ways, adults mediate the world for children and teach them how to get the most from it.

Within the Vygotskian (Vygotsky, 1978) concept of the zone of proximal development, social interaction is the basis for cognitive growth. As with many significant theories in the academic world, the concept of ZPD has been expanded and turned into new ideas since Vygotsky's original research and extended into concepts like scaffolding and the Zone of Reflective Capacity (ZRC).

Scaffolding refers to the process whereby an MKO supports and helps students in their ZPD as necessary, diminishing this aid as and when it becomes unnecessary. The ZRC (Tinsley & Lebak, 2009) is related to the ZPD, but targets it in more detail and guides the way in which an adult's capacity for reflection can expand when collaborating with other adults with similar goals over an extended period of time.

The previous concepts underpin constructivist learning which occurs when learners actively build meaningful mental representations from the presented information (Mayer et al., 1999). Active construction processes involve selecting relevant phrases and image sequences; in terms of the presented material, organising them into coherent causal chains (known as internal connections) and relating them to mental prior knowledge (Mayer & Moreno, 1998a; Mayer et al., 1999). In this context, hypermedia, simulation, virtual reality and open-ended learning environments are beneficial in exploring and acquiring information more effectively.

2.5 Interactivity

Interactivity is an important element in learning supported by technology (Lipponen, 2002). The term has evolved through time in a manner that is used in different contexts. Two of these dissimilar contexts are presented: one related to pedagogy and the other concerning new technologies in education (Beauchamp & Kennewell, 2010). In the former, interactivity and pedagogy have a long history together. Interaction between the teacher and

the students is standard for an effective pedagogy (Doherty & Hilberg, 2007). Doherty (2007), for example, claims that the students' gain was greater in classrooms where teachers used effective pedagogies in the classroom than in other classrooms without it. In the latter, student-teacher interaction has evolved to be considered an essential component of any e-learning system (Palacios & Evans, 2010a). Interactivity in this context refers to the degree of responsiveness established in a two-way communication multimedia environment. Beauchamp (2010) considers interactivity play a fundamental role in promoting learning in England. He cites the Department for Education and Employment (1998), which defines interactivity as the ability to respond contingently to the learner's actions. DfEE (1999) characterises interactivity as one of the factors contributing to success in learning, along with discussion, pace, confidence and ambition.

The analysis of interaction is based on reciprocity (Kirsh, 1997), which requires cooperation. The parties involved must co-ordinate their activity or the process will descend into chaos. All parties exercise power over each other, influencing what the others will do, and there is usually some degree of (tacit) negotiation over who will do what, when and how. Thus, in this respect, interactivity is a complex, dynamic coupling between two or more intelligent parties. In some instances, interaction does not require explicit co-operation, negotiation or coordination; an example of this given by Kirsch (1997) is the interaction amongst the bodies in the solar system. The moon's gravitational field acts on the Earth and Sun, just as the Earth and the Sun's gravitational fields act on the moon (and all other solar bodies); this occurs mutually and reciprocally and everything is automatic and axiomatic. Kirsch (1997) also gives an example of intermediate interaction is also presented here: when someone is bouncing on a trampoline, that person is interacting with it, in the sense that his behaviour is closely coupled with its behaviour and vice-versa. These environments of action, rich with reactive potential, are not agents themselves, capable of forming goals and therefore capable of performing truly reciprocal actions.

The above definition is not the only one found in the literature, and others have attempted to define the term *interactivity* in a way that is closer to this study. For example, Sims (1994; 1992) describes interactivity as a series of seven levels, in which each is distinguished by the form of communication between the user and the computer. Moore (1989) proposed three different types of interactivity: learner-content interaction, learner-instructor interaction and learner-learner interaction. He described learner-content interaction as a fundamental characteristic of education. Indeed, interaction and

interactivity are considered characteristic features of multimedia materials: interaction is present in all components of instructional materials (the content, the organisation and the interface through which it is presented). Furthermore, interaction plays a communicative role in the human-computer dialogue.

From a cognitive perspective, the incorporation of interactivity within computer-based systems rests with the learner's freedom to influence the flow of information, in terms of timing or content. For example, button-clicking can be used to allow the learner to indicate when they want the next portion of text to be displayed, and interactive multiple-choice questions can be used to provide meaningful feedback for self-assessment. In the multimedia environment, interactivity is the key to enhancing learning by supporting higher levels of cognitive activity among students. Evans & Gibbons (2007) emphasised that interactivity is a fundamental mechanism in both knowledge acquisition and the development of cognitive skills; in their research, interactivity encouraged the learner to play an active role in the control of the pace and management of the presented material. These types of interactivity have strong implications for deep learning.

Evans and Sabry (2003) formulated the interaction model in order to study the processes and the effects of interaction in learning. The three-stage model of computer-initiated interactions defines the terminology and methodology as follows: according to the model, an interaction involves a sequence of three actions: initiation, response and feedback, with exchange of information occurring between the two agents involved. In a multimedia system, initiation refers to the system's request for input, in order to begin the process. The response refers to the second agent providing the input, and feedback is the reaction to the first agent's input. The three actions are interrelated and are a direct consequence of each agent's response. The term *interactivity* thus includes interaction between students (student–student interaction), interaction with the tutor (teacher–student interaction) and interaction with the teaching material itself (student–content interaction) (Moore, 1989; Schrum & Berge, 1997). In their study, Evans and Gibbons (2007) claim that due to an *interactivity effect*, students learn better when they interact with a simulation (in terms of control and pace) and answer interactive self-assessment questions. In Evans and Gibbons' (2007) study, learners interacted with an e-learning system and could control the pace of the presentation by indicating when they were ready to jump to the next part of the presentation.

Evans and Sabry (2003) pointed out that all forms of computer-initiated interactivity may be described in terms of their model, and it has three actions in terms of navigation or pacing interaction:

1. Present button or control to learner (computer initiation).

2. Student presses button or uses control (learner response).

3. Present new information to learner (computer feedback).

A lesson in a computer-based learning system may be described as non-interactive if it requires little or no computer-initiated interactivity in order for a lesson to be completed. In contrast, a computer-based learning system is said to be interactive if it uses computer-initiated interactivity as an intrinsic part of the lesson. Interactivity is examined in general and within the context of the different multimedia principles that underpin the design of research experiments, relating to interactive pedagogical feedback, interactive audio feedback and interactive texting feedback mechanisms.

2.5.1 Interactivity Components

An interesting approach in studying interactivity is to focus on the essential components that must be present in a session of interaction (Zazelenchuk, 1997). The six essential components, with regards to the above, are as follows: active learning environment, learner control, feedback, multiple media, learner response option and adaptability.

Active Learning Environment refers to an educational environment that provides the student with the resources to become actively involved in a learning activity. Zazelenchuk (1997) stated that an interactive learning environment requires learners to actively process the information that is being presented to them by the multimedia programme. Thereby, learners will actively engage in analysis, comparing, modifying and other dynamic instructional activities (Wilson, 1999).

Learner Control refers to the opportunity of learners to direct the course of their process of learning (Lawless & Brown, 1997). Lawless & Brown (1997) identified two types of control within the multimedia environment: external (programme control or PC) and internal (learner control or LC). PC refers to the specific limits set up by a multimedia computer program which all users must deal with, and the most common types of LC are pacing and sequencing. Pacing allows learners to specify how much time they want to invest in each of the tasks for the entire lesson, while sequencing allows learners to choose

their path, in terms of educational content. Pedagogically speaking, LC is important because individual students learn more when allowed to control their instruction (as opposed to learners without such control) (Hannafin & Sullivan, 1995). However, an overloaded multimedia design may generate a multitude of options and choices available to learners, thus imposing a cognitive load on them (Lim, 2004).

Interactive Feedback is considered as a reactive computer response to learner input. Feedback on learning encompasses a great range of activities that provide diagnoses and remedial suggestions for changing future actions.

Multiple Media or Multimedia refers to the blending of sound, music, images and other media into a synchronized whole. The term is also referred to as cross-media, which means live demonstrations by human speakers, supported by a combination of slide projectors, motion-picture projectors and audio-tape players. Furthermore, the term *digital multimedia* is used to distinguish such multimedia from artistic works, audiovisual presentations, theatre and other non-computer-based multimedia. Interactive multimedia systems enable end users to choose the information they see and receive by actively engaging with the system (Lang, 2006). However, interactivity is not unique to digital media; it has long been a feature of traditional media, such as newspapers, where readers must scan a page and decide what articles to read and in what sequence. For the sake of precision, the term *interactive digital multimedia* is thus preferable to *multimedia* or *interactive multimedia.*

Learner Response Option considers that learners communicate or interact with a computer program by typing, dragging a mouse or joystick, pressing an image on a touch screen, giving a voice command to voice recognition systems or any other associated type of input (Zazelenchuk, 1997). The availability of feedback and learner response options are essential characteristics of interactive systems.

Adaptability refers to the ability of a computer system to adapt to a variety of individual learners' needs (Zazelenchuk, 1997). It is the adaptation of the interaction process and the exchange of information between individuals (Chou, 2003) and it is expected that a computer program should be capable of adapting to the preferred learning style of a particular student and that the computer system must be able to adapt to the learner's needs and reciprocate accordingly.

A further taxonomy (Hannafin, 1989) is based on the classification of the five functions of interaction, which are confirmation, pacing, inquiry, navigation, and elaboration.

Interaction is considered as having been achieved if one or more instructional functions are presented and procedural control with cognitive processing effects is provided.

Confirmation verifies that the intended learning has taken place and typically focuses on the learners' attainment of the intended lesson objectives. Through confirmation, student progress is monitored, branching is executed and decisions are enforced, in terms of activities in subsequent lessons. Typically, criterion-referenced questions are embedded during a lesson, which requires the demonstration of knowledge or skills.

Pacing refers to lesson control through clear directions or indications, such as 'click the arrow to proceed'. Pacing options optimise learning by taking into account students' reading and processing rates, which differ, and some research has found evidence indicating that students learn better when they are able to control the order and pace of a presentation (Mayer, Dow & Mayer, 2003).

Inquiry increases access to lesson support, based upon uniquely defined needs. Inquiries often take the form of help routines or student-accessible lesson features, such as performance updates and lists of completed lesson sections.

Navigation is concerned with the route of the lesson sections, and interaction provides the learner with controlled access to defined parts of a lesson. Normally, the specific navigational functions are provided via designer-imposed menu options.

Elaboration refers to the process of relating previously successfully encoded knowledge with current lesson content, and this is accomplished through the use of pedagogical strategies such as encouraging the learner to compare and contrast existing knowledge with new lesson content or to combine additional relevant information with current lesson content.

2.5.2 Interactive Multimedia

Multimedia systems are an important key environment of interactivity and such systems use computers to present text, graphics, video, animation and sound in an integrated manner (Domagk et al., 2010). More specifically, multimedia systems deliver content using concurrent types of media communication in one presentation which combines different content forms. A concurrent type of media communication is a CD-ROM, a website, etc and these communication and media technologies are permitted to interactively amalgamate a blend of information built into a variety of content forms, such as text, audio, still images, animation and video. From a technology perspective, it entails the use of

multiple forms of delivery device, such as computers, screens and loudspeakers (Olson, 1988). Mayer and Chandler (2001) defined multimedia as words and pictures that provide an account of how a cause-and-effect system works. Multimedia presentations are engaging because they stimulate human senses through a combination of sounds and images.

In a multimedia computer system, interaction may be initiated by the system or by the learner (Schar & Krueger, 2000). When a student initiates interaction, they seek information from the content in a similar way to other traditional media. When interaction is initiated by the system, it demands some input from the learner, such as pressing a button or answering a question. In the case of computer-initiated interaction, the response action is performed by the learner and the feedback action is performed by the computer.

There is evidence that multimedia and interactivity help to convey an instructional message. For example, Mayer (1997; 1998b) carried out various studies in which learners indicated that they understood explanations better when a message was constructed using words and pictures. The use of multimedia can offer a new perspective compared to the traditional static representation of information. Students experience deeper learning from well-designed multimedia presentations than from traditional, verbal-only messages (Mayer, 1997; Moreno & Mayer, 1999). However, these multimedia materials should be designed according to the principles set out in the following section to deliver the instructional message appropriately.

2.5.3 Multimedia Principles

Mayer (2005) devised a series of principles for designing instructional messages within a multimedia environment leading to constructivist learning, which are as follows:

The multimedia or multiple representation principle asserts that it is better to use narration and pictures (two modes) to present an explanation rather than narration or pictures alone (one mode). This multimedia effect is consistent with the cognitive theory of multimedia learning (Mayer & Moreno, 1998a), as those given a multimedia explanation are capable of creating two different mental representations relating to the auditory and visual channels and making connections between them. In Mayer's experiments (Mayer & Anderson, 1992), students who listened to a narration explaining how a bicycle tyre pump works while also viewing a corresponding animation generated twice as many useful solutions to subsequent problem-solving transfer questions than those students who listened to the same narration without viewing any animation.

The coherence principle (Moreno & Mayer, 1999) indicates that students learn better when extraneous material is excluded from multimedia explanations. Based on the cognitive theory of multimedia learning, this is due to limitations in the capacity of the visual and auditory channels. If a narrated multimedia animation presentation is delivered, the narrated component flows through the auditory channel, while the animation is processed by the visual channel. Any additional auditory or visual information competes with its earlier-presented counterpart, with a tendency to overload. Less capacity being available for the processing of narration negatively affects students' learning.

The modality principle recommends the use of narration with pictures rather than written words with pictures. Research by Mayer and Moreno (1998a) showed that when students are listening to verbal information instead of visually witnessing on-screen text, they outperform those who learn through concurrent on-screen text and animations. This group may have an advantage in being able to experience two channel of information simultaneously; i.e., the auditory and the visual channels, while the latter group may overload the visual channel, with two visual sources competing for the same channel.

The spatial and temporal contiguity principles (Moreno & Mayer, 1999) relate to how far display words should be placed away from pictures. The principle is consistent with the cognitive theory of multimedia learning, as corresponding words and pictures must be in working memory at the same time in order to facilitate a connection between them.

The spatial contiguity principle recommends the displaying of words adjacent to the parts of the picture to which they relate. In giving a multimedia explanation, this means presenting corresponding words and pictures contiguously rather than separately. Research has demonstrated that students who learn through integrated verbal and visual explanations outperform those who learn using material that was separated (Mayer, 1997). In a review of ten studies concerning whether multimedia instruction was effective, Mayer (1997) manipulated the physical proximity of the on-screen text and animation and concluded that there was consistent evidence in favour of what is referred to as the ‘spatial-contiguity effect’.

The temporal contiguity principle refers to the fact that students understand an explanation better when corresponding words and pictures are presented at the same time, as opposed to them being shown separately. For example, students who listened to a narration explaining how a bicycle tyre pump works whilst also viewing a corresponding animation

outperformed students who viewed the animation before or after listening to the narration (Mayer & Anderson, 1992).

The redundancy principle (Mayer & Moreno, 1998b) recommends the use of narration and pictures rather than narration, text and pictures, providing the visual information is presented simultaneously to the verbal information. There is a misconception that when using a multimedia learning system, the more material presented (such as animations, video, graphics with simultaneous text and audio) the better the message will be delivered. Unfortunately, redundant information presented simultaneously through different channels will only achieve the overloading of the channel due to the split-attention effect (Mayer & Moreno, 1998b; Moreno & Mayer, 1999) of the on-screen text and the animation and the redundant message hinders rather than assists student learning. However, students presented with redundant verbal material outperformed those students who learned through non-redundant verbal materials when such presentations were sequential.

The split-attention principle (Chandler & Sweller, 1991; Sweller et al., 1990) recommends the presenting of words as auditory narration rather than as visual on-screen text. The rationale for this is that on-screen text and animation can overload the visual information processing system, whereas narration is processed in the verbal information processing system and animation is processed in the visual information processing system. For example, students who viewed an animation while also listening to a corresponding narration outperformed students who viewed the same animation with corresponding on-screen text consisting of the same words as the narration.

The personalisation principle (Kartal, 2010) states that using words in a conversational style rather than a formal style increases learning. The conversational style aids learning because people work harder to understand material when they feel they are in conversation with a partner. In the formal style, the first and second-person narrative is avoided.

The segmenting material principle recommends that learning material is presented in learner-paced segments rather than as a continuous unit (Mayer, 2005). Students learn more deeply when a multimedia message is presented in user-paced segments rather than as a continuous unit and segmenting slows the pace of the presentation, enabling the learner to carry out essential mental processing.

The pre-training learning principle recommends that it is better if learners are familiar with the names and characteristics of the main concepts (Clark & Mayer, 2003).

This equips students with knowledge that can be used to process the next multimedia message with less cognitive effort.

The signalling principle recommends that it is preferable that words include cues in the organisation of a presentation (Mayer, 2005). The learner's attention is held by highlighting or flashing the appropriate elements in the multimedia message, and this helps to reduce extraneous cognitive load within the learning process.

The voice principle recommends that it is better if words are spoken in a standard-accent by a human (Mayer, 2005). People learn more deeply from a multimedia message when the narration is done by a human rather than by a computerised voice. The human voice triggers a social response in the learner that encourages them to make sense of the information presented.

The image principle indicates that learning performance is improved when the speaker's image is added to the screen.

The individual differences principle indicates that multimedia effects, contiguity effects and split-attention create the largest effect on high spatial or low knowledge learners and are dependent on individual differences in the learners. For example, students with high prior knowledge may not require a contiguous visual presentation because they can generate their own mental images while listening to an animation or reading a verbal text. In addition, students who score high on spatial ability tests show greater multimedia effects than those students who score low on spatial ability. In accordance with the cognitive theory of multimedia learning, students with high spatial ability are able to hold the visual image in visual working memory and so are more likely to benefit from the contiguous presentation of words and pictures. For example, students who lack prior knowledge are inclined to show stronger multimedia effects and contiguity effects than those students who possess high levels of prior knowledge (Mayer & Gallini, 1990). The eleven principles presented above encompass the cognitive theory of multimedia learning.

2.6 Practice

Traditional practice is defined as asking questions during instruction, and evidence has been provided that adjunct questions increase the amount learned from a written passage (Rothkopf, 1966). Other researchers (Hannafin, Phillips & Tripp, 1986; Hannafin et al., 1987; Salisbury, 1988) have studied this instructional variable in depth in order to consider its importance in increasing learning. Learning is believed to be the result of the frequent

rehearsal of relevant lesson information paired with appropriate feedback and reinforcement (Wager & Wager, 1985) and although such behavioural practice activities are believed to be most effective for lower level or fact learning, interactive approaches and new pedagogical designs elicit cognitive and deeper learning.

In this realm, Rieber (1990) considered two types of practice (behavioural and cognitive) that integrate with our general theories in order to explain how learning occurs. Behavioural practice, with a large reinforcing component of practice activity, consisted of five multiple-choice questions, presented after each of the four lesson parts in Rieber's research. The questions covered the relevant material in each lesson part, with feedback provided to the students in the form of information on the correct results. Rieber's (1990) experiment consisted of a structured simulation activity in which students were given increasing levels of control over an interactive dynamic that simulated a free-floating object in a frictionless, gravity-free environment. The free-floating object was called a *starship* and was represented by a triangular symbol on the computer screen. Students practiced increasing and decreasing the speed of the starship after the third part of the lesson and after the fourth part of the lesson, they applied forces to the starship in 90° increments, which demonstrated how orthogonal forces affect the starship's trajectory in two-dimensional space. The experiment focused on cognitive practice.

2.7 Assessment

Assessment may be a frightening and threatening experience for teachers and students alike (Gibbs, 1999). Technological innovations triggered by computer and network-based learning have given assessment a new dimension and changed this emotional and highly sensitive activity. Assessment is generally considered a term that involves the process of giving students tests and then assigning grades to them.

More specifically, it is a mechanism for providing either the teachers (summative assessment) or the learners (formative assessment) with vital information for improving their teaching/learning methodology and determining (if accompanied by feedback) where mistakes have been made, to reflect on them and become more effective, self-assessing, self-directed learners (Angelo & Cross, 1993).

Assessment has long been categorised depending on whether the purpose of the evaluation is summative or formative (Black & William, 1998; Boud, 1995; Bransford, Brown & Cocking, 2000; Brown & Knight, 1994; Buchanan, 2000; Khan, Davies & Gupta, 2001;

Manogue et al., 2002; Velan et al., 2002). The former measures performance during or at the end of a lesson, unit of study, etc, while formative assessment plays an important role in an assessment-centred learning environment, motivating students to learn and directing their learning (Bransford et al., 2000) and improving their knowledge and skills (Morss & Murray, 2005).

With technology-driven education over recent decades, teachers are focusing more on assessment for learning in which the role of the learner changed from passive to active. Therefore, the role of the teachers transform from a dominant to a flexible position where their acting on facilitate comprehension of ideas built on learners own cognitive conceptions.

Assessment is one of the most important topic for future research in the effect interactivity because it is area for measuring learning outcomes performance. It is also an important function of formative assessment to provide students with 'meaningful feedback' that should occur continuously, but not intrusively, as part of instruction. In addition, this is beneficial in the adjustment of teaching strategies and in the application of appropriate remedial techniques. Research (Bell & Cowie, 2001) has suggested that the teacher should gather formative assessment information (feedback) from student learning activities and then respond to promote further learning.

Formative assessment refers to the help provided to the learner, in order to improve their knowledge and skills (Morss & Murray, 2005). With the advent of technology-driven education over the past decades, teachers are focusing more on assessment for learning in which the role of the learner changes from passive to active. Thus, the role of the teacher is transformed from a dominant to a flexible position; they act to facilitate the comprehension of ideas built upon the learners' own cognitive conceptions. Self-assessment provides the pertinent mechanism for enhancing individual performance, either through summative or formative evaluation, and is used in courses within the medical profession that implement CPD (continuing professional development) activities to disseminate expertise and in staff development that is self-directed and electronically delivered (Dorman, 2008).

Activities that contribute to assessment for learning include the use of detailed feedback, teacher questioning, built-on specific learning goals and self-assessment. In this context, self-assessment is formative assessment, which provides feedback for reflection on learning activities.

2.7.1 Self-Assessment

Self-assessment provides a pertinent mechanism for enhancing individual performance, either through summative or formative evaluation. It generates feedback for learners through reflection on learning activities. It is used in courses within the medical profession that implement CPD (continuing professional development) activities to disseminate their expertise and for staff development that is self-directed and electronically delivered (Dorman, 2008).

2.7.2 Interactive Self-Assessment Questions (ISAQ)

Interactivity is examined within the context of the different multimedia principles that underpin the design of research experiments related to interactive pedagogical feedback using ISAQs. Interactivity plays a pivotal role in all scenarios but its importance is highlighted when used as part of an ISAQ. An ISAQ is a computer-based multiple-choice or text-entry question that requires input from the learner and provides feedback based on that input (Evans & Gibbons, 2007). Self-assessment provides the pertinent mechanism for enhancing individual performance: it is a type of formative assessment that provides feedback to learners, so that they may reflect upon learning activities. Interactive self-assessment questions, if they are to be effective, must be designed using well-established design principles. These principles, when applied to the design of the web learning content, create the playground for the fostering of deep learning, where interactivity plays a crucial role in student education. Research on the interactivity effect (Evans & Gibbons, 2007; Mayer, 2001) has indicated that learner performance increases when students are exposed to a system which interactively reacts to their input through self-assessment questions.

However, in order to work effectively, the technology must be embraced within pedagogical methods, in order to elicit performance and provide a well-guided element of interactivity. Interactive self-assessment questions, if they are to be effective, must be designed in accordance with well-established design principles (Mayer, 2001). These principles, when applied to the design of web learning content, create the potential to foster deep learning wherever interactivity play a crucial role in student education (Evans & Sabry, 2003). A basic characteristic of interactivity is learner control of the pace of a multimedia presentation, which establishes that students learn better when they are allowed to control the flow of the presentation or a narrated animation (Mayer & Chandler, 2001).

Studies that allow students the freedom to interact and control their own pace while learning in a computer-based simulation show evidence of higher performance (Mayer et al., 2003), while research on the interactivity effect has indicated that learner performance increases when they are exposed to a system that interactively reacts to their input through self-assessment questions (Evans & Gibbons, 2007). ISAQs have the potential to indicate to what extent a user's response is correct or incorrect; thus, they allow the learner to actively engage in the presented material, in order to build cognitive mental representations.

2.8 Feedback

It is important to refresh the understanding and role of this concept since ISAQ is a type of feedback. Feedback in a broad perspective is the process used to help learners indicate where and how their learning experience can be improved and has long been recognised as an important instrument in the improvement of education (Smit et al., 2008). Feedback on learning encompasses a great range of activities that provide a diagnosis and remedial suggestions for changing future actions. Feedback can make students more effective, self-assessing, self-directed learners and is usually related to assessment as a constructive response to coursework and exams. However, high-quality individualised and meaningful feedback is expensive to provide: it also takes time to design and implement (World Economic Forum, 2002), as Open University research has demonstrated. However, it compensates for this effort by actively engaging the learner and increasing the depth of the student's understanding, in terms of increased performance in problem-solving transfer questions (Evans & Gibbons, 2007). The effectiveness of feedback in improving learning has made its implementation valuable (Gibbs, 2003) and various implementations have been used to maintain or increase these positive effects, while diminishing the burden on cost and workload. For example, Gibbs (2003) outlined a two-stage test, used in medicine, which incorporates both formative and summative assessments. In the first test, formative assessment is only used to inform the students, grab their attention and present remedial feedback that provides a diagnosis and remedial suggestions for the changing of future actions. The second test, on the same topic area, comes two weeks later and implements the summative assessment only, giving marks but no feedback, in order to determine what has been learnt.

Many educators recognize the crucial role that feedback plays in contributing to the learning process (Kumar & Stracke, 2011; Wang & Wu, 2008). Recently the effectiveness of formal feedback has undergone some scrutiny. For example, Søndergaard and Thomas (2004) found that in a survey implemented in their faculty, one in three students disagreed or strongly disagreed with the statement: "I received helpful feedback on how I was going". They argue that this dissatisfaction is widespread. There is also a growing body of evidence that indicates that the potential benefits of feedback are often not attained (Chanock, 2000; Duncan, 2007; Hounsell et al., 2008). There is recognition amongst authors that providing feedback is often a time-consuming activity, and that if the feedback system is to be improved it must not increase the workload of tutors. Clearly if learners are to benefit from feedback it must be relatively quick and easy for tutors to provide it to an adequate standard of quality.

2.9 Audio Feedback

Another type of feedback manipulated in this research is audio feedback. Whilst written or typewritten feedback seems to be the norm, there is evidence to suggest that spoken feedback is much more easily generated. Developmental studies indicate that written skills develop much later than oral skills and take more cognitive processing to exercise (Grabowski, 2010) and this cognitive overhead may partially explain why most people find it quicker to speak than to write. This suggests that one mechanism for reducing the workload burden for creating feedback might be to use the spoken rather than the written modality.

Several studies have considered the relative speeds of speaking and writing. In early informal studies, Gould (1978) suggested that people could handwrite memorised material at about 40 words per minute (wpm), but speak it or read aloud at around 200 wpm. Card (1983) reported that an experienced typist could reach approximately 80 wpm. Of course, the process of generating feedback is not simply a matter of speaking or writing; it also involves the critical evaluation of students' work and the synthesis of sentences. The real test is whether the speed enhancements of speaking rather than typing carry over to the process of creating feedback.

2.10 Audience Response System

Audience response systems (ARS) have followed the traditional trial and error path in their evolution (Kay & LeSage, 2009). They were initially introduced at Stanford University in 1966 and featured as an expensive piece of technology that did not function as expected. ARS became commercially available from 1992 to 1999, but cost was still a limitation in

widespread distribution. They were substantially in use from 2003, due to affordability and technology reasons.

ARS technology is considered an excellent tool in creating further interactivity and engagement within the classroom (Collins, 2006). Learning is underpinned through the provision of immediate feedback, focusing students' attention, identifying any gaps in knowledge and enhancing student involvement. There is great agreement that the ARS promotes learning when coupled with appropriate pedagogical methodologies (Fies & Marshall, 2006) (e.g., TEFA) (Beatty & Gerace, 2009). It can also be used as a mediated tool in overcoming the limitations imposed by the traditional methods of education. The loss of attention is apparent after prolonged periods of teaching, with only 25% of students recalling material during a 3 hour, one-way lecture (McIntosh, 1996).

ARS is the integration of hardware and software and allows the lecturer to pose real-time questions to students. The students reply with an answer using different types of handheld devices, e.g. clickers (TurningPoint, 2007) (Figure 4), laptops, personal digital assistants and mobile phones (Beatty & Gerace, 2009). After responses are received, the software compiles and displays the results using histograms or percentage graphs (Collins, 2006).

Figure 3: The Turning Point Clicker (TurningPoint, 2007)

There are obvious benefits to using the ARS system. Indeed, Robin's (2009) comprehensive review of 67 peer-reviewed papers from 2000 to 2007 highlighted the benefits and challenges associated with the use of an ARS. The relevant benefits within the classroom environment included improved attendance, an increase in the levels of attention and participation and the intensification of engagement: students are more interested in the concepts presented and discussed through an ARS. In addition, audio response systems enhance the learning experience as a result of their interactive characteristics, the quantity

and quality of class discussions, teaching guidance, improvements in performance and the quality of education.

A key beneficial element of ARS is within the field of assessment. General feedback and feedback in the form of formative assessment is used to determine students' understanding of concepts, thus helping to identify misconceptions that may alter the course of classroom instruction (Bergtrom, 2006; Jackson et al., 2005; Siau, Sheng & Nah, 2006).

2.11 Short Message Services (SMS)

Short Message Services (SMS) are an active part of Chapter 6: Interactive Texting Feedback. SMS enable mobile phones to receive and send text messages through a network operator's message centre or from the Internet through a "SMS gateway" websites (Lai, 2004). SMS messages are transmitted to a subscriber's mobile number via an SMSC (Short Message Service Centre). SMSCs are not restricted to sending SMS just to the subscribers of the mobile network the SMSC belongs to, they can send to any international mobile subscriber that the mobile network, or its backbone provider, has interworking or roaming agreements with.

SMS is an almost instantaneous communication medium when compared to the conventional email because of the differences in the concept of operation. SMS operates on a 'store-and-forward' concept (even if the recipient's phone is switched off, they will still be able to receive the message) while email operates on a 'store-and-retrieve' concept (senders must wait for the receiver to come on-line and access the network to retrieve the message).

2.12 e-Learning Systems

Although interactivity is present in all types of human activities this research is limited to the effect of interactivity on e-Learning systems which are a just a particular mechanism to deliver educational resources. e-Learning is defined as 'learning facilitated and supported through the use of information and communications technology' (Knight, 2007). Indeed, e-learning is considered a significant internet service, due to the increasing dissemination of knowledge (Carchiolo et al., 2007) and its widespread use in higher education (Lu & Chiou, 2010). Its increasing popularity is a response to the benefits produced. Such benefits in the use of e-learning systems are that they can be used at any time and in any place, they allow the creation of learning communities and they facilitate the implementation of a

learner-centred approach that helps deal with the many differences between learners (Lu & Chiou, 2010).

Although research comparing the effectiveness of educational television and face-to-face instruction found little difference in student achievement (Wetzel, Radtke & Stem, 1994) and a distance learning study (Storck & Sproull, 1995) found no differences between the performance of students given interactive video instruction and face-to-face instruction, advances in technology have indicated that more interactive teaching styles are positively associated with the effectiveness of learning outcomes (Webster & Hackley, 1997). Effectiveness is an important indicator of an effective learning management system (LMS), as presented in Douglas' (2004) research. The results of his research indicated that student performance is significantly improved by the incorporation of multiple choices within the e-learning environment.

2.13 Learning Objects

Components of an e-Learning system concerned with reusability of the material are learning objects. They were used to provide precise content in the lessons designed in this research. A Learning Object (LO) is defined (Fig. 1) as a re-usable self-contained digital entity with embedded metadata resources and a learning strategy that may interact with other objects and encapsulate other resources (information instances) in an interconnected and platform independent environment (Palacios, 2002). It is tagged with metadata based on the SCORM standard, in order to describe the elements of content (Palacios, 2008).

Information Object (IO) is a general term used to represent several real entities (or groups) with similar properties, rather than one individual. Learning strategies are the methods that students use to learn and/or the pedagogy teachers employ to convey a particular lesson. These range from techniques for improved memory, better study skills and an institutional curriculum designed for a specific course of academic study.

In general, a learning strategy helps to implement methods and adopt techniques that increase effectiveness in any aspect of the general cognitive process of acquiring skills or knowledge. Granularity and reusability properties are essential parts of the learning object concept, and by looking at Figure **4** it may be noted that LOs differ from IOs, due to the fact that information can be communicated without the intention to teach.

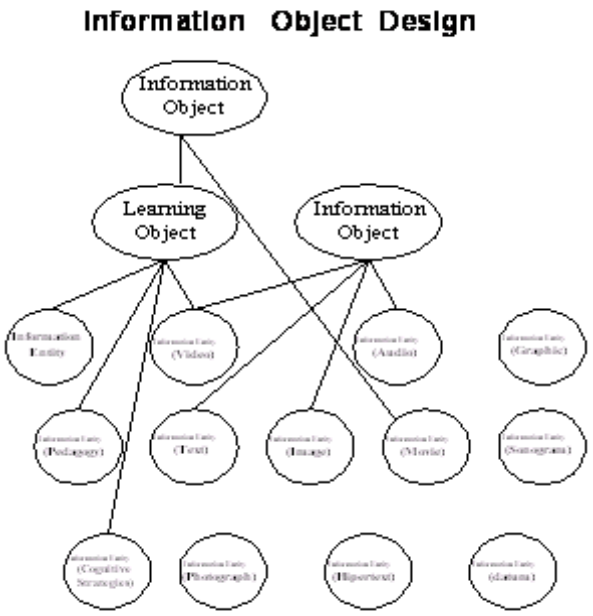

Figure 4: Learning Object as Part of an InfOb Layout (Palacios, 2002a)

Learning repositories should be designed in such a way that the content will be actively used by teachers. The quality of the content is paramount and is retained in the peer evaluation process (Jones & McNaught, 2011).

There are similar systems based on web-based multimedia interactive components, such as the Telelearning system (MITS) (Megzari, Yuan & Karmouch, 2002). This system provides a multimedia interactive learning environment, with easy-to-search and highly reusable learning objects and an emphasis on metadata and media content management mechanisms. Metadata and media contents are generated, stored and utilised in order to facilitate the search and the on-demand presentation of learning objects. Learner preferences, performance and progress information are maintained by the profile database, in order to ensure that courseware presentation is adaptable and more interactive.

2.14 Discussion

People have the intuitive feeling that technology and interactivity as an intrinsic element improve learning (Conole et al., 2004). A large amount of research on e-learning, for example, claim to derive from well-established theoretical approaches as described at the beginning of the chapter, e.g., cognitivism, constructivism, etc., but no scientific explanation is given for adopting the principles of these approaches in such different contexts. In many cases, there is little scientific evidence that support these claim.

Therefore, instructional design underpinned by such flaw perception reflects 'common sense' rather than theoretically informed design.

Using technology to enhance learning requires a more consistent and innovative approach that interrelates the theoretical framework with a scientific methodology that generates the evidence to support such an endeavour (Conole & Oliver, 2002). Conole (2004), for example, amalgamates this conception in her research. Her work intends joining theory and practice using learning design decision-making resources that use a model of pedagogical approaches as a basis for developing effective learning design plans.

Same limitations are perceived exist when researching on the effect of interactivity, therefore, a similar approach is taking into consideration to support the findings. Media researchers consider that e-learning creates a new realm for innovative instructional methods to be implemented (Clark, 2001). e-Learning delivery mechanisms (e.g. computer, electronic devices, etc.) have deeply revolutionised present society to the extent of displacing other traditional delivery media, such as the books in this task. However, the delivery mechanism per se does not yield learning, but the instructional methods effectively managed by the teacher. Others researchers have found that effective learning remains constant when the same instructional methods are used but the delivery mechanism has been changed (Mayer, 2001). Therefore, the same pedagogical principles that yield learning in traditional environments are likely to promote learning in electronic environments. However, new instructional designs applied in these new environments that have the potential to enhance learning and promote better learning opportunities need to be supported by scientific methodology. A scientific methodology is a key element to understanding how people learn in an electronic environment (e-learning). Mayer (2003) points out that three elements are essential for the science of e-learning. The three elements are evidence, theory and applications.

Evidence is "the available body of facts or information indicating whether a belief or proposition is true or valid" (Oxford Dictionaries, 2010). The template of replicated findings originated in precise research (Webler et al., 1991). These factual events that may be recreated once and again with similar results. There is a lack of evidence and conceptual framework when investigating the effect of interactivity in e-Learning systems that this research intent to deal with.

Three specific scenarios provide the environment to validate the effects of interactivity on e-learning systems. The former scenario relates to Interactive pedagogical feedback that evaluates the effect that different levels of interactivity impinge on the memory and understanding of the students. A chapter in the book "Cases on Transnational Learning and Technologically Enabled Environments" (Palacios & Evans, 2010a) and a journal publication (Palacios & Evans, 2011) are published to support the research. The next study refers to Interactive Audio Feedback. The experimental results were presented with the title "Using Audio to Enhance Learner Feedback" in the International Conference on Education and Management Technology (ICEMT 2011) in Cairo, Egypt. Audio feedback significantly reduces the time used by tutors to produce the required feedback compared to typed text and open an interactive mechanism to channel teachers' emotions and perceptions. The latter scenario is Interactive Texting Feedback that combines technological and pedagogical strategies to improve the learning experience. This scenario underpinned by research was presented in the International Conference on Computer Science and Information Systems 2011 (IADIS 2011) in Rome, with the title "Interactive Feedback in the Classroom using SMS messages". The interactivity effect (replicated findings) is found in a variety of contexts and with a variety of learners in these scenarios.

A theory to support the research on how people learn using e-learning systems that generates testable predictions is another essential element for the science of e-learning. The research shows evidence of an interactivity effect for deep learning (understanding) as indicated both by improvement in transfer test scores and reduced time needed to complete transfer test questions. The weaker effect for memory compared with understanding is consistent with previous multimedia learning studies (summarised in Mayer, 2001) which suggest that effects are more pronounced in transfer tests than in retention tests.

Finally, the applications of theory-based principles on how to design electronic learning environments that can be successfully tested in research studies.

The limited knowledge about the effect of interactivity required to be overcome using a systematic approach. This study of interactivity as a vital component of e-Learning contributes to strength the science of e-Learning and provides sound evidences.

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3 Chapter 3: Research Methodology

3.1 Introduction

The research in this thesis is underpinned as indicated in previous chapters by three empirical studies developed following a range of methods explained in detail within the following chapters related to each study. However, a theoretical explanation that indicates the rationality behind the use of these research methods is missing. This chapter focuses in providing this rationality by presenting an epistemology view that amalgamate and uphold the research to effectively show reliability in the experiments drawn.

The three main research studies developed to support the research hypotheses were conducted mainly based on the framework of positivism and action research paradigms.

The empirical methodology adopted follow the footsteps of others renowned researchers in the field (Mayer, 2001, 2005; Evans & Gibbons, 2007 and others) who adopted an evidence-based approach in this area of educational research subjective by nature.

The cyclical nature of the action research approach explained in the following section is considered during the whole research for its intrinsic capacity to support new models and research dealing with innovation.

Then, the experiments and methods used in the three studies are presented in a general manner to provide a glimpse of the details provide in each chapter that follows.

3.2 Methodology

The convergence of research in Information and Communication Technologies (ICT) and a number of others fields and disciplines, creates an epistemological challenge. In particular, the knowledge explosion as a result of emerging technologies represents an obstacle to researchers' abilities for processing this high volume of new information (Adair & Vohra, 2003).

The challenge increases with the complexity of social systems, which translates into diverse issues of scientific methodology. The rules applied to scientific events, and their consequent analysis and interpretation, differ from the methodology applied to social phenomena. Therefore, the need exists for developing and implementing theories or models to better interpret these social events.

Positivism in contrast to interpretivism establishes that educational researchers should "eliminate their biases, remain emotionally detached and uninvolved with the objects of

study, and test or empirically justify their stated hypotheses" (Johnson & Onwuegbuzie, 2004). Interpretivism on the other hand claim for the superiority of constructivism, idealism, relativism, and humanism approaches that proclaim understanding the meaning of knowledge by personal interpretation of it (Schwandt, 1994).

Both philosophical approaches attempt to provide warranted assertions about a particular problem or social phenomenon (Biesta & Burbules, 2003). Both approaches describe their data, look for valid explanation from their data, and speculate about the reasons the outcomes they observed occurred (Sechrest and Sidani, 1995).

Educational research deals with the complexity of social systems that cannot easily be reduced, even for study reasons. Gill and Johnson (1997) suggest that "methodological pluralism" is the most appropriate approach to undertaking studies developed in social systems. This research supports this idea although understand that prevailing academic research is based on positivist epistemology, which considers theory above practice (Reeves, 2002). Research in this context focuses on the development of perdurable theories and principles that underpin the work of practitioners. The positivist scientific approach works well with the exact sciences where predictions and knowledge verification are possible by measurement, experiment, observation and rigorous logical arguments, it has not been very successful in the social sciences, particularly in education. Therefore, there is the need in this research to follow a mixed approach that encompasses several angles of the studied phenomenon.

Reeves (2002) is emphatic in proposing that research on ICT technologies applied to the field of education, also referred to in broader terms as "Educational Informatics" by Levy (2003) and "Instructional Technology" by Seels and Richey (1994), must be seen as development research focused on a personal attempt to understand, improve and reform practice. Action research complies with these assertions and provides, to educationalists and practitioners developing online learning materials, a methodology to combine theory with practice. Kemmis and McTaggart (1998) defined action research methodology as a "form of collective, self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out."

This methodology is highly suitable to the development of online learning material where new models and attitudes are required to deal with constantly emerging and evolving environments and interactions. Action research bases a researcher's involvement directly in the configuration and activities themselves. This involvement provides empirical and research evidence, thus allowing for a better understanding and learning of the researcher's own practice by means of investigating and testing different points of view within ad hoc situations, and reacting to the feedback responses. It is a systematic and collaborative collection of evidence to support group reflections. In other words, action research is motivated by the desire to improve the environment by changing it and learning how to improve on it by studying the effects of the changes made. The cornerstone of action research is the collection of feedback from the people (academics, technologists, tutors, administrators, etc.) involved in the activities prior to, during, and after the development of the online resources, in order to adapt solutions to specific teaching and learning needs.

There are many models of action research used by practitioners and adapted to specific educational contexts. Altrichter and Gstettner (1993) proposed a four stage model: (1) finding the starting point for the research; (2) clarifying and expressing the problem; (3) developing and implementing action strategies, and (4) disseminating the acquired knowledge. This framework, although considered generic by its critics, is clear and consistent with basic action research methodologies. Cohen et al. (2000) present a more comprehensive educational model that consists of eight stages: (1) identification, evaluation and formulation of the study; (2) discussion, negotiation and establishing the research question involving all stakeholders; (3) literature review; (4) revision and redefinition of the research question and establishing specific objectives or testable hypotheses; (5) selection of research procedures (i.e. words, data collection methods, teaching methods, etc.); (6) selection of evaluation procedures; (7) implementation of the research design; (8) interpretation of data, and overall evaluation and extension of theory. This generic framework provides a more accurate structure for examining educational settings. However, there is a disadvantage in the model in that there is a lack of links to pedagogical, institutional, and administrative events that might constrain the research.

Amongst educational models, one particularly addresses issues in the realm of online learning with a focus on innovation. The model is entitled "The Educational Management Action Research Model" (EMAR) and it provides, in addition to communication channels to the pedagogical, institutional and other constraining factor areas, the structure and spiral

cycles of an action research approach (McPherson & Nunes, 2004). The EMAR model (Fig. 5) was produced as a result of research conducted at the University of Sheffield. It is composed of four basic areas through which a developer interacts by means of four essential cycles that constitute the action research framework (Coghlan & Brannick, 2001). The spiral cycles start with an earlier step, which is essential for the action research to be effective, called Diagnosis. Diagnosis includes data collection, analysis and representations. It is followed by Action Planning that comprises building the curriculum design according to the organisational context and pedagogical model. Action Taking follows, which encompasses instructional design and implementing mechanisms for delivery. And finally Action Evaluation where evaluation is performed on the learning activities, modules and programmes planned.

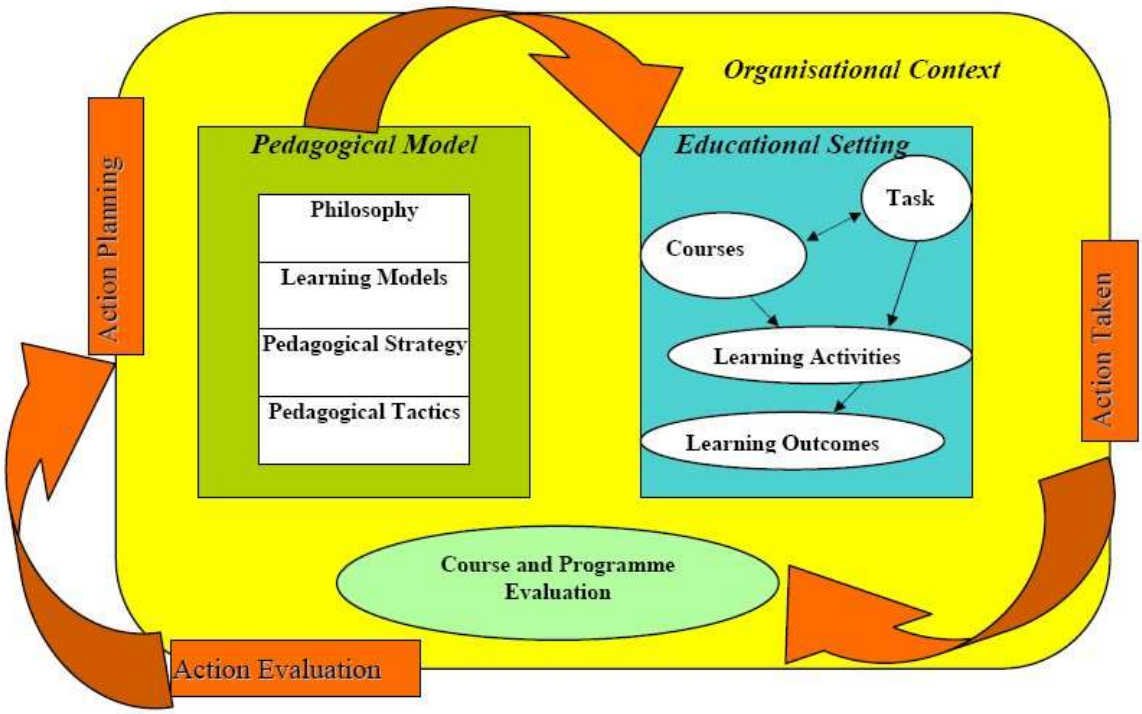


Figure 5: The EMAR Model (Mcpherson et al., 2004)

The cycle is repeated at other stages of implementation as a result of feedback collected from learners, subject experts, administrators, technologists, etc. in the previous cycle. Therefore, there is a continuous process of improvement and refinement before, during and after the development activities. The four basic EMAR areas are: the Organisational Context (OC), the Pedagogical Model (PM), the Educational Setting (ES) and the Evaluation (E) process. It is in these areas that the cycles intersect and they are usually present in any project developing online learning. The OC context, for example, is the

engine that drives forward the educational programme while at the same time establishing policies and strategies that constrain its normal flow. The PM introduces the theoretical knowledge that underpins the creation of the learning tasks, activities and outcomes to be implemented, as well as identifying the ICT technologies most appropriate for the delivery and composition of the educational resources. The PM is the place where learning and cognition theories are incorporated into the design. Academic learning involves the acquisition of high levels skills of critical thinking and problem solving (McPherson & Nunes, 2004). The ES relates to the curriculum design process by establishing the objectives, content to be delivered and assessment procedures. The ES is the area where the subject expert introduces the syllabus, the specific nature of the content and the ways in which it should be taught. Finally, the most important part of action research is E. E differs from assessment in that the former focuses on examining the holistic nature of the process while the latter focuses particularly on the content. Assessment is therefore more related to the programme and the efficiency in achieving the learning outcomes. Evaluation E is intended to monitor all the activities related to the learning process, and provide useful feedback and remedial actions.

In summary, each approach major characteristics follows. Traditional positivism research focuses on deduction, confirmation, theory/hypothesis testing, explanation, prediction, standardized data collection, and statistical analysis. While traditional interpretivism research concerns with are induction, discovery, exploration, theory/ hypothesis generation, the researcher as the primary "instrument" of data collection, and qualitative analysis

On the other hand action research major characteristics are better understanding, participation, improvement, reform, problem finding, problem solving, a step-by-step process, modification, and theory building.

A mixed research approach to be effective should consider the relevant characteristics of each approach in such a way that understand when and how complement their strengths and no overlap their weaknesses (Johnson & Onwuegbuzie, 2004). The research in this thesis takes an experimental approach in areas where objectivity is required. It also employs the cyclical nature of action research to contribute with theory and practice.

3.3 Experiments

The first study tests the first hypothesis, that interactivity incorporated in a computer-based system in the form of interactive formative feedback enhances learning. Experimental design manipulating interactivity (with and without the interactive condition) was utilized. Scores were taken from the groups randomly selected to compare differences in performance between the two conditions. This allowed observing the interactivity's effect in the system embedded with ISAQ condition and compare it to the control group. Two types of learning are further examined within the ISAQ condition: recall and transfer.

The other study examines interactive audio feedback to evaluate the hypotheses that the process of creating interactive feedback in an audio form is quicker than creating feedback in a typewritten form, and that feedback received in audio form is better quality than feedback received in written form. A mixed method approach was implemented in this studied by measuring the performance when using two different condition types (writing and oral). Then, surveys were applied to capture the opinion of the students and lecturers involved in the experiments.

The final study investigates the hypothesis that interactive texting feedback is an effective approach to enhance learning by implementing a learning environment using an audience response system developed with learner mobiles phones and free website that manage and display learner responses.

3.4 Methods

It is relevant in this section to highlight the distinction between the methodology and methods of the investigation. Methodology focuses to the framework that structures the data collecting process and allows implementation of theory while methods refer to tools for data collection.

A range of methods were used in the research performed for this thesis that draws from both empirical and opinion based research methods. The fact that different research methods offer possible solutions for one another's problems and represent important critical perspectives in the nature of the research (Brewer, & Hunter, 1989) makes important the selection of the appropriate method(s).

There are three basic methods of collecting data. Post test scores were taken to determine learner performance, surveys and interview were also used in this study.

The survey research method was utilized to grab learner and lecturer perceptions of interactivity in the required experiments. The following three chapters describe the experiments developed to test the effects of interactivity in the context of the educational triangle. The methods in chapter 5 are triangulated on the search for validity and reliability. The scores obtained in different experiment for example are evaluated and compared against the opinion of the students and lecturers obtained after experiments are finished.

4 Chapter 4: Interactive Pedagogical Feedback

4.1 Introduction

This research aims to introduce evidence on how pedagogically-designed formative feedback enhances e-learning environments through the practical implementation of ISAQ within an e-Learning environment (Palacios and Evans, 2010).

It considers the impact that different levels of interactivity have on students' memory and understanding. In particular, it considers the use of pedagogical feedback in the form of interactive self-assessment questions (ISAQs) as a mechanism to promote learning when using an e-Learning system. A general feature of the two e-Learning system prototypes developed is the use of ISAQs to allow students to evaluate their grasp of the material with a view to revisiting it if they feel it to be necessary.

Two experiments were developed to complement each other and to determine if any contrasts can be made between them. Following the action research methodologies, any pitfalls detected and lesson learned in the initial experiment were taken into account in the second experiment and subsequent activities. Both case studies consider whether the incorporation of ISAQs has a measurable impact on learning, as indicated by their performance in tests applied. It is believed that the addition of feedback will enhance the learning experience significantly because it will contribute to the development of higher order cognitive skills.

The ISAQs seems to improve the capacity of the memories describes in the cognitive model of learning (Sweller, 1988) by relating previous knowledge stored in LTM to new information being processed in more limited and less permanent memories (see page 20) which is consistent with the theory of generative learning (see page 24). STM and WM hold much less information than LTM, which is considered a huge reservoir for data accumulation. Information to be transferred from STM to WM and then to a more permanent location (LTM) requires the student to have the ability to extend what has been learned in one context to new contexts (Byrnes, 1996). Transfer is different to remembering facts or procedures as it carries more complexity in learning. The distinction between the two is of great value because the effectiveness of a learning system is enhanced when a higher learning activity such as transfer is achieved (Bransford et al., 2000).

The experiments and systems developed in both case studies are underpinned by the dual coding theory (Paivio, 1986), the cognitive load theory (Chandler & Sweller, 1991), the

cognitive theory of multimedia learning (Mayer & Moreno, 1998b), and a constructivist learning approach (see 2.3 Cognitive Theory and 2.4 Constructivist Learning Theory).

Authorware and a Web-based multimedia e-Learning system were used to deliver the lessons. They are ideal tools to complement or replace traditional delivery. e-Learning can be defined as a combination of technology and the pedagogical approaches that are required when presenting and teaching a particular subject. e-Learning systems are key delivery components to communicate the educational message by using text and visual images. The content was designed according to Mayer's (2001) multimedia principles of learning (see 2.5.3 Multimedia Principles).

Interactivity and the interaction model (see 2.5.2 Interactive Multimedia) have been studied in similar contexts before, but without considering the pedagogical benefits of ISAQs.

Assessment has been used in these experiments as part of feedback mechanism (see page 37). Although assessment is generally considered to be a term that describes the process by which students are given tests and assigned grades. It is specifically a mechanism for providing either the teachers (summative assessment) or the learners (formative assessment) with vital information for improving their teaching/learning methodology and, if accompanied by feedback, to determine where mistakes have been made to reflect on them and to become more effective, self-assessing, self-directed learners (Angelo & Cross, 1993).

However, for the technology to work effectively it must embrace pedagogical methods to elicit performance and provide a well-guided element of interactivity. For ISAQs to be effective, they must be designed following well-established design principles (Mayer, 2001). When these principles are applied to the design of web learning content, it creates a playground in which deep learning can be fostered and where interactivity plays a crucial role in student education (Evans & Sabry, 2002). A basic characteristic of interactivity is learner control of the pace of a multimedia presentation; this is useful as students learn better when they are allowed to control the pace of presentation of a narrated animation (Mayer & Chandler, 2001). Research studies that allow students the freedom to interact and keep control of their own pace while learning in a computer-based simulation have shown evidence of higher performance (Mayer et al., 2003). Research on the effect of interactivity indicates that learner performance increases when they are exposed to a system that interactively reacts to their using ISAQs (Evans & Gibbons, 2007). In the two experiments

investigated, both consider the effect of adding ISAQs to a computer-based system already used by undergraduate students. Evans & Gibbons (2007) describe ISAQs as computer-based multiple-choice or text-entry questions that require input from the learner, and provide feedback based on that input. Each case involved two different types of ISAQs, designed to engage either memory (retention) or understanding (transfer) in an effort to determine which is the most effective. The studies look at retention and transfer, as considered by Mayer (2001), where retention is the power to recognise or recall past learning events (surface learning), while the transfer skill involves recognition but also interpretation and implementation of that knowledge in a different context (deep learning).

For each experiment, a computer-based system was designed to teach a lesson about how the circulatory system and the heart work, in resemblance to other experiments developed by Evans & Gibbons (2007) and Mayer (2001; 2003) on how a bicycle pump work. A non-interactive component was added as a control group for comparison reasons. The experiment looks to measure the (retention and transfer) learning effects taking place in the learners and provides a degree of the impact by measuring their scores. The hypothesis is that adding interactivity in the form of retention and transfer self-assessment questions to a computer-based system will increase learning. The prediction is made on the basis that ISAQs help the learner to identify misconceptions, create mental schemas that can be added to existing knowledge by providing constructive feedback, and integrate those schemas to form new skills or attitudes.

4.2 Experiment 1 (using Authorware)

4.2.1 Methodology

4.2.1.1 Participants

A group of 30 students aged between 21-30 from different ethnic backgrounds and of different genders. Recruitment was made via email notification on a first-come-first-served basis with a £5.00 reward for participating in the experiment. Participants were not informed of either the topic or the mechanism for knowledge acquisition. Students were randomly divided into three groups: 10 in the ISAQ group (with retention type interactive self-assessment questions), 10 in the ISAQ group (with transfer type interactive self-assessment questions), and 10 in the nISAQ group (non- interactive self-assessment questions). They share similar educational backgrounds and are all registered on MSc courses at Brunel University.

4.2.1.2 Materials and apparatus

Three interactive e-learning systems developed in Adobe Authorware 7 were designed to teach students how the heart and the circulatory system work. Their structure contains: a pre-test to determine the student's previous knowledge; the lesson explaining the heart main parts, the circulatory system function and how both relates to the process of pumping the blood in the human body; and a post-test to assess what the student learned. A computer laboratory with thirty computers running Microsoft Windows XP was the environment used to implement the study. The three content-identical systems consisted of two containing ISAQ components (retention and transfers interactive self-assessment questions), and one without them (the nISAQ - non-interactive self-assessment question). After a brief **introduction** giving instructions on the procedures used to operate the simulation, personal information was collected to keep general statistics about the groups. Materials and apparatus were consistent with previous experiment developed by Evans (2008).

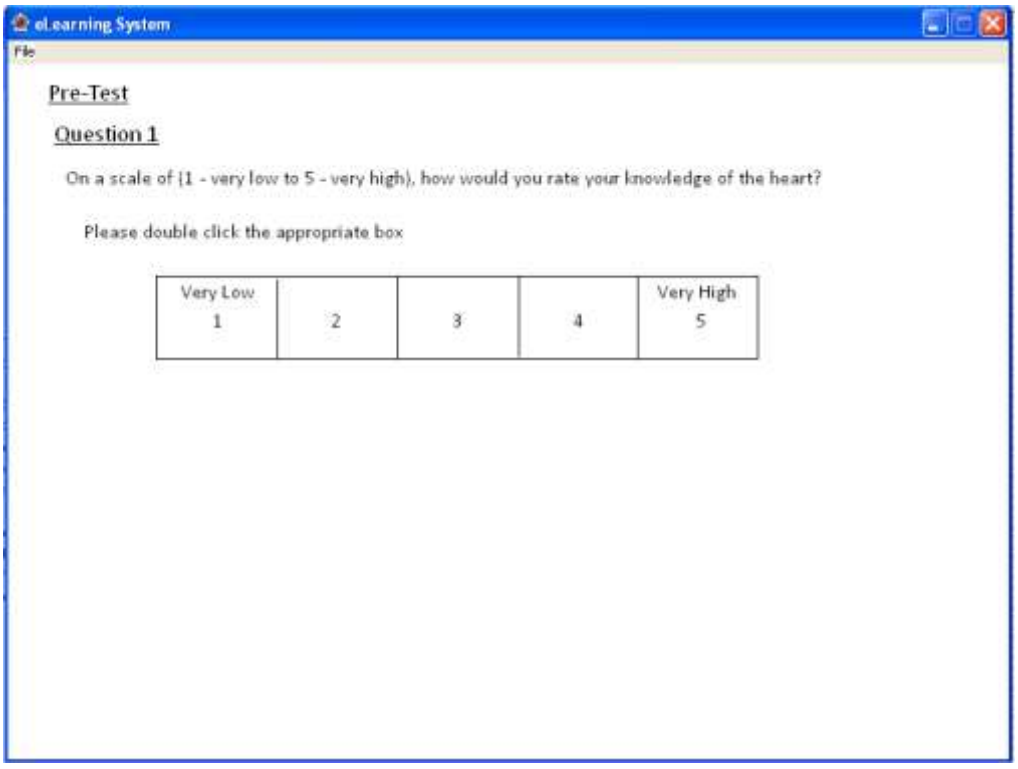


Figure 6: The Likert-scale pre-test question for each topic

The pre-test consisted of four questions designed to determine the students' prior knowledge of the heart and the circulatory system. Two Likert - scale type questions were asked for each topic and presented to the learners before starting the lesson, where the learner was required to rate his/her knowledge from very low (1) to very high (see Figure 6). Another two open-ended questions were given asking the students to type in an

explanation of how the heart and the circulatory system work (Figure 7). They allowed the learners to describe their previous knowledge about the subject.

Figure 7: The open-end type pre-test question

The lesson consisted of two components: one related to the circulatory system and another to the heart. They kept this order during the online presentation. The lesson on the circulatory system focused on the 16 stages taken by the heart to pump the blood around the body (Figure 8 and Figure 9). The lessons are presented in very interactive flash animation embedded in Authorware describing the stages below performed by the heart to pump blood around the body.

Atria systole
The left and right atrial muscles contract
The left and right atria decrease in volume
The pressure in the atria increases
The mitral and tricuspid valve open

Ventricular systole
The left and right ventricle muscles contract
The left and right ventricles decrease in volume
The pressure in v increases
The m and t valves close (muscle)
The semi lunar valves open
Blood flows into pulmonary artery and aorta

Atria and Ventricular diastole
Both muscles relax
Atria increases in volume
Pressure in v decreases
Semi lunar valves close
Blood flows into atria.

As can be seen in the previous list, these stages are related to the four cardiac cycles in the heart: the Atria and Ventricular systole (contraction) and the Atria and Ventricular diastole (dilatation). This corresponds to other studies performed by Evans' (2007) twelve-stage operation and Mayer and Gallini's (1990) ten-stage description, where the operation of a bicycle pump is used to study the effect of interactivity.

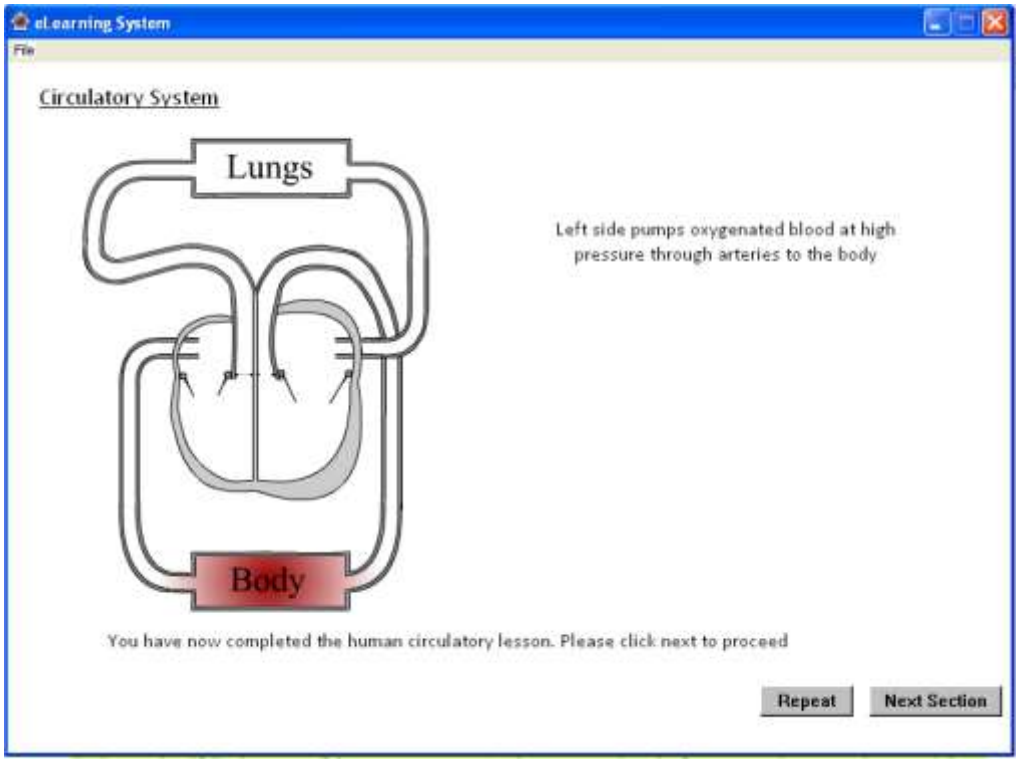


Figure 8: Screenshot of the animation representing the circulatory system.

The ISAQ mechanism located after the lesson content and before the post-test consisted of eight multiple-choice questions. The pedagogical design used to build them offers constructive feedback for both correct and incorrect answers. The structure of the questions offers distracters, which are the incorrect answers presented as a choice in a multiple-choice test. The selected item could be dragged and dropped into an answer box (Figure 10). Then, constructive feedback pops up with a related explanation; if incorrect,

the learner is allowed to repeat the question. The learner controls the pace by means of two buttons located at the lower right part of the page; these are identical throughout the entire system.

The ISAQ questions for the transfer and retention systems differ from one another for obvious reasons. The retention ISAQs provide questions pedagogically designed for retention, while the transfer ISAQs provides questions for deep learning. They both differ from the nISAQ system, as that does not include any feedback at all. Both types of ISAQ were consistent with the lesson content. In other words, the ISAQ information was a formative assessment of the lesson material.

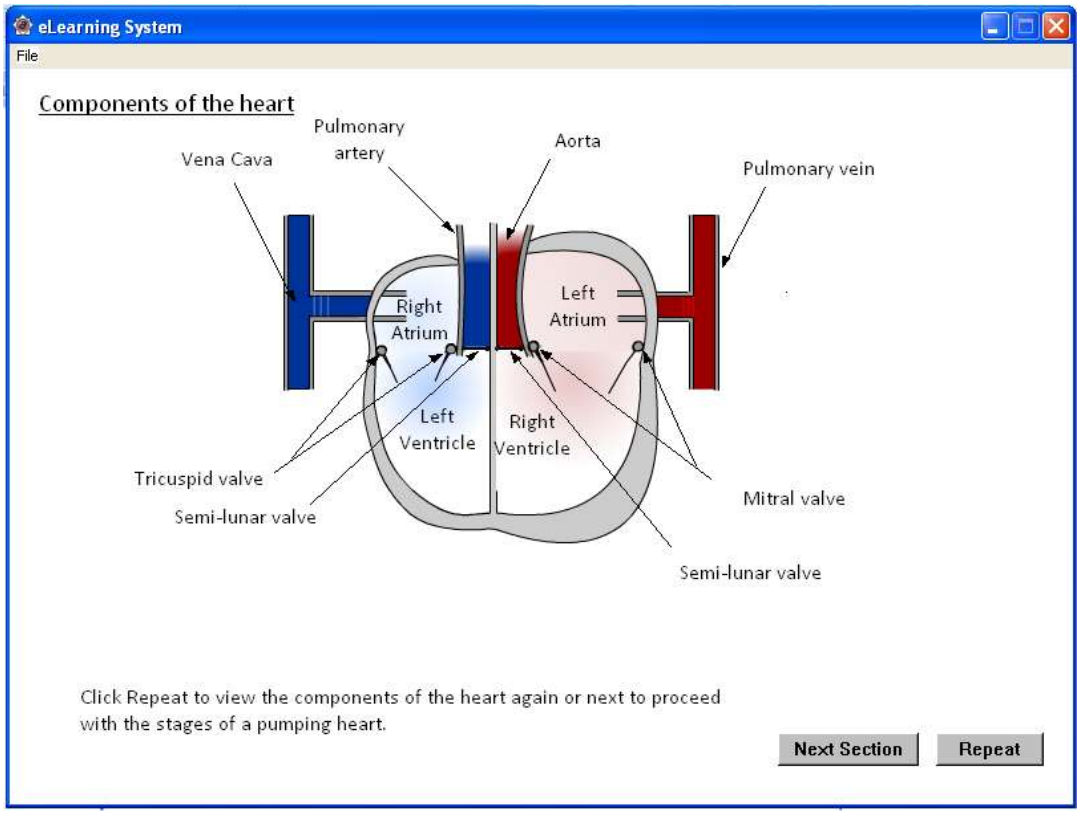


Figure 9: Screenshot of the animation describing parts of the heart

The next image (Figure 10) shows the initial interactive self-assessment question for the ISAQ systems. Dragging the right answer into the box triggers the feedback mechanism that allows the user to proceed to the next question.

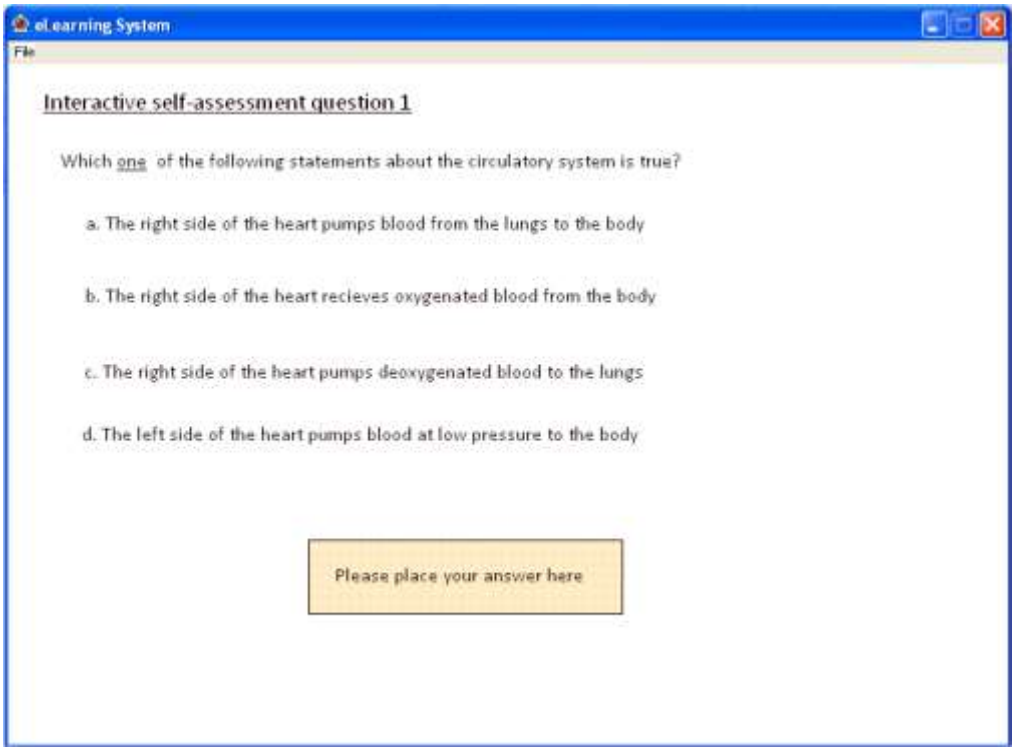


Figure 10: Interactive self-assessment question example.

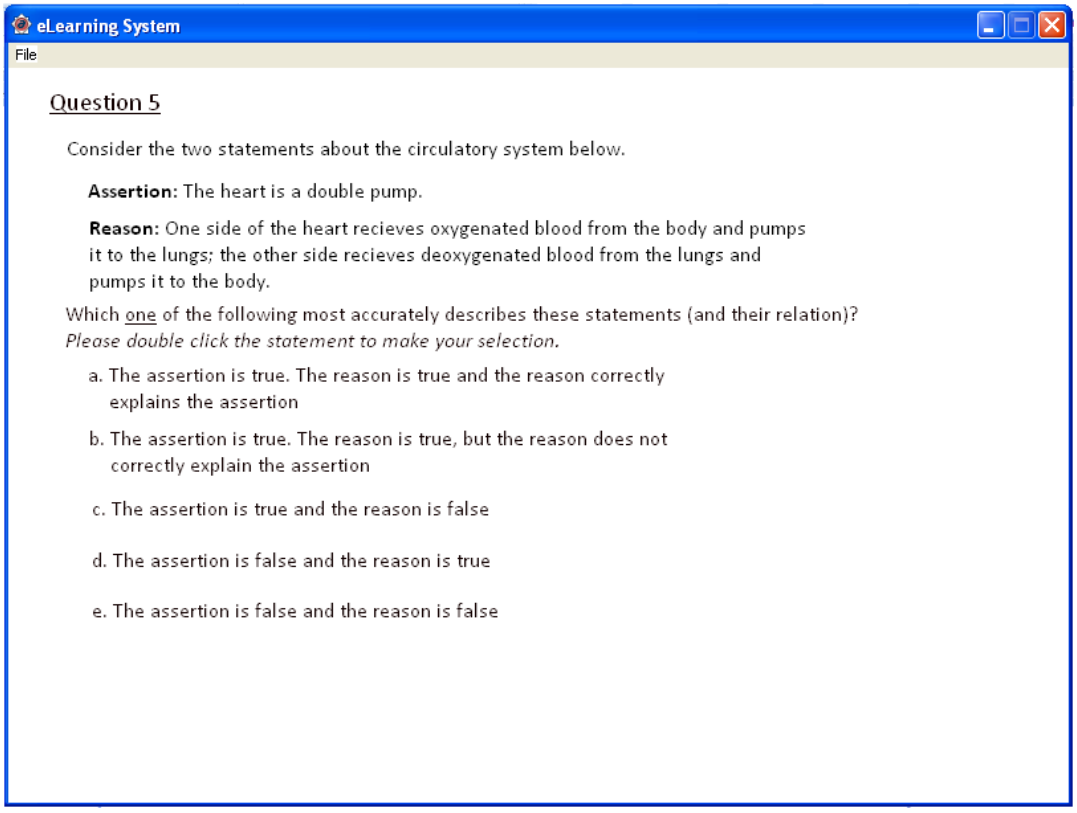


Figure 11: Example of a Post-test question

The post-test (Figure 11) consisted of a summative assessment to determine the final score of the student. It measured how much the learner had retained or understood the lesson. It is located in the final part of the three systems and consisted of five retention questions and three transfer questions.

4.2.2 Results

The pre-test indicates that all three groups had low prior knowledge. It shows that all three groups possessed general prior knowledge about the heart function, as can be seen from a mean score of 45% (SD=0.759). Majority (85%) of students rated their knowledge of the "heart" higher than their knowledge of the "circulatory system". They rated their knowledge of the heart as (3) and of the circulatory system as (2) "little knowledge" in the Likert scale. The mean score average was 1.80 (SD.786) from a total of 25 possible marks.

System n=10	**Post test scores for**			
	Retention questions		**Transfer questions**	
	M (OUT OF 5)	SD	M (OUT OF 3)	SD
rISAQ	1.87	.98	.37	.51
tISAQ	1.68	1.27	.32	.49
nISAQ	1.32	.57	.25	.42

Table 1: Post-test scores (n) =10 for each group M=mean SD=Standard deviation

For the post test, the means and standard deviations for the retention, transfer and control condition are given in

Table 1**.** The evidence suggests that students in the rISAQ (retention) system had the best (M=1.87) performance when compared to the tISAQ (transfer) system (M=1.68) and the nISAQ (control –No ISAQs) system (M=1.32) in terms of overall scores.

The findings conclude that the use of ISAQs definitely enhances the learning experience. These results are consistent with the interactivity principle, which suggests that interactive

self-assessment should increase learning by actively engaging students in the learning process.

A set of interviews were designed in order to collect the students' feedback. It was deducted from the interviews that participants were positive about the help obtained from the navigation mechanism used to control the pace and interaction in the systems. This is consistent with Mayer & Anderson's (1992) experiments that found a negative effect for the absence of pacing control on test scores, leading to cognitive overload.

Students complained about the lesson structure and the clarity of the lesson, but rated the overall experience as positive. All students interviewed indicated that the overall experience exceeded their expectations. They also felt they had learned using the systems.

4.3 Experiment 2(using Forceten)

4.3.1 Methodology

4.3.1.1 Participants

The participants are a group of 25 students aged between 18 and 30 years old from different ethnic backgrounds. The gender of the population is balanced, with 52% female and 48% male. Recruitment was performed in a Management of Information with Technology course. Participants were not informed about the subject of the topic or the mechanism for knowledge acquisition. Students were randomly divided into three groups: 8 in the ISAQ group (with retention type interactive self-assessment questions), 9 in the ISAQ group (with transfer type interactive self-assessment questions), and 8 in the nISAQ group (non-interactive self-assessment questions). They share similar educational backgrounds and are registered at Brunel University.

4.3.1.2 Materials and apparatus

Three interactive e-learning systems were designed to teach students how the heart and the circulatory system work. The interactive e-learning systems were constructed, and delivered using a browser-based proprietary Learning Content Management System (LCMS) called ForceTen. The technology employed in this virtual learning environment is object technology, as shown in Figure 4. Materials and apparatus are consistent with previous experiment developed by Evans (Evans, 2008) as indicated in experiment one.

Their structure contains a pre-test to determine student previous knowledge; the lesson explaining the heart main parts, the circulatory system function and how these relate to the process of pumping the blood in the human body; and a post-test to assess what the student learned. A computer laboratory with thirty computers running Microsoft Windows XP was the environment used to implement the study. The three content-identical systems consisted of two containing ISAQ components (retention and transfer interactive self-assessment questions), and one without (the nISAQ - non-interactive self-assessment question).

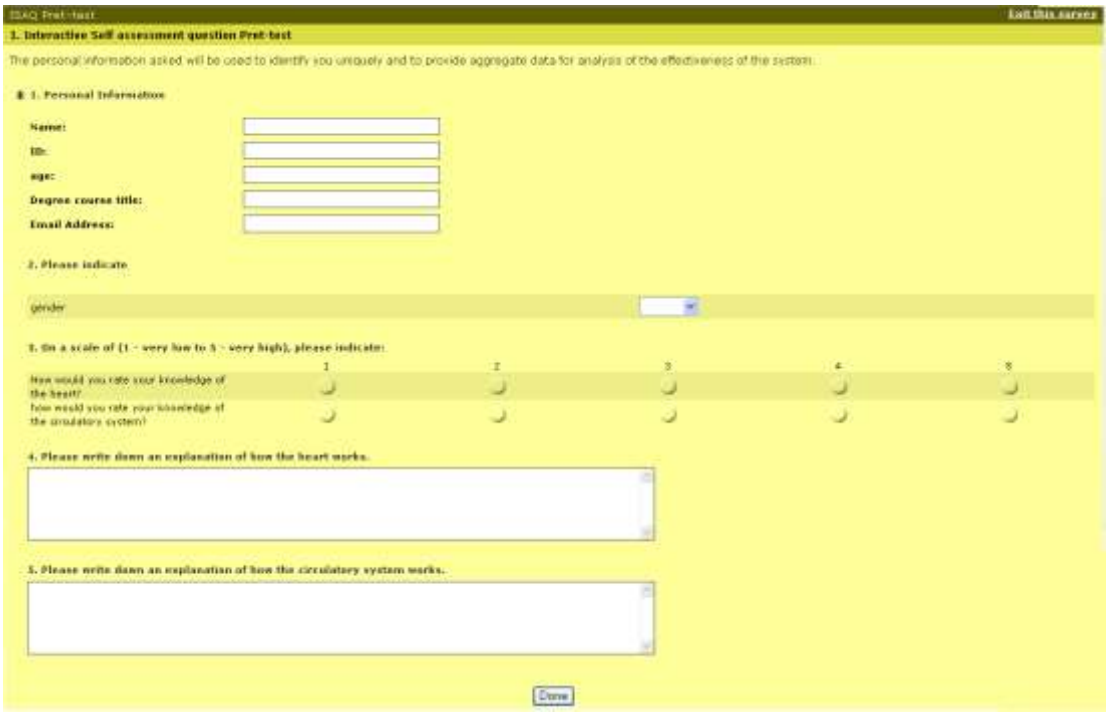


Figure 12: Experiment 2 pre-test questions.

The pre-test consisted of four questions. The two initial questions were designed to collect demographic information. Then the next question is composed of two Likert scale-type questions created to rate the student's knowledge from very low (1) to very high (5) of the heart and the circulatory system. The final two questions were two open-end questions asking the user to type in an explanation of how the heart and the circulatory system work in order to check their prior knowledge (see Figure 12). This allowed the learners to describe their previous knowledge of the subject. Marking was performed on all 4 questions in base 4.

The lesson consisted of two components: one related to the circulatory system and another to the heart. They kept this order during the online presentation. The section on the

circulatory system focused on the 16 stages taken by the heart to pump the blood around the body (See Figure 13). The second element of the lesson described the whole cycle followed by the heart to pump the blood around the body (See Figure 14).

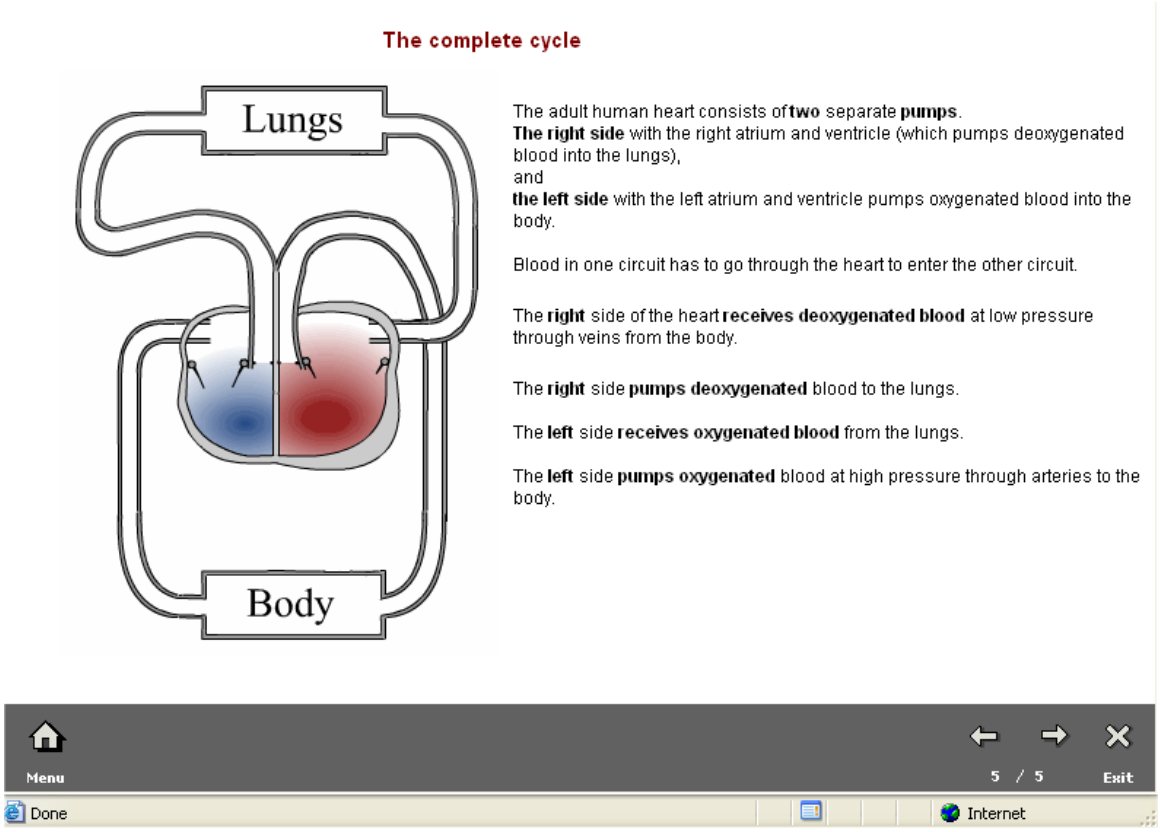


Figure 13: Screenshot of the animation with main functions in the circulatory systems.

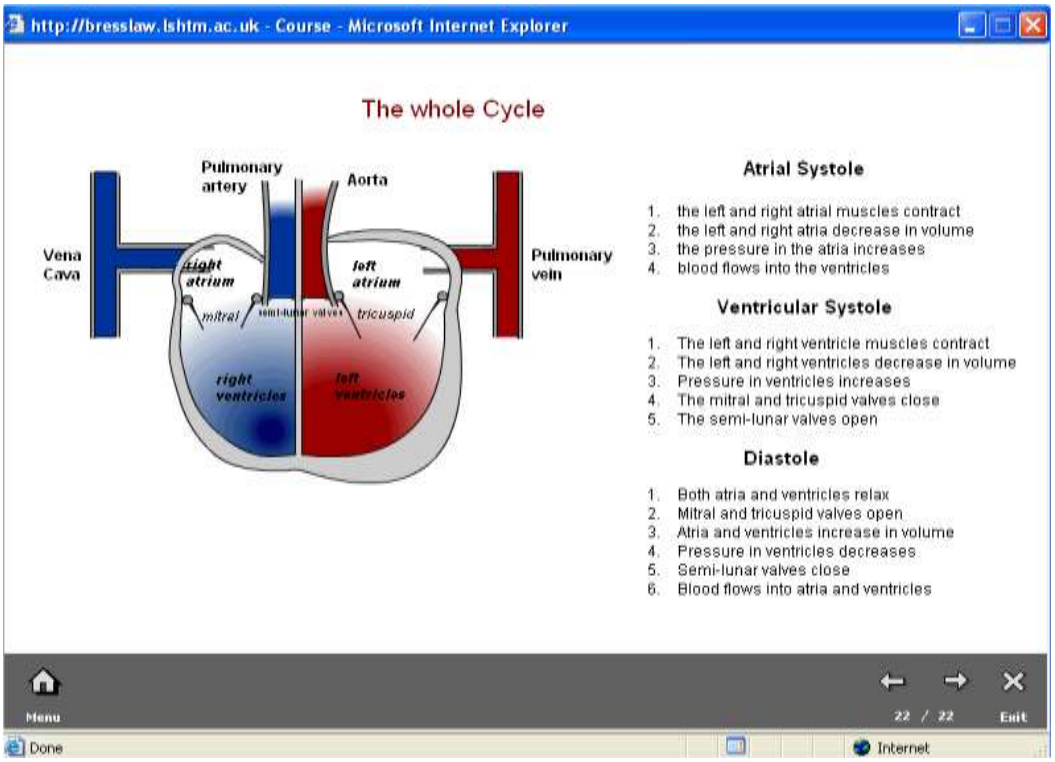


Figure 14: Screenshot of the animation describing the whole cycle in the heart

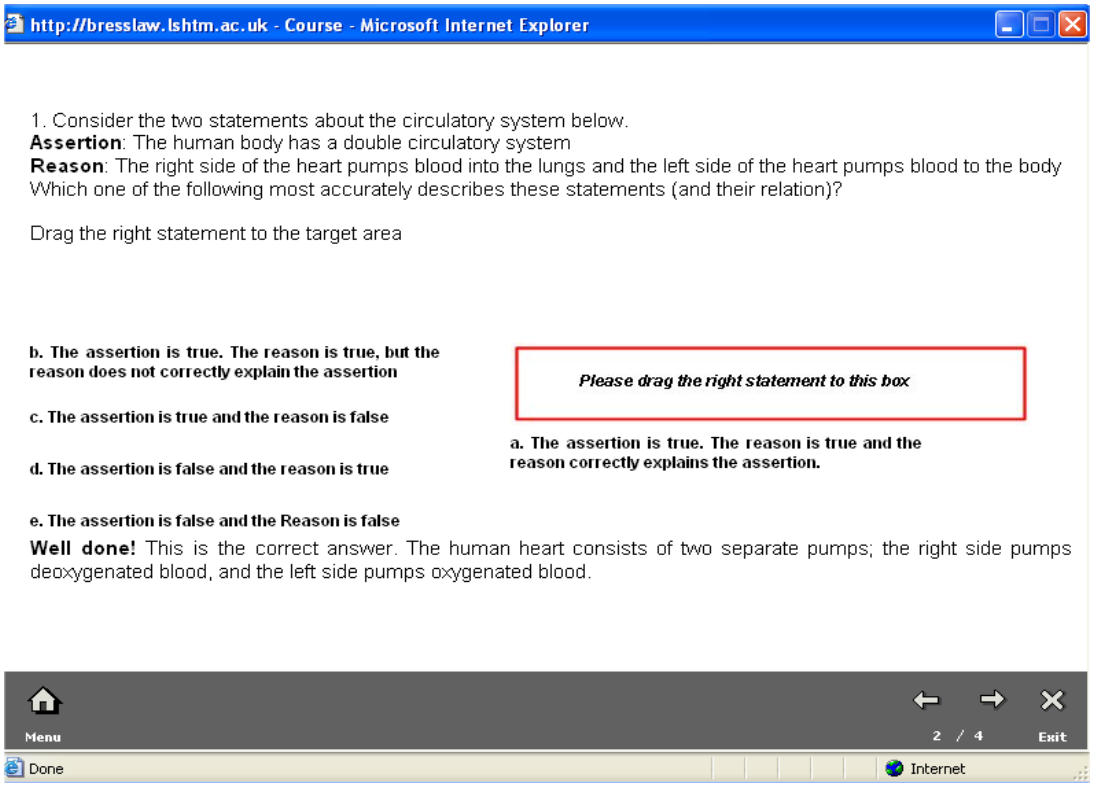


Figure 15: The Screenshot shows an ISAQ for the transfer system.

The ISAQ mechanism located after the lesson content and before the post-test consisted of 4 multiple choice questions. Figure 15 is a screenshot showing a transfer ISAQ system. The

Screenshot shows that dragging the right answer into the box triggers the feedback mechanism that allows the user to proceed. Figure 16 is a screenshot of the retention ISAQ.

The pedagogical design used to build the ISAQs considers constructive feedback for both correct and incorrect answers. The structure of the questions uses distracters, which are incorrect answers presented as a choice in a multiple-choice test. The selected item could be dragged and dropped into an answer box, then constructive feedback would pop up with an explanation; if incorrect, the learner is allowed to repeat the question.

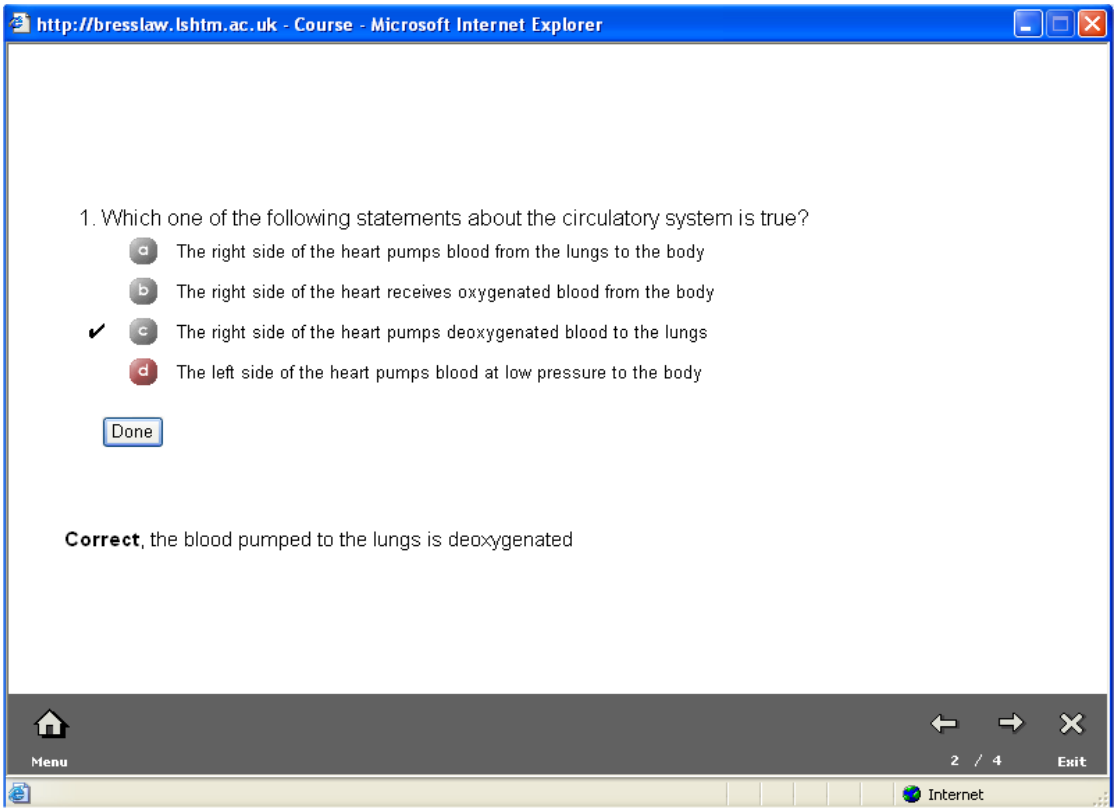


Figure 16: Screenshot showing an ISAQ for the retention system.

The post-test (see Figure 17 and 18) consisted of a summative assessment that determined the final score of the student. It measured how much the learner retained or understood about the lesson. It is located in the final part of all the three systems and consisted of five retention questions and three transfer questions.

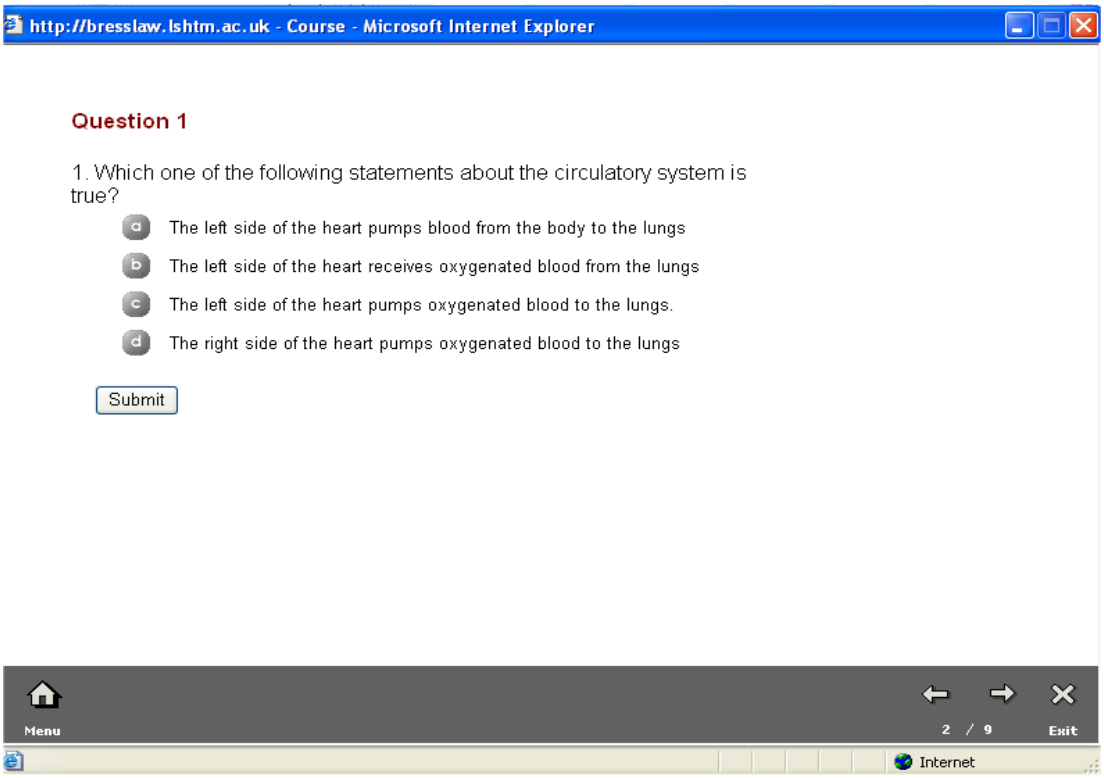


Figure 17: Screenshot showing questions to measure retention in the post-test.

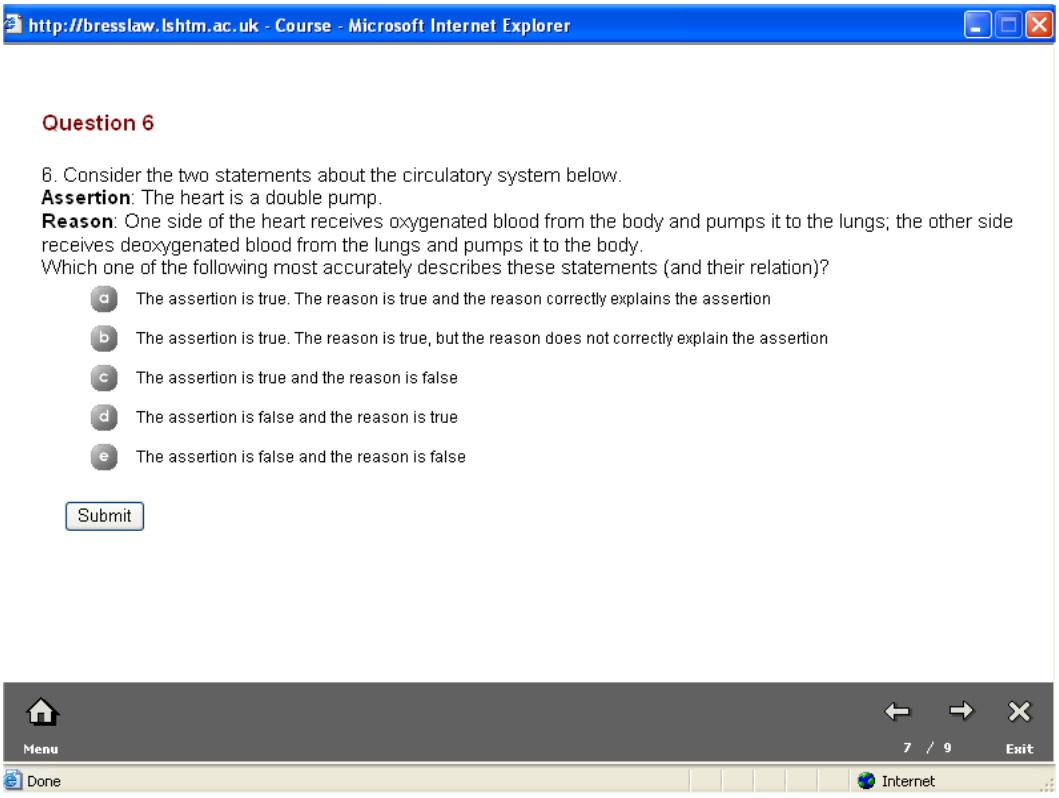


Figure 18: Screenshot showing a question to measure transfer in the post-test.

4.3.2 Results

The pre-test indicates that all three groups had low prior knowledge. It revealed that all three groups believed their knowledge of the heart to be greater than the post-test revealed. The circulatory questions had a mean of 2.64 (sd=.907); and the circulatory system a mean of 2.40 (sd=0.957).

The best post-test score within the three system was 3.1 (SD .59) out of a maximum score of 4 for the transfer questions. The means and standard deviations for the retention and transfer tests are given in Table 1.

System Type	**Post test scores for**			
	Retention questions		**Transfer questions**	
	M (OUT OF 5)	SD	**M**(OUT OF 3)	SD
rISAQ n=8	2.6	.44	1.33	1
tISAQ n=9	3.1*	.59	1.88	.38
nISAQ n=8	1.7	1.20	0.88	.44

Table 2: Post-test scores * p < .05, M=mean SD=Standard deviation

There is significant difference in the t test scores, $F(2,22) = 6.86$, $P < .05$. A one-way ANOVA with a Turkey HSD post hoc test for all pairwise comparisons reveals a significant difference between the tISAQ and nISAQ retention score.

4.4 Discussion

The objective of this experiment was to determine to what extent, if any, learning is increased when using pedagogical feedback in the form of ISAQs within multimedia e-learning systems.

The existing of a learning effect and its two types (retention or transfer) were investigated. Retention relates to recall from memory and transfer is related to deep learning. The results

definitely indicate that a learning effect has been detected in both experiments # 1 and # 2 that is consistent with the principle of interactivity.

Furthermore, in the experiment #1 the results indicate that the two groups with ISAQs (retention and transfer conditions) got a better performance than the control group in terms of overall scores. When the two groups embedded with the ISAQs are compared, the group with the retention condition perform better than the group with the transfer condition. The experiment actually indicates that ISAQs actually increase memory.

In the experiment #2, the results point out that the two groups with ISAQs (retention and transfer conditions) again got a better performance than the control group. But when the two groups embedded with the ISAQs are compared, the group with the transfer condition perform better than the group with the retention condition. These may be interpreted as an indication that the use of ISAQs promotes deep learning. The effects of interactivity in this experiment are consistent with the generative theory of learning (Wittrock, 1974) because the ISAQs encouraged students to engage in appropriate cognitive processing (see 2.3).

However, the results at the level of the retention and transfer conditions seem to be contradictory. These results may be explained by the differences in LCMS that were used to deliver the lesson (see 7.1).

5 Chapter 5: Interactive Audio Feedback

5.1 Introduction

The production of feedback on submitted work is widely regarded as an important formative part of learning in higher education institutions (Gikandi, et al, 2011). In the past producing feedback has meant creating handwritten comments on students' scripts or on a separate sheet. Many tutors have progressed from handwritten to providing typewritten (word-processed) comments in an effective way.

For most people, speaking is a much quicker form of communication than typing (Gould, 1982). People experimenting on writing and speaking letters under various conditions demonstrate that speaking required only 35-75% of the time that writing did. The reason perhaps is founded on the fact that speaking as an innate part of human behaviour is more universal than writing which was invented around 5000 years ago (Cleland, 2006).

In addition, the sounds produced when we speak include structures classified as paralinguistic e.g. prosody and rhythm and as linguistic e.g. phonology, syntax (Shankar, 2006). The linguistics and syntactic structures can be easily transported to written expression. On the contrary, those paralinguistic structures based in music and rhythms are lost in translation.

The possibility for people with low computer background to interact with technology have now made relatively easy to record and return audio feedback as an alternative to typewritten feedback. It will produce the immediate benefit of reducing the time to create the feedback and complement the feedback with some paralinguistic structural components, which are not present in writing. The present research seeks to establish whether the use of such interactive technology can enhance the feedback process for both tutors and learners.

Whilst handwritten or typewritten feedback seems to be the norm, there is evidence to suggest that spoken feedback can be much more easily generated. Furthermore, developmental studies indicate that written skills develop much later than oral skills and take more cognitive processing to exercise (Grabowski, 2010). This cognitive overhead may partially explain why most people find it quicker to speak than to write. This suggests that one mechanism for reducing the heavy load for creating feedback might be to use the spoken rather than written modality.

Several studies have considered the relative speeds of speaking and writing. In early informal studies Gould (1978) suggested that people could handwrite memorized material at about 40 words per minute (wpm) but speak or read it aloud at around 200 wpm. Card et al. (1983) reports that an experienced typist can reach approx. 80 wpm. Of course the process of generating feedback is not simply a matter of speaking or writing. It also involves the critical evaluation of students' work and the synthesis of sentences. Audio feedback has the promise to be quicker than entering text into a word processor and is often regarded as richer and more personalized by students.

The study involved determining whether the speed enhancements of speaking rather than typing are carried over to the process of creating feedback. Therefore, the investigation sought to test the hypothesis (H_1) that suggests creating feedback in audio form is quicker than creating feedback in typewritten form.

The investigation also analysed if the phonetic benefits of audio over typewritten feedback are carried over to the learner. The study thus also sought to test the hypothesis (H_2) that feedback received in audio form is better quality than feedback received in written form.

In order to test these hypotheses several experiments were designed. The first was a pilot study to test the time-reduction hypothesis H_1. On the basis of this outcome, three studies were designed to corroborate the time-reduction hypothesis H_1 (under slightly different conditions). Students' opinions were collected to test the quality-enhancement hypothesis H_2. All these experiments are described in the next paragraphs of this section.

5.2 Pilot Experiment (Experiment One)

5.2.1 Method

5.2.1.1 Participants

The subject was a male Senior Lecturer in Emotional Labour at Brunel University in West London, UK, using assignment essays submitted by undergraduate students taking a BSc in Business and Management.

5.2.1.2 Materials and apparatus

Audio feedback (speech) was recorded using an Olympus WS-310M handheld digital voice recorder as a WMA file. Text feedback was recorded (typed) using Microsoft Word 2007, a Viglen PC and a 17" TFT display. It was stored as a Windows .docx file.

The following questionnaire was designed to capture the opinion of the lecturer and identify the effectiveness of audio feedback in the final assignment. The questionnaire structure contains ten questions that focus on determining the lecturer's previous experience, expectations, possible outcomes and attitudes toward using audio feedback and/or written feedback.

AUDIO VERSUS TEXT FEEDBACK **Lecturer questionnaire**
1. Describe the main reason to consider audio versus text feedback.
2. What were your expectations about the possible outcome?
3. Do you feel the expected outcome was achieved and why?
4. Did you expect any drawbacks, explain?
5. Do you think, if any, the drawback(s) were as you expected?
6. Do you think audio is more successful than text feedback?
7. Were there any problem(s) that you didn't expect?
8. Would you do anything different if you do it again?
9. Would you use audio feedback for real in the future?
10. Do you have any additional comment or suggestion?

5.2.1.3 Procedure

Two one-hour marking slots were assigned for conducting the experiment. The submitted assignments were randomly divided into two groups. The scripts had all been read on a previous occasion and hand-written notes had been made on the scripts, but no feedback had been formally recorded or created.

The first group of scripts was used for the audio feedback condition (A). During the first allotted hour, each script was re-read and audio feedback was recorded. Thinking and

reading time formed part of the measure in an effort to capture as close as possible the real world conditions of a lecturer generating and recording feedback. The process was conducted for each script in the pile until one hour had elapsed. The number of complete feedback recordings was then noted. For the text feedback condition (T), the second batch of scripts was used. During the second allotted hour, as in the first, each script was re-read and feedback was recorded, this time in typed form. The number of complete feedback recordings was again noted. Subsequent to the feedback recording, the tutor was interviewed using the previous questionnaire.

5.2.2 Results

The number of scripts processed with audio feedback in the one-hour slot was eight and the number of scripts processed with text feedback in one hour was four.

The completed Lecturer questionnaire is attached below.

AUDIO VERSUS TEXT FEEDBACK

Lecturer questionnaire

11. Describe the main reason to consider audio versus text feedback

I feel more comfortable working with audio than with text feedback

12. What were your expectations about the possible outcome?

Completely positive. ….I think that will reduce and facilitate my job

13. Do you feel the expected outcome was achieved and why?

Yes….because I could produce more student feedbacks in a shorter amount of time

14. Did you expect any drawbacks, explain?

Yes….the transformation of the files to MP3 files and the whole process until they are inserted in the system ready for the student to hear it. It will be cumbersome.

15. Do you think, if any, the drawback(s) were as you expected?

No ….because the Dictaphone facilitated the recording task and he managed to upload all 8 MP3 files.

16. Do you think audio is more successful than text feedback?

Yes, because it helped me to save time

17. Were there any problem(s) that you didn't expect?

After listening to the first he noticed quite a few 'ums' and 'ers' that he expect to avoid with more practice.

18. Would you do anything different if you do it again?

Not many things….the practice will help to improve the procedure and I feel that I can do it faster

19. Would you use audio feedback for real in the future?

Yes, absolutely

20. Do you have any additional comment or suggestion

I must say that I felt very at ease giving audio feedback. It felt very unconstrained, like free-wheeling down a hill with plenty of elbow room either side. After an hour I did not experience any flagging of energy and certainly no sudden sag in enthusiasm, which I admit to getting when marking conventionally…

5.2.3 Discussion

The experiment suggests that audio feedback doubles the number of scripts that can be processed in an hour (and, equivalently, reduces the time taken to process text feedback by 50%). The lecturer comments emphasised the usefulness of recording feedback as indicated in the questionnaire. This provides initial support for the time-reduction hypothesis H_1.

When interviewed, the tutor in this pilot experiment reported that he felt more comfortable working with audio than text feedback. He particularly appreciated the increase in the recording rate facilitated by audio. He reported that he had erroneously expected the creation and uploading of MP3 files to be much more complex than it turned out to be. The only reported drawback was the number of "ums" and "ers" that were recorded; but he expected this to decrease with practice. He added, "It felt very unconstrained, like free-wheeling down a hill with plenty of elbow room either side. After an hour I did not experience any flagging of energy and certainly no sudden sag in enthusiasm, which I admit to getting when marking conventionally".

In order to subject the findings to statistical analysis, the experiment was repeated, this time recording the time taken for each script so that a mean could be established and subjected to significance testing.

5.3 Experiment Two

5.3.1 Method

5.3.1.1 Participants

The subject was a male Senior Lecturer in Marketing at Brunel University in West London, UK, using dissertation proposals submitted by eight postgraduate students taking an MSc in Marketing. The tutor's mean typing speed was 24 words per minute assessed using the average of two tests.

5.3.1.2 Materials and apparatus

Audio feedback (speech) was recorded using an Olympus WS-310M handheld digital voice recorder as a WMA file. Text feedback was recorded (typed) using Microsoft Word 2007, a Viglen PC and a 17" TFT display. It was stored as a Windows .docx file. Typing speed was assessed using Mavis Beacon Teaches Typing™.

5.3.1.3 Procedure

A random sample of eight MSc dissertation proposals was divided into two groups. The scripts had all been read on a previous occasion but no feedback had been recorded.

The first group of four scripts was used for the text feedback condition (T). For each script, the start time was recorded at the point where typing began and the end time at the point where typing was completed to the satisfaction of the tutor. The reading time prior to commencement of typing did not form part of the measure. However, reading time during the construction of feedback was included.

For the audio feedback condition (A), again the start time was recorded at the point the recorder was first switched on, and the end time at the point where recording was completed to the satisfaction of the tutor. The tutor was permitted to pause the recording at any time to re-read the script or collect their thoughts. This thinking/reading time was included in the overall time. Significant differences between the times were assessed using a one-tailed Student's *t*-test. All statistical tests were performed with an alpha (α) value (significance threshold) of .05. Subsequent to the feedback recording, the tutor and A condition students were interviewed.

5.3.2 Results

In Experiment Two, the average time taken to produce the text feedback was 8:26.5 min and to produce the audio feedback was 5:07.5 min (see Table 3). Thus the use of audio reduced the overall feedback time by 39%. The mean difference of -199 s (3:19 min) is statistically reliable, unpaired Student's *t*-test, $t(6) = -2.854$, one-tailed, $p < .05$, with an effect size of 2.02 (small).

Group	**Recording Time/s**	
	M	***SD***
T (n-4)	506.50	99.07
A (n=4)	307.50*	98.12

**p < .05; ES = 2.02*

Table 3: Experiment 2 Feedback Recording Times (in seconds)

5.3.3 Discussion

This study (Experiment Two) confirms the time-reduction hypothesis H_1 that audio recording can decrease the time it takes to create feedback by 39%.

The tutor reported that he expected audio feedback to be beneficial because he believed students preferred it, and he thought it would be a "richer" medium. However the experience led him to think that there was actually no significant time saving (contrary to the reality; the findings were obviously unknown to him at the time). He also reported that in trying to balance the quality in the two modes he believed that the audio did not end up being richer. Despite these reservations he preferred recording audio feedback because the spoken word "is more natural" and "a lot of [wasted] effort is spent in typing the letters".

The students' perceptions did not match those of the tutor. They praised the audio feedback for feeling "extremely personal" and "less abstract than written text".

The students also suggested that audio "helped the relationship by reinforcing the professional bond between tutor and tutee". One interviewee commented that because he could "hear rustling paper, he knew the tutor had taken time to read through it".

Interviewees also commented that tonal feedback on "how good it is or not" made him feel the "information was richer" than written text. Another commented "I prefer audio because

you get the additional layers of feedback in the form of tonal suggestion". One added, "if it is more time-efficient than written feedback it is definitely worth it because it is a richer standard of feedback".

One related new effect that emerged from interviews was authenticity. One interviewee suggested that audio feedback was "more reliable because you can hear them flicking through your essay in the background", and "more rewarding and enjoyable because the tutor is perceived to have put in the effort". Another commented that the audio "reinforced that they had actually read through it". These learner effects all support the quality-enhancement hypothesis H_2.

5.4 Experiment Three

Following the initial successful experiments providing audio feedback for replacing text feedback, a follow up study to support the hypothesis H2 regarding quality enhancement was developed for the MBA course. Audio as summative feedback was provided to inform on students' final assessment.

5.4.1 Method

5.4.1.1 Participants

The subject was a male Senior Lecturer in Emotional Labour at Brunel University in West London, UK, using final assignment essays submitted by postgraduate students taking the module "Managing for the future" for their Master in Business and Administration.

5.4.1.2 Materials and apparatus

Audio feedback (speech) was recorded as a MP3 file using audio software named Audacity installed on a Viglen PC using windows XP. Audacity® is an open source software for recording and editing sounds.

Text feedback was recorded (typed) using Microsoft Word 2007, a Viglen PC and a 17" TFT display. It was stored as a Windows .docx file.

In addition, a questionnaire (Figure 19) was designed to capture the opinion of the students and identify the effectiveness of audio feedback in the final assignment.

The questionnaire structure encompasses three main areas. An initial area that requires demographic information such as date of birth, native language, age, gender and country of origin for example: Date, Module, Native Language, Age, Gender, Country of Origin.

A second area in the questionnaire focuses on previous experience, devices used and the technical difficulties faced and initial attitude before or at the moment the students have received the feedback. e.g.

5. Which form of feedback would you prefer (tick one only)?

Audio ____
Written ____

Then, a final area that evaluates student opinion after feedback has been received. A Likert scale is introduced in these question areas to evaluate accessibility of the feedback, if it is considered a valuable contribution, a contribution to learning, and the students' expectations about use of audio feedback in other courses, or coursework for example.

"I found the use of audio feedback contributed to my learning"
a. Strongly Disagree ____
b. Disagree ____
c. Neutral ____
d. Agree ____
e. Strongly agree ____

It was designed to determine the experience and the tools employed for listening to the feedback. The questionnaire also investigates accessibility to the audio file, how valuable the students consider the audio feedback, contribution to the students learning, and interest in using the audio feedback in the future in other courses.

MB5526 Managing for the Future
Audio Feedback for final assignment Survey

Luis Palacios (cbpglpp@brunel.ac.uk)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date:		Native Language	
Module		Gender	
Age		Country of origin	

1. Have you experienced audio or video feedback in the past?
   Audio ____
   Video ____
   Both ____
   No ____

2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____

3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No____
   If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written ____

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6. "I found the use of audio feedback accessible"					
7. "I found the use of audio feedback a valuable contribution					
8. "I would like to see continued use of audio feedback for my coursework"					
9. "I found the use of audio feedback contributed to my learning "					
10. "I would like to see audio feedback used for other courses at Brunel"					

Figure 19: Experiment 3- Questionnaire to capture student opinion

5.4.1.3 Procedure

Audio feedback was produced following the same procedure as indicated in the experiment one. Then, it was delivered to a group of regular MBA students as interactive feedback for their final assignments by dropping the audio feedback file and the questionnaire into the student's u-Link account (u-Link is the Blackboard learning content management system personalised for Brunel University). The audio file feedback is in MP3 format. The students listen to the audio file, complete the questionnaire and send it back by dropping the completed questionnaire in the lecturer's u-Link account.

5.4.2 Results

The results from the students' surveys are described as follows.

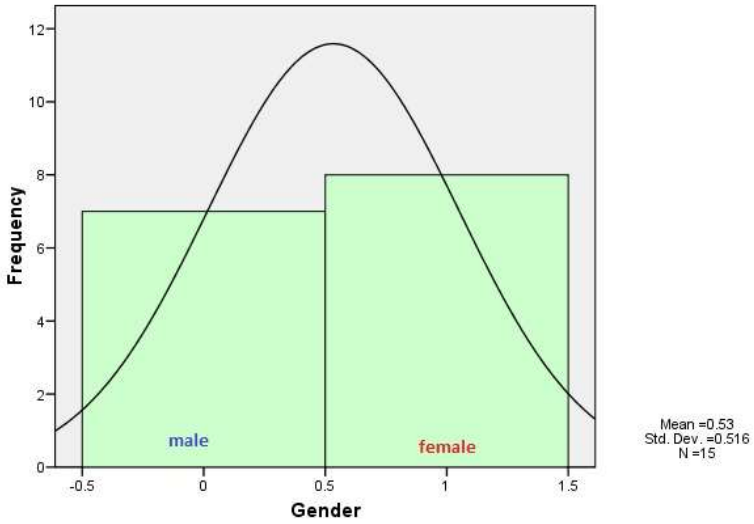


Figure 20: Gender distribution

The sample (N = 15) of postgraduate students was composed of 7 (46.7%) males and 8 (53.3%) females.

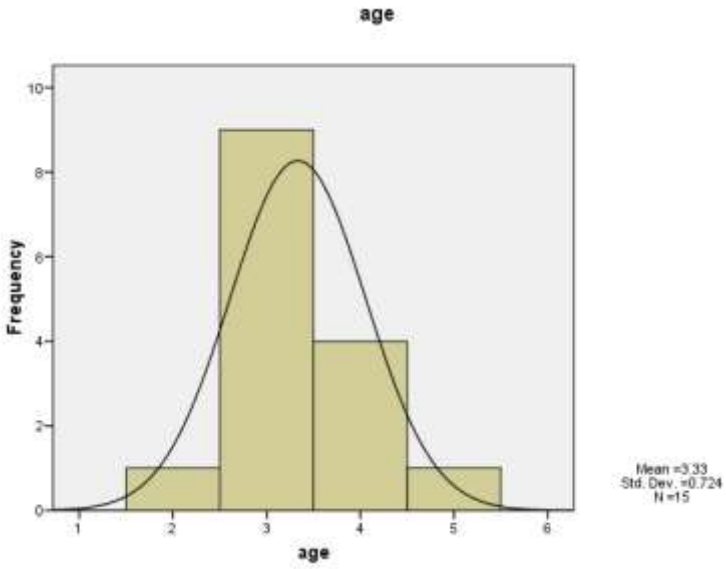


Figure 21: Age distribution

Five groups encompass the sample age (Figure 21): from 20 years old or below; between 21 and 25 years old; between 26 and 30 years old; between 31 and 36 years old, and from 36 years old or above. Of the total sample, in the age group 2 there was 1 (6.7%) respondent; in the age group 3 there were 9 (60%) respondents; in the age group 4 there were 4 (26.7%) respondents, and in the age group 5 there was 1 (6.7%) respondent.

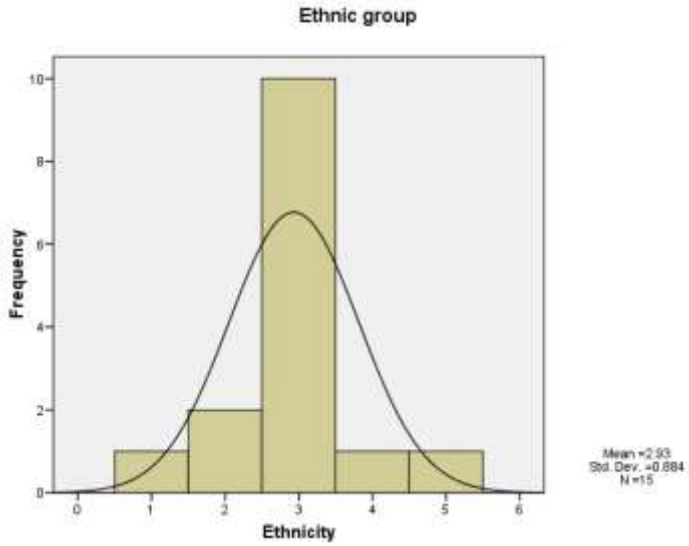


Figure 22: Ethnic groups

The ethnicity groups of the respondents are represented by (Figure 22) 1 (6.7%) was White (group 1), 2 (13.3%) were Mixed (group 2), 10 (66.7%) were Asian (group 3), 1 (6.7%) was Black (group 4), and 1 (6.7%) was Chinese (group 5). This classification was also used for classifying ethnicity in the 2001 UK Census.

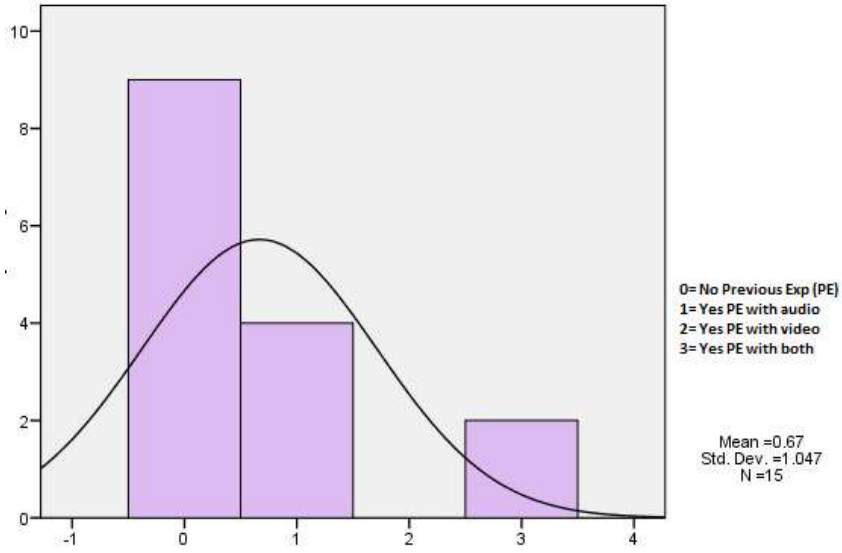


Figure 23: Question (1): Have you experienced audio or video feedback in the past?

The respondents who answered the question (1): Have you experienced audio or video feedback in the past? **(**Figure 24**)** 9 (60%) reported no previous experience with audio or video feedback in the past; 4 (26.7%) reported having experience with audio feedback in the past and 2 (13.3%) reported having experience with both video and audio feedback. Nobody reported having only video feedback experience.

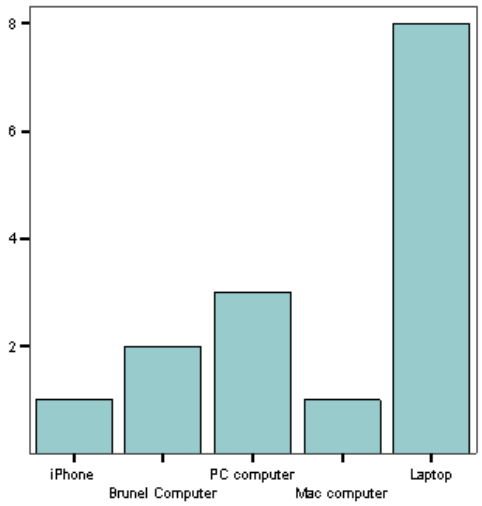


Figure 24: Question (2): What device you use to listen to your audio feedback on?

Regarding the respondents who answered the question (2): What device you use to listen to your audio feedback on? (Figure 24) 1 (6.7%) reported having used the iPhone to listen to the audio feedback; 2 (13.3%) reported having used the Brunel computers to listen to the audio feedback; 3 (20%) reported having used PC computers out of Brunel University to listen to the audio feedback; 1 (6.7%) reported having used the Mac computers to listen to the audio feedback; and 8 (53.3%) reported having used the Laptop computers to listen to the audio feedback.

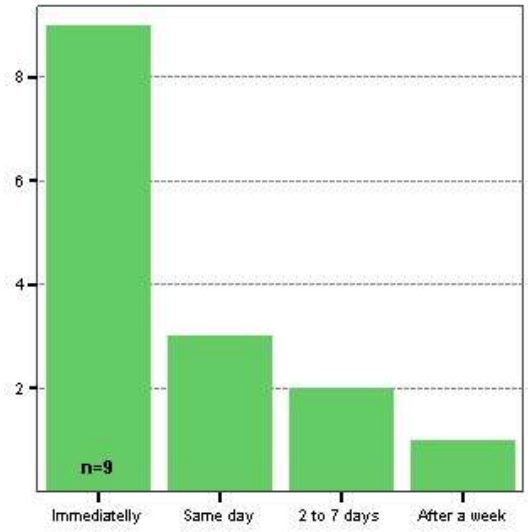


Figure 25: Question (3): How long did you wait before listening to it?

On the respondents who answered the question (3): How long after you received the audio feedback file did you wait before listening to it? (Figure 25) 9 (60%) reported having listened to the audio feedback recording immediately; 3 (20%) reported having listened to the audio feedback recording the same day; 2 (13.3%) reported having listened to the audio feedback recording between 2 to 7 days later; and 1 (6.7%) reported having listened to the audio feedback recording after a week.

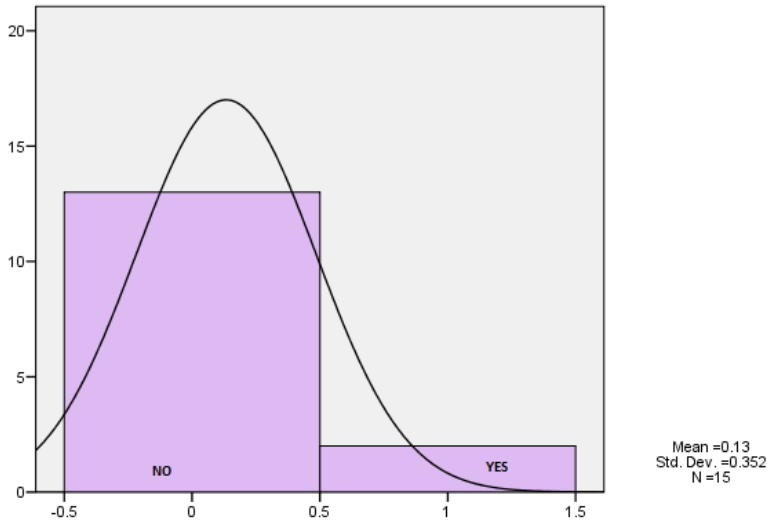


Figure 26: Question (4): Did you face any technical problems listening to the file?

Regarding the respondents who answered the question (4): Did you face any technical problems listening to the audio feedback recording? (Figure 26)

13 (86.7%) reported No; and 2 (13.3%) reported Yes to having faced any technical problems listening to the audio feedback recording.

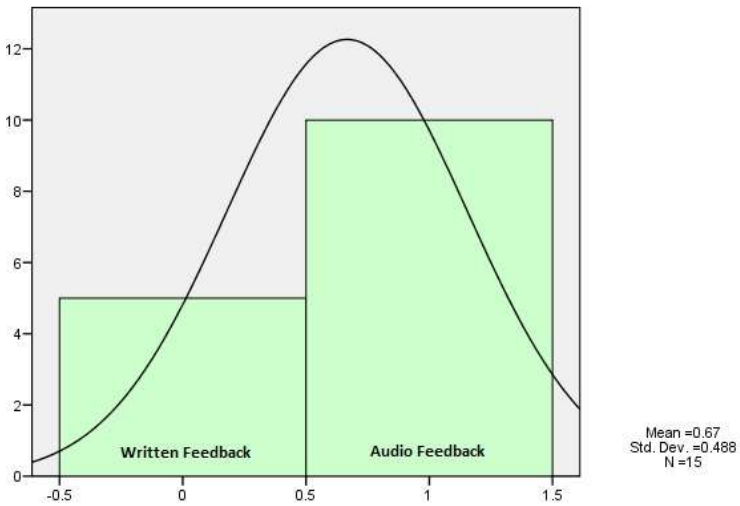


Figure 27: Question (5): Which form of feedback would you prefer?

Regarding the respondents who answered the question (5): Which form of feedback would you prefer? (Figure 27)

10 (66.7%) reported to have preferences for audio feedback; and 5 (33.3%) reported to have preferences for written feedback.

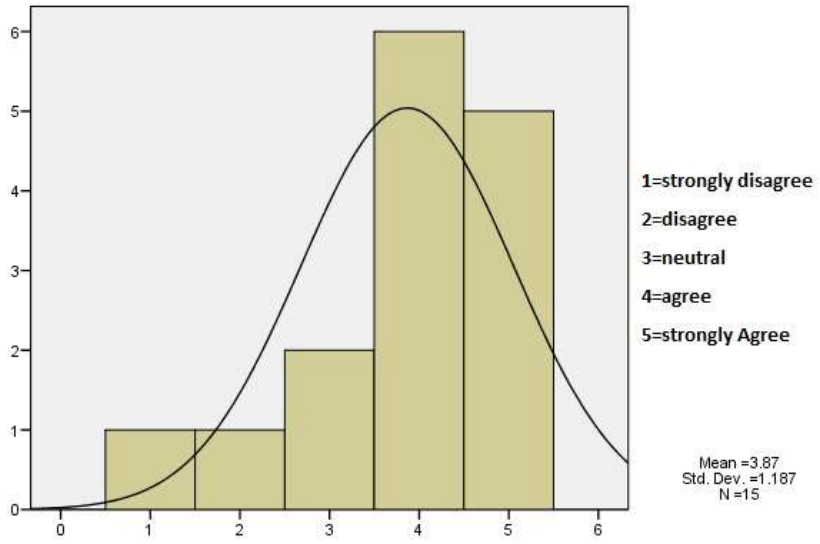


Figure 28: Question (6): I found the use of audio feedback accessible?

Regarding the respondents who answered the question (6): I found the use of audio feedback accessible? (Figure 28)

1 (6.7%) reported strongly disagree with the statement.

1 (6.7%) reported disagree with the statement.

2 (13.3%) reported neutral with the statement.

6 (40%) reported agree with the statement.

5 (33.3%) reported strongly agree with the statement.

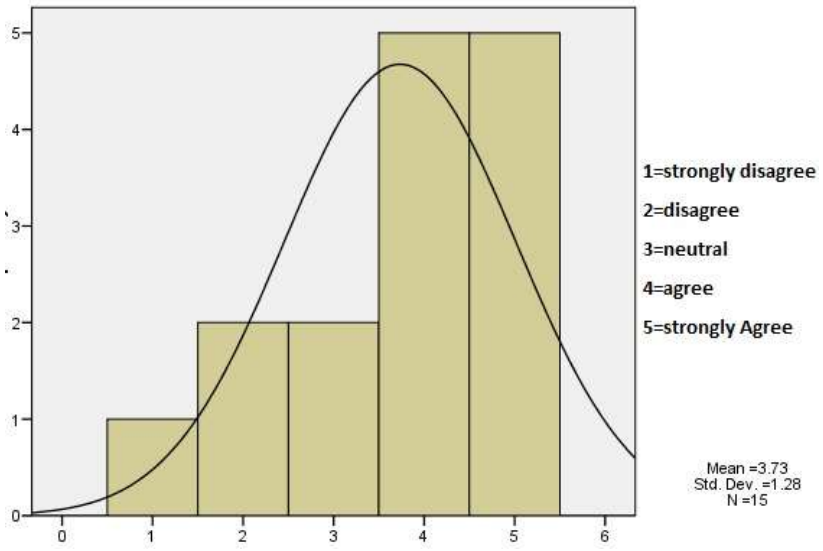


Figure 29: Question (7): I found the use of audio feedback a valuable contribution?

Next, of the respondents who answered the question (7): I found the use of audio feedback a valuable contribution? (Figure 29)

1 (6.7%) reported strongly disagree with the statement.

2 (13.3%) reported disagree with the statement.

2 (13.3%) reported neutral with the statement.

5 (33.3%) reported agree with the statement.

5 (33.3%) reported strongly agree with the statement.

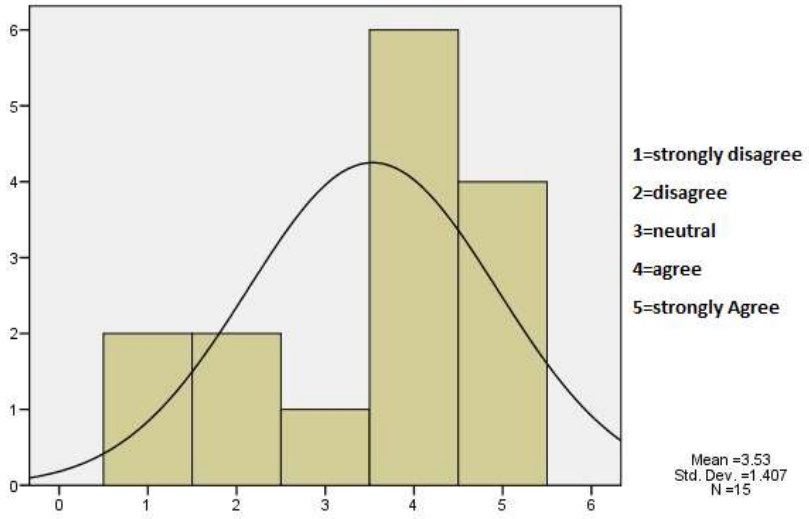


Figure 30: Question (8): I would like to see continued use for my coursework?

Next, of the respondents who answered the question (8): I would like to see continued use of audio feedback for my coursework? (Figure 30)

2 (13.3%) reported strongly disagree with the statement.

2 (13.3%) reported disagree with the statement.

1 (6.7%) reported neutral with the statement.

6 (40%) reported agree with the statement.

4 (26.7%) reported strongly agree with the statement.

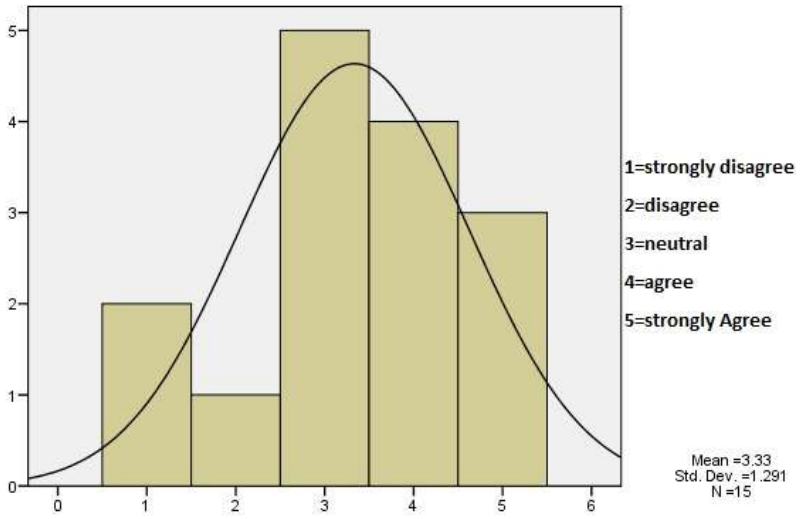


Figure 31: Question (9): I found the use of audio feedback contributed to my learning?

Next, of the respondents who answered the question (9): I found the use of audio feedback contributed to my learning? (Figure 31)

2 (13.3%) reported strongly disagree with the statement.

1 (6.7%) reported disagree with the statement.

5 (33.3%) reported neutral with the statement.

4 (26.7%) reported agree with the statement.

3 (20%) reported strongly agree with the statement.

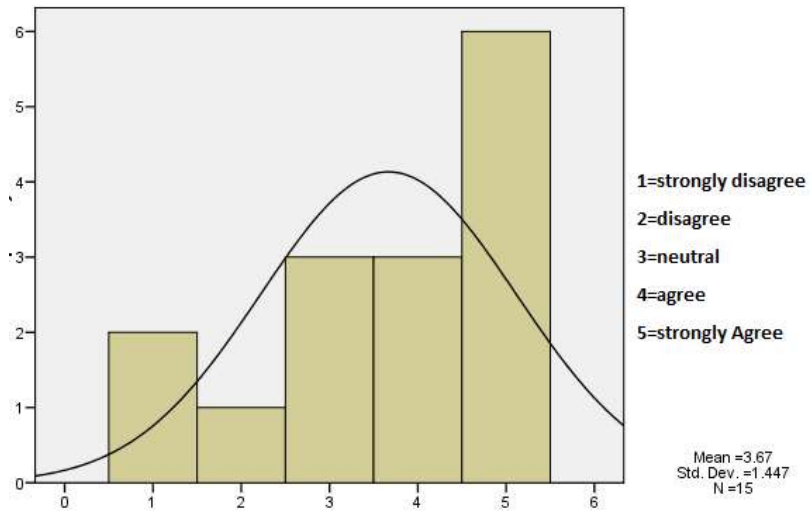


Figure 32: Question (10): I would like audio feedback used for other courses?

Next, of the respondents who answered the question (10): I would like to see audio feedback used for other courses at Brunel? (Figure 32)

2 (13.3%) reported strongly disagree with the statement.

1 (6.7%) reported disagree with the statement.

3 (20%) reported neutral with the statement.

3 (20%) reported agree with the statement.

6 (40%) reported strongly agree with the statement.

5.4.3 Discussion

The students' opinions collected for this study are favourable to the use of interactive audio feedback for final assignments.

The majority of the students didn't have previous experience with audio feedback. It can be considered favourable because it helps to avoid any confounding effect being introduced into the study by a third variable (Clark, 1983). The device that was used most often to listen to the audio feedback was the laptop, even though they could use personal PCs or university PCs available in the campus. It makes perfect sense if we consider that a laptop is the more immediate computer device to an MBA student. The tendency was listening to the audio feedback immediately (60%) or the same day (80%) after it was received. Few expressed any technical difficulties in downloading and listening to the audio files. Most simply clicked on the link and the file opened in Windows Media Player. The only reported

downside of audio feedback (from the students' perspective) was that it was more difficult to navigate and focus on specific aspects.

Number of participants (N)= 15	**mean**	**SD**
Audio feedback found **accessible** (Likert scale 1 to 5)	3.87	1.187
Audio feedback a **valuable contribution** (Likert scale 1 to 5)	3.73	1.280
Will like **use** of audio feedback for **my coursework** (Likert scale 1 to 5)	3.53	1.407
Audio feedback **contributed to my learning** (Likert scale 1 to 5)	3.33	1.291
Audio feedback **used for other courses** at Brunel (Likert scale 1 to 5)	3.67	1.447

Table 4: Experiment 3 Students' opinions about the use of audio feedback

Audio feedback was considered by a majority to be accessible, and to be a valuable contribution to teaching and learning (see Table 3). It is expected to be used as a feedback mechanism in others coursework and courses in Brunel University. The results provide support for the quality enhancement hypothesis H2.

5.5 Experiment Four

5.5.1 Method

5.5.1.1 Participants

The subject is a male Senior Academic Practice Advisor in the Staff Development Unit at Brunel University in West London, UK. The Unit provides support to probationary members of academic staff, in their academic role, helps in settling within the Brunel and wider HE community, and helps with personal commitments to achieve personal and organizational expectations.

He is using a guiding template (Figure 34 and Figure 35) with notes taken from oral/poster presentations given as final assignments by new or probationary members of Brunel academic staff taking the course for teaching "Programme of Development in Academic Practice" (PDAP). The PDAP programme is designed specifically to meet the professional development needs of probationary members of academic staff at Brunel University.

The Professional Development in Academic Practice programme is accredited by the Higher Education Academy, and on completion provides eligibility for recognition as Fellow of the Higher Education Academy.

5.5.1.2 Materials and apparatus

Audio feedback (speech) was recorded as a MP3 file using audio software named Audacity installed on a Sony VAIO VGN-FS115B Laptop using windows XP. Audacity is open source software for recording and editing sounds.

Audio Feedback for Oral/Poster Presentation

Luis Palacios (cbpglpp@brunel.ac.uk)

The purpose of this survey is to identify the effectiveness of Audio feedback within an Oral/Poster presentation context

Date:	**Native Language**
Module	**Gender**
Age	**Country of origin**

1. Have you experienced audio or video feedback in the past (tick one only)??
   Audio ____
   Video ____
   Both ____
   No ____

2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____

3. How long after you received the audio feedback file did you wait before listening to it (tick one only)??
   a. immediately ____
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No____
   If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written ____

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6. "I found the use of audio feedback accessible"					
7. "I found the use of audio feedback a valuable contribution					
8. "I would like to see continued use of audio feedback for my coursework"					
9. "I found the use of audio feedback contributed to my learning "					
10. "I would like to see audio feedback used for other courses at Brunel"					
11. "I consider audio feedback deliver the message more accurately than written feedback"					
12. "Audio feedback is more personalised than writing feedback "					

Figure 33: Experiment 4- Questionnaire to capture presenter opinion

Text feedback was recorded (typed) using Microsoft Word 2007 in the same Sony VAIO VGN-FS115B. It was stored as a Windows .docx file.

The previous questionnaire (Figure 19) was redesigned to produce a new improved version (Figure 33) to capture the opinions of the lecturer and students and to identify the effectiveness of Audio feedback in these final presentation assignments.

Professional Development in Academic Practice

Programme of Development in Academic Practice (PDAP)
ORAL PRESENTATION

Brunel UNIVERSITY LONDON

Presenter's Name: **Date:**
School/Unit:

1 - unsatisfactory, 2 - satisfactory, 3 - impressive, 4 - outstanding

Criteria	1	2	3	4	**Comments** Identify particular strengths and suggestions for improvement
Presentation is Clear: e.g., audibility, pace, fluency, body language, eye contact					
Presentation is Engaging: e.g., suitable balance of oral and visual resource, interesting topic, appropriate to audience					
Content is Informative: e.g., well organised, cohesive, focused, relevant to audience					
Presentation is Original or Innovative: e.g. original research, innovative approach to research or presentation					

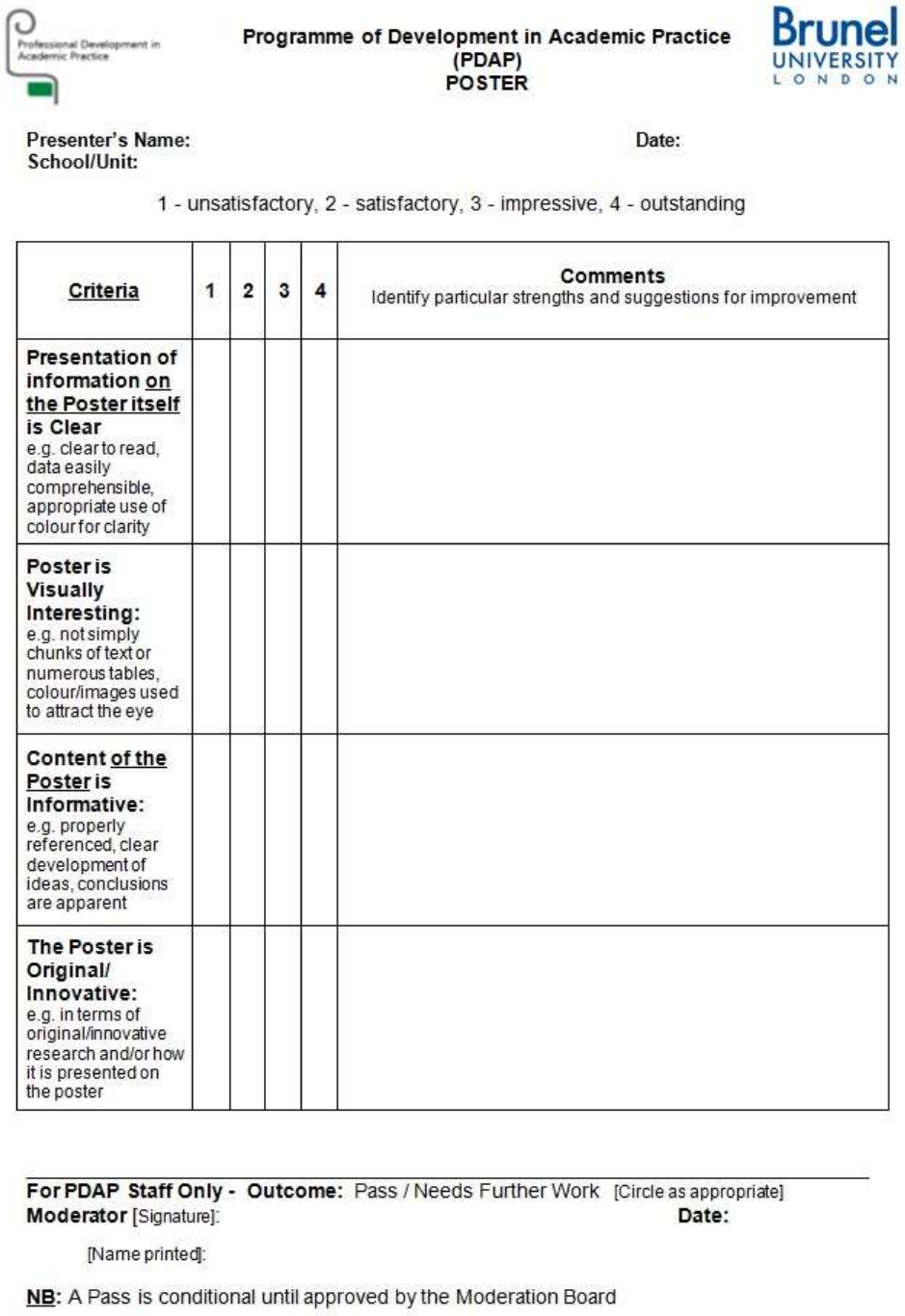
For PDAP Staff Only - Outcome: Pass / Needs Further Work [Circle as appropriate]
Moderator [Signature]: **Date:**

[Name printed]:

NB: A Pass is conditional until approved by the Moderation Board

Figure 34: Experiment 4- Template to guide the evaluation of the oral presentation

In addition, the lecturer used a template that guides the assessment of the main areas to be taken into consideration. The template helps the process to take notes from final oral presentation assignments on new or probationary members of Brunel academic staff



Programme of Development in Academic Practice (PDAP)
POSTER

Presenter's Name: **Date:**
School/Unit:

1 - unsatisfactory, 2 - satisfactory, 3 - impressive, 4 - outstanding

Criteria	1	2	3	4	Comments Identify particular strengths and suggestions for improvement
Presentation of information on the Poster itself is Clear e.g. clear to read, data easily comprehensible, appropriate use of colour for clarity					
Poster is Visually Interesting: e.g. not simply chunks of text or numerous tables, colour/images used to attract the eye					
Content of the Poster is Informative: e.g. properly referenced, clear development of ideas, conclusions are apparent					
The Poster is Original/ Innovative: e.g. in terms of original/innovative research and/or how it is presented on the poster					

For PDAP Staff Only - Outcome: Pass / Needs Further Work [Circle as appropriate]
Moderator [Signature]: **Date:**

[Name printed]:

NB: A Pass is conditional until approved by the Moderation Board

Figure 35: Experiment 4- Template to guide the evaluation of the poster presentation

The notes used by the lecturer evaluating the presentation to produce the feedback were created following four main criteria: clarity of the presentation e.g. audibility, pace, fluency, body language, eye contact; engaging e.g. suitable balance of oral and visual

resources, interesting topic, appropriate to audience; informative e.g. well organized, cohesive, focused, relevant to audience; and originality or innovative e.g. original research, innovative approach to research or presentation (see Figure 34: Experiment 4- Template to guide the evaluation of the oral presentation and Figure 35: Experiment 4- Template to guide the evaluation of the poster presentation**).**

The questionnaire structure encompasses three main areas. An initial area that requires demographic information such date of birth, native language, age, gender and country of origin for example.

Date: __Module ___ Native Language ___Age _Gender: M _F _Country of origin: ____

A second area that focuses on previous experience, devices used and the technical difficulties faced and initial attitude before or at the moment the students have received the feedback.

5. Which form of feedback would you prefer (tick one only)?
Audio ____
Written ____

Then, a final area that evaluates student opinion after feedback has been received. A Likert scale is introduced in these question areas to evaluate accessibility of the feedback, if it is considered a valuable contribution, a contribution to learning, and the students' expectations about use audio feedback in other courses, or coursework for example

"I found the use of audio feedback contributed to my learning"
a. Strongly Disagree ____
b. Disagree ____
c. Neutral ____
d. Agree ____
e. Strongly agree ____

It was designed to determine the experience and tools used when the feedbacks were listened to. The questionnaire also investigates accessibility to the audio file, how valuable the students consider the audio feedback, contribution to the students learning, and interest in using the audio feedback in the future in other courses.

5.5.1.3 Procedure

In experiment three, the conditions were kept the same as in experiment two ("A" for audio and "T" for text) but the procedures have slightly changed including different participants and materials. The introduction of a template that guides the production of feedback is one of the main factors considered in this approach.

A random sample of eight finals guiding template (Figure 34 and Figure 35) with notes taken from oral/poster presentations templates were divided into two groups.

The first group of four evaluations were used for the T condition. For each evaluation, the start time was recorded at the moment where typing began and the end time at the moment where typing was completed as indicated by the tutor. There was no reading time prior to commencement of typing. This requirement was different than in experiment 2. However, reading time of the evaluation report during the construction of feedback was included.

For the A condition, again the start time was recorded at the moment the Audacity recording button was first clicked on, and the end time at the moment where the Audacity recording button was clicked off as indicated by the tutor. The tutor was not permitted to pause the recording button. This is also different than in experiment 2. The thinking/reading time was included in the overall time. Immediately after the feedback recording finished, the tutor was interviewed. Then, audio files and a feedback survey were delivered by email to the students to collect their experiences.

5.5.2 Results

In experiment 3, the average time taken to produce the text feedback was 6,8 min and to produce the audio feedback was 2,5 min (see Table 6). The Shapiro-Wilk test for Normality that is more appropriate for the small sample sizes (< 50 samples) of the data was applied to indicate the normality of the data.

	group	Shapiro-Wilk		
		Statistic	df	Sig.
Feedback	T	.723	4	.021*
	A	.843	4	.206*

***p < .05; ES = 2.02**

Table 5: Experiment 3- The Shapiro-Wilk test for Normality

We can see from the above table that for the "A", and "T" Feedback condition the dependent variable, "Time", was normally distributed.

There is a reduction from the time taken to create the text feedback to the time taken to create the audio feedback of around 63% (mean difference = -257 s or 4:17 min).

Unpaired Student's *t*-test, $t(6) = -3.801$, $p < .05$, with an effect size of 2.88.

Group	**Recording Time/s**	
	M	***SD***
T (n-4)	416.25	123.82
A (n=4)	158.75	54.97

**p < .05; ES = 2.88*

Table 6: Experiment 3- Feedback Recording Times (in seconds)

The tutor considers that one of the main reasons to use audio rather than text feedback is related to the popularity that the use of audio feedback is having in the industry. There were concerns about the mistakes that could be produced while developing the audio feedback. However, the tutor created a mental structure to follow while developing the audio feedback to keep consistency among all of them. However, he recognised that some mistakes were made while following this mental structure e.g. not highlighting that the participant had not been told that they had passed the exercise, but they were reduced with practice. The tutor found the exercise "pretty tiring and would probably do this again in a more relaxed context such as at home". It may be because of the intensity of trying to ensure that he was speaking clearly and leaving nothing out. The tutor felt more confident using Audacity indicating that it was "far easier to use than podcasting software such as "Camtasia" which he found very difficult to pause". However, he is not sure how the students will react to the introduction of this new approach. The tutor is very enthusiastic about the idea of using audio feedback on real courses.

The results from the students' survey are presented below. The sample (N = 4) of new staff participating in the programme in development of academic practice was composed of four males. Five groups encompass the sample age from 20 years old or below; between 21 and 25 years old; between 26 and 30 years old; between 31 and 36 years old, and from 36 years

old or above. All the respondents belong to the age group 5 were from 36 years old or above.

The ethnicity groups of the respondents is represented by 5 groups as follow: White (group 1), Mixed (group 2), Asian (group 3), Black (group 4), and Chinese (group 5). The respondents belong to the ethnicity groups 1 and 5 in the following proportion 50% white and 50% Chinese.

Of the respondents who answered the question (1): Have you experienced audio or video feedback in the past? all 4 (100%) reported no previous experience with audio or video feedback in the past.

Regarding the respondents who answered the question (2): What device do you use to listen to your audio feedback? 2 (50%) reported having used the Brunel computers to listen to the audio feedback; 1 (25%) reported having used the Mac computers to listen to the audio feedback; and 1 (25%) reported having used the Laptop computers to listen to the audio feedback.

Of the respondents who answered the question (3): How long after you received the audio feedback file did you wait before listening to it? 3 (75%) reported having listened to the audio feedback recording immediately; and 1 (25 %) reported having listened to the audio feedback recording the same day.

Next, of the respondents who answered the question (4): Did you face any technical problems listening to the audio feedback recording?

All respondents (100%) reported not having faced any technical problems listening to the audio feedback recording.

Regarding the respondents who answered the question (5): Which form of feedback would you prefer?

3 (75%) reported to have preferences for audio feedback; and 1 (25%) reported to have preferences for written feedback.

Regarding the respondents who answered the question (6): I found the use of audio feedback accessible?

1 respondent (25%) reported agree with the statement; and

3 (75%) reported strongly agree with the statement.

Next, of the respondents who answered the question (7): I found the use of audio feedback a valuable contribution?

2 (50%) reported agree with the statement.

2 (50%) reported strongly agree with the statement.

Next, of the respondents who answered the question (8): I would like to see continued use of audio feedback for my coursework?

2 (50%) reported neutral with the statement.

1 (25%) reported agree with the statement.

1 (25.7%) reported strongly agree with the statement.

Next, of the respondents who answered the question (9): I found the use of audio feedback contributed to my learning?

2 (50%) reported neutral with the statement.

2 (50%) reported strongly agree with the statement.

Next, of the respondents who answered the question (9): I found the use of audio feedback contributed to my learning? (Figure 31)

2 (13.3%) reported strongly disagree with the statement.

1 (6.7%) reported disagree with the statement.

5 (33.3%) reported neutral with the statement.

4 (26.7%) reported agree with the statement.

3 (20%) reported strongly agree with the statement.

Next, of the respondents who answered the question (10): I would like to see audio feedback used for other courses at Brunel?

1 (25%) reported disagree with the statement.
2 (50%) reported neutral with the statement.
1 (25%) reported strongly agree with the statement.

Next, of the respondents who answered the question (11): I consider audio feedback delivers the message more accurately than written feedback?

2 (50%) reported disagree with the statement.

1 (25%) reported neutral with the statement.

1 (25%) reported agree with the statement.

Next, of the respondents who answered the question (11): I consider audio feedback delivers the message more accurately than written feedback?

2 (50%) reported disagree with the statement.

1 (25%) reported that neutral with the statement.

1 (25%) reported that agree with the statement.

Next, of the respondents who answered the question (12): Audio feedback is more personalized than written feedback?

3 (75%) reported neutral with the statement.

1 (25%) reported agree with the statement.

5.5.3 Discussion

This study also reiterated that the process to create feedback is reduced by using audio feedback by 63%. In addition, the reduction in time is increased in this experiment compared to the previous. When comparing the experiments two and three in this regard, it indicates that the time taken to produce the audio feedback is even less (from 40% to 63%). This suggests that the template guidance introduced to facilitate the development of the feedback is having a positive effect in the production of the interactive audio feedback.

When interviewed, the tutor reported that he felt more comfortable working with audio than text feedback.

He particularly appreciated the increase in the recording rate facilitated by audio. He reported that he had erroneously expected the creation and uploading of MP3 files to be much more complex than it turned out to be.

The students' perceptions praised the audio feedback for feeling "extremely personal" and "less abstract than written text".

None of the students expressed any technical difficulties in downloading and listening to the audio files. Most simply clicked on the link and the file opened in Windows Media Player.

The only reported downside of audio feedback (from the students' perspective) was that it was more difficult to scan and focus on particular aspects. However most believed this was more than compensated for by the richness of audio feedback.

5.6 Chapter Discussion

The studies suggest that audio recording can decrease the time it takes to create feedback by 40-63%. There are significant differences in the production of audio versus written feedback. In experiment 2, the mean difference of -199 s (3:19 min) is statistically reliable, with Unpaired Student's *t*-test, $t(6) = -2.854$, one-tailed, $p < .05$, with an effect size of 2.02 (small). In experiment 4, the time taken to create the audio feedback was 63% (mean difference = -257 s or 4:17 min) with Unpaired Student's *t*-test, $t(6) = -3.801$, $p < .05$, with an effect size of 2.88. There is an increase in the reduction of the time between the two experiments (production time of the audio feedback in experiment 4 is less) that seems to be related to the introduction of the guiding template (Figure 34 and Figure 35) that directs the procedure of taking notes when evaluating the presentations. These results allow us to conclude that the interactive features of technology have generated a sort of speeding effect in the production of feedback.

Tutors reported that there was a significant time saving in the process of creating the feedback. All tutors producing feedback preferred recording audio feedback because the speaking is a more "natural" and effortless process than typing. There was concern about the mistakes that could be produced while developing the audio feedback. However, all tutors created a mental structure to follow while developing the audio feedback to keep consistency among all of the audio feedbacks. They feel positive about the use of this methodology. None of the students expressed any technical difficulties in downloading and listening to the audio files. Most simply clicked on the link and the file opened in Windows Media Player. The study assumed that the quantity of feedback was similar for each mode (audio or text). Indeed tutors were asked to attempt to ensure this.

The key aspects that participants valued in audio feedback were: audio is more detailed because it carries more information, it seems to create a more personal and closer relationship, and the understanding of the feedback is not corrupted by poor typing. It imply that there is a communicational effect in the use of interactivity to deliver the audio feedback.

It is also an on time effect as the result of using interactivity to deliver the audio feedback.

6 Chapter 6: Interactive Texting Feedback

6.1 Introduction

Brunel is one of a number of British universities created in the 1960s following the Robbins Report on higher education that recommended immediate expansion of universities. In 1995 the University expanded again, This increased the number of courses that Brunel University was able to offer and the size of the student body increased to over 12,000. This dramatic expansion in recent years makes it increasingly difficult for all students to physically attend a lecture, at a particular time and place. Pedagogically speaking it is also not appropriate to deliver the lessons with traditional methods to these large audiences. Therefore, an alternative mechanism using technology named Interactive Texting Feedback (ITF) has been envisaged to enhance and verify that the teaching is reaching the students. It will engage the learners in these large courses to the lecturer in order to experience certain degree of interactivity. ITF is a pedagogical approach to provide formative feedback to a student audience using SMS often called text messaging.

ITF adds another technological resource to the teacher's arsenal combining technology and pedagogical strategies to improve the learning experience. Interactive feedback as used in this research is information sent back to the student to modify his or her thinking or behaviour in order to improve their learning (Shute, 2008). Immediate constructive feedback offers a valuable contribution to the learning experience because it helps to identify misconceptions and create mental schemas that can be added to existing knowledge to form new skills or attitudes.

There is a four step pedagogical procedure in the process of using ITF: question, answer, response collection and feedback discussion. The procedure is based on the interaction model described in section 2.5 Interactivity. The lecturer poses a *question* to the audience after teaching a lesson to determine the level of understanding of the material presented. Technology is used to display the information e.g. power point, whiteboard, etc. and eliciting a cognitive process (**initiation**). Then, the students *answer* by sending a SMS message using their mobile phones to a SMS voting polls system (**response**). At this stage students just reply with a SMS text message indicating the letter that identifies the correct answer to the question. The system *collects* and processes the *responses.* Next, the students receive immediate *feedback* about the presented material that elicits a pedagogical discussion (**feedback**). The results are displayed in real time. The constructive feedback

based on the student's response is used by the lecturer to facilitate discussion and provide guidance.

A good voting system, whether electronic or using traditional paper ballots, is characterised (Kohno, 2004) by anonymity, tamper-resistance, comprehensibility and usability by the entire voting population (human factors criteria). ITF comply with these features. Anonymity is guaranteed since the process is performed automatically with no intervention from the lecturer. Security is based on compiled algorithms generated by the system. It used HTML to easily integrate into a company or personal website where the system generates a short JavaScript code that is simple to integrate. It is very simple to use due to the fact that almost everybody has a mobile phone. A normal network charge applies when voting using a mobile phone and since there are no entirely free SMS polls they are less likely to be abused.

An important piece of technology is the mobile phone and the surrounding pedagogical framework (Sharples, Taylor & Vavoula, 2005) employed. Learning mediated by mobile devices assists the learners in their goals of transforming their knowledge and skills by engagement and use of contemporary practices that enable effective learning. These practices according to Sharples (2005) make emphasis in the following aspects: a learner-centred approach that enables the student to reason based on their own experience. A knowledge-centred approach that focuses on a curriculum built from sound foundations on validated knowledge and an assessment-centred approach that provides constructive feedback.

SMS usages are increasing in education (Stone, Briggs & Smith, 2002). Research implemented to test the effectiveness of a two-way SMS campaign for a UK youth brand demonstrated that participants were motivated to participate and able to perform complex tasks using their mobile phones. Complexity was achieved by requesting users to perform a series of interactive SMS exchanges to achieve completion of a task or goal. There are economical and educational motivations for this research. The size of undergraduate classes in the business school is too big to be pedagogically appropriate. On the other hand, there are assurances that learning is achieved using the correct methodology.

The Interactive Texting Feedback study is related to the mediator system in the pedagogical triangle. The methodologies used focus on determining the effectiveness of interactivity in this context. It responds to the final experimental hypothesis in this research

that Interactive Texting Feedback is an effective approach to enhance learning practice. The following study was designed to confirm the experimental hypothesis.

6.2 Experiment

6.2.1 Method

6.2.1.1 Participants

The participants were two groups of 49 and 65 students belonging to undergraduate and postgraduate in marketing courses in the Business School at Brunel University in London, UK. Their age ranged between 18 and 30 years old and they were from different ethnic backgrounds.

6.2.1.2 Materials and apparatus

There are four technological components used in this experiment: mobile devices, a Viglen computer using PowerPoint with access to the Internet, a projector, and the "Cardboard Fish" SMS poll service. The mobile phones were the personal devices of the students that voluntarily accepted to participate in the experiment. They were from different brands and operators. They were used to send SMS messages to the Cardboard Fish central system. The PC computer was a normal PC with access to the Internet that was employed to display a PowerPoint presentation and provide access to the Cardboard Fish SMS polls tool. It also interacted with the projector to magnify the display onto the bigger screen of the classroom. The Cardboard Fish SMS polls tool allows setting up voting polls and displaying the results on your, or any, particular website. Normal network charges apply when voting. Anybody can sign up for a free account to use the Webmaster SMS tools and some other services by going to http://webmastersms.cardboardfish.com. Registration is required by giving some essential basic information such as contact name, username, password, e-mail address. With the SMS Poll application you can allow visitors to the website to vote in polls by simply sending a SMS message. The lecturer can set up and administer the poll options and the results will be displayed on the website for all the visitors to see. The poll offers up to 26 options at once and it is fully customized using Cascading Style Sheets (CSS) to change the colours, fonts, borders and other elements of the webmaster SMS

Interactive Texting Survey

Luis Palacios (Luis.Palacios@brunel.ac.uk)

The purpose of this survey is to identify the effectiveness of interactive SMS texting with the view to the possibility of using it again later.

Date:_____Module_____Level_____Age__Gender:M__F__Country:_____

1. Do you have a mobile phone?
   Yes____No____ if *yes* indicate the make of your mobile phone_____

2. Who is your telecom service Provider?

a. T-Mobile	b. Vodafone	c. O2
d. Orange	e. Virgin	f. Other

3. How many free texts do you get per month on your current plan?
   a. 0 ____
   b. 1-300 ____
   c. 301-600 ____
   d. 601-900 ____
   e. more than 900 ____

4. Would you be willing to use some of your free texts to participate in a seminar? Yes____No____

5. Did you have sufficient signal/reception on your mobile phone in the lecture room for SMS texting?
   Yes____No____

6. How many texts would you be willing to use during a talk?
   a. 0 ____
   b. 1-3 ____
   c. 4-7 ____
   d. 8-15 ____
   e. more than 15 ____

7. When interactive SMS texting was used in the talk, did you participate in sending texts?
   Yes____No____

8. "I found the use of interactive SMS texting entertaining"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____

9. "I found the use of interactive SMS texting contributed to my learning"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____

10. "I would like to see continued use interactive SMS texting in my lectures"
    a. Strongly disagree ____
    b. Disagree ____
    c. Neutral ____
    d. Agree ____
    e. Strongly agree ____

11. "I found the use of interactive SMS texting a valuable contribution"
    a. Strongly disagree ____
    b. Disagree ____
    c. Neutral ____
    d. Agree ____
    e. Strongly agree ____

12. "I would like to see interactive SMS texting used for other seminar and lectures at Brunel"
    a. Strongly disagree ____
    b. Disagree ____
    c. Neutral ____
    d. Agree ____
    e. Strongly agree ____

Figure 36: Interactive Texting Survey

applications. CSS is a style sheet language used for describing the presentation semantics (the look and formatting) of a document written in a mark-up language (Pfaffenberge et al., 2004).

A questionnaire was developed to capture the opinions of the students. It contains twelve questions (see Figure 36) regarding demographic data, service provider, signal strength, SMS texts students receive from their service provider, how many they were willing to use in the experiment and students' attitudes about the use of the pedagogical approach.

6.2.1.3 Procedure

The experiments design consists in the lecturer using the four step pedagogical procedure mentioned in the introduction: question elicitation, students answer, and response collection gathering process for displaying the data and finally a pedagogical process of discussion about the feedback is initiated.

The process starts when a question is presented to the audience after teaching a lesson (Figure 37). The question is related to the Marketing subject previously taught. These courses are designed for either those wishing to become marketing professionals (undergraduates) or others seeking a master's qualification in Marketing. The question is displayed using PowerPoint and projected on the main board of the classroom where everybody can see it. The question usually follows a multiple-choice format with a "key" (right answer) and distracters to take the students into a thoughtful state. Distracters are the incorrect answers presented as a choice in a multiple-choice test (Palacios & Evans, 2010b).

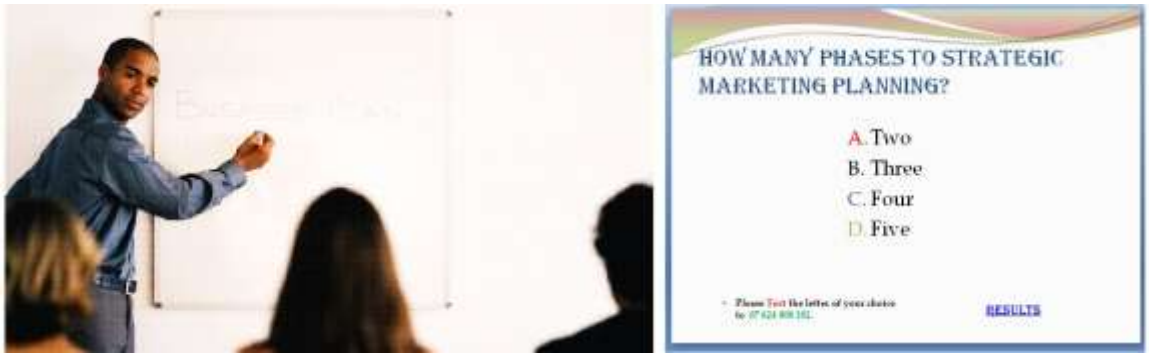


Figure 37: First step: lecturer asking a question to the students

Then, students (Figure 38 left) reply sending an SMS message using their mobile phones to a Cardboard Fish website that behaves like an electronic poll system. The students cast the vote by texting a keyword and the option letter of their choice. Students are charged standard network rate to send SMSs to the service number. The website service does not charge any extra fees.

The website previously described collects the responses sent by the students and displays them using a customized template (Figure 38 right). The voting poll is easy to set up in any website because it automatically generates a short JavaScript code that can be inserted in the html website source after the choices to be presented in the poll's interface are selected. Any messages sent to the poll system which does not contain a valid vote, count as spoiled votes. The spoiled votes can be identifying using administrator privileges offered to the manager of the account; also you will be able to see a list of all current vote counts. Feedback is processed in real time. Therefore, the lecturer and the students can analyse the information almost immediately after the last answer has been sent.

Figure 38: Second and third step: Student answers and data are collected

The lecturer facilitates discussion and provides constructive feedback based on the students' responses. Therefore, the lecturer can easily channel discussion to areas where he or she perceives the lesson was not understood. Students also get immediate feedback to clear misconceptions.

6.2.2 Results

The information collected for the two groups (Table 7) indicates that the majority of the students have a mobile phone in the classroom. Only two didn't have a mobile phone with them in the Masters course and one in the Undergraduate course at the time of the experiment but they all own one. Therefore, we are taking into account only students with their mobile phones in the class.

	Masters	Undergraduate
Number of participants (N)	65	49
Students with mobile 'phones	64 (98%)	45 (92%)
Good signal	43 (66%)	39 (78%)
Willing to use texts	59 (91%)	30 (61%)

Table 7: Students participation by courses

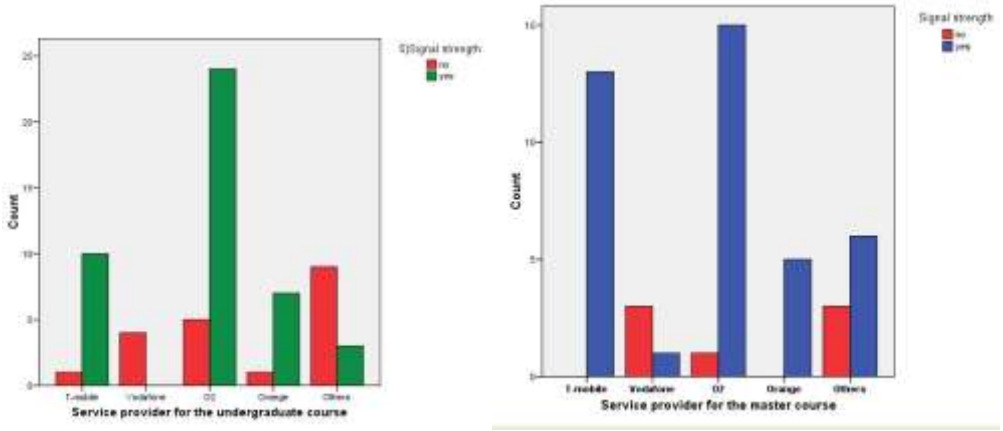


Figure 39: Service providers vs. signal (Undergraduate and Master's Students)

Based on the information observed (Figure 39) the service provider with the best signal in the area is O2. We could also observe that students are willing to use up to a maximum

of three text messages to participate. However, there is a decrease in this attitude when more messages are required.

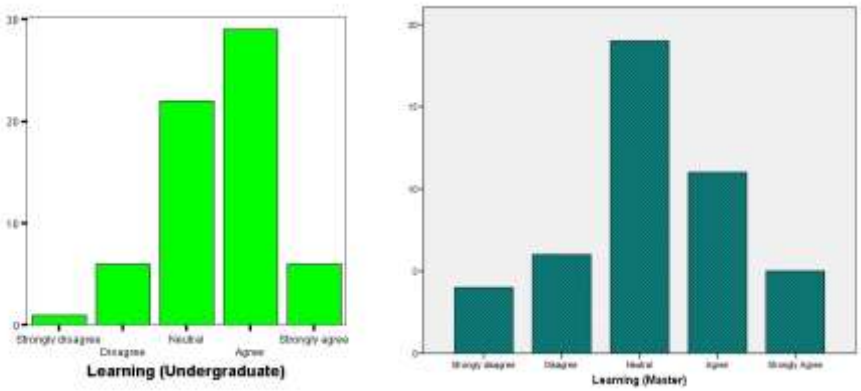


Figure 40: Contributed to learning using SMS (Undergraduate and Master's Students)

There is a positive attitude towards the use of this approach and students consider it as a valuable complement of the instruction as can be seen in Table 8.

Students seem to be more willing to use texts in the Undergraduate course (mean 2.3 (SD=1.5) than in the Master's course (mean1.5 SD=.9). However, Masters (mean 3.5 (SD=.7) consider that use of the system is valuable unlike Undergraduate students (mean 3.1 (SD=.9)

	Undergraduate course			Masters course		
	Mean	Std. Deviation	N	Mean	Std. Deviation	N
Entertainment	3.44	1.099	45	3.66	0.801	64
Contribute to Learning	3.16	1.086	45	3.52	0.854	64
Continuing using in class	3.00	0.977	45	3.55	0.775	64
Valuable Contribution	3.13	0.919	45	3.50	0.735	64
Spread to other modules	2.91	1.062	45	3.42	0.887	64

Table 8: Descriptive Statistics for the Undergraduate and Master's Courses

Pearson Correlation Sig. (2-tailed)= PC

	(E)		(CL)		(CU)		(VC)		(SM)	
PC	Master	Under	Master	Under	Master	Under	Master	Under	Master	Under
Entertainment (E)	1	1	.588 (**)	.531 (**)	.512 (**)	.572 (**)	.405 (**)	.637 (**)	.564 (**)	.716 (**)
Contribute to Learning (CL)	.588 (**)	.531 (**)	1	1	.598 (**)	.642 (**)	.620 (**)	.752 (**)	.588 (**)	.643 (**)
Continuing using in class(CU)	.512 (**)	.572 (**)	.598 (**)	.642 (**)	1	1	.544 (**)	.734 (**)	.698 (**)	.788 (**)
Valuable Contribution (VC)	**.405 (**)**	**.637 (**)**	.620 (**)	.752 (**)	.544 (**)	.734 (**)	1	1	.597 (**)	.780 (**)
Spread to other modules (SM)	**.564 (**)**	**.716 (**)**	.588 (**)	.643 (**)	.698 (**)	.788 (**)	.597 (**)	.780 (**)	1	1

Table 9: Correlations for both Undergraduate and Master's Course

Correlations among the variables relating to their attitude towards the system show it to be significant as can be seen from the correlation in the Table 9.

6.3 Discussion

The objective of this experiment was to determine if interactive feedback using SMS is a valid and effective pedagogical approach to learning. The results confirm student satisfaction and willingness to participate in present and future experiments. Inferential analysis demonstrates good correlations among the variables related to service provider, signal strength and number of SMS texts students were willing to use. Significant results indicate that students consider the use of this approach as a viable contribution to learning, and it should spread to other modules in Brunel University.

There has been noticed that student intervention increased using this approach because of the anonymous nature of the SMS text sent. There is a communicational effect of this interactive system between the lecturer and the students. The lecturer almost instantly could determine if his/her educational message has been deliver to the audience independently of the size of the classroom.

Similarly it can be seen in the variables related to attitudes. This is a cost-effective approach to learning since it is a new educational strategy where the students receive immediate constructive feedback and it motivates them to react in real time to the lesson presented.

7 Chapter 7: General Discussion

This thesis examined the hypothesis that interactivity has a positive effect in enhancing the learning experience when used in an e-learning system. Interactivity has the ability to respond contingently to the learner's actions and is positioned as an important instrument for promoting learning (Beauchamp and Kennewell, 2010) but with little scientific evidence to sustain this idea. This position is reinforced by the penetration of technology that has increased worldwide at an exponential rate in the last decade (Chinn and Fairlie, 2010). Interactivity is notably associated with technology because of the unlimited capability of computers to automatically repeat processes or instructions. This association has equivocally made us think that learning will be enhanced by the mere fact of acquiring computers or technological devices capable of reproducing the iterative process. Technological tools alone do not seem effective at enhancing the learning experience (McCabe and Meuter, 2011). Technology and pedagogy need to be well engrained for interactivity to yield a learning effect.

Moreover, it is important to take into account the existence of different types of interactivity that span from a single user interaction to more complex types of interactivity. The former just convey a reaction to a particular input (Sims 1997; 2003) described often in the literature. The latter can produce a particular cognitive effect in the user and are not common mentioned in academic papers for the novice of the research. Navigating by using interactivity in the context of a lesson is a natural type of single user interactivity to control the flow. Using ISAQs is a good example of a more complex type of interactivity. This thesis addressed this particular complexity and examined them in three different contexts.

Effective use of technology will require a paradigm shift from "teaching" to "learning" (Rogers, 2000) which will incorporate sound research on interactivity embedded with pedagogical strategies to enhance the learning experience. The research on "the effects of interactivity in e-Learning system" contributes to reduce this vacuum of scientific evidence (Sims, 2003; Leiner and Quiring, 2008) and study interactivity within three main agents of the educational triangle: the learner, the teacher and the system.

The empirical studies related to each area of the educational triangle report significant results about the effects of interactivity in enhancing the learning experience. These results clearly show evidence of learning, on time, speeding and communicational effects caused by the use of interactivity in these contexts.

7.1 Interactivity in Pedagogical Feedback

The first empirical study (Chapter 4: Interactive Pedagogical Feedback) focused on Pedagogical feedback in the form of ISAQs that was incorporated in an academic lesson to determine the impact that different levels of interactivity have on students' memory and understanding. The ISAQs constitute an important feature of the two e-Learning prototypes developed and their use allows students to evaluate their grasp of the material since immediate constructive feedback offers a valuable contribution to the learning experience.

The ISAQs rehearsing abilities may help to reduce the cognitive load generated by the intrinsic complexity of the lesson presented (Sweller & Chandler, 1994). Mental schemas (see 2.3) to be formed require of complex process to organise information into meaningful cognitive containers in the individual mind. This information presents a degree of complexity that is directly dependent to learner's previous knowledge. In other words, schemata in the mind of a mathematician are different to the schemata of the musician. Each expert has a particular mental map that will make them able to recognise complex pattern related to their own file of expertise almost instantaneously. When learner previous knowledge is high, his/her ability increase to assimilate new information related to this previous knowledge. On the contrary, if this knowledge is low. However, The ISAQ interactive elements allow the learners to rehearse almost instantaneously and validate their answers. Thus, it helps to create the appropriate individual schemata generating a learning effect. They are consistent with the theory of multimedia learning (Mayer, 1997) because meaningful learning takes place when relevant information in the ISAQs makes connections with corresponding representations in the individual cognition.

The ISAQs have a beneficial impact in student learning performance because they are able to construct their own understanding of the material. The potential for ISAQS implementation and fostering students' understanding are enormous. In both experiments implemented it has been observed a learning effect as direct consequence of embedding interactivity in the e-Learning systems.

They in detail indicate that the two groups with ISAQs (retention and transfer conditions) got a better performance than the control group in terms of overall scores. But when the two groups embedded with the ISAQs are compared, the group with the retention condition perform better than the group with the transfer condition in the experiment #1 and the group with the transfer condition perform better in the experiment #2. So in the experiment

#1 the results gave an indication that the ISAQs actually increase memory and in the experiment #2 the results gave an indication that the use of ISAQs promotes deep learning.

These results may be explained by the differences in LCMS that were used to deliver the lesson. The e-learning systems in the experiment #1 used to deliver the lesson were developed in Adobe Authorware 7. It generated a standing alone application that each student use to learn the lesson. In the experiment #2 the delivery mechanism was a web based LCMS. Students accessed the educational material directly from the web server that hosted the leaning objects that amalgamate the lesson. These different in design may provide a different effect in reflection time. However, these ideas need to be investigated further to provide scientific evidence.

The initial experiment that was implemented using Authorware took longer time to load the images and simulations required to present the content because of the design of the application. It was a stand-alone application designed to load the flash and educational material at once. Therefore the flow of the lesson was slower at the beginning. Students reported this stagnant behaviour as inefficient considering that it delayed the normal flow of the material. It was corrected in the second experiment by using a different delivery mechanism. It is considered that this behaviour introduced an extraneous cognitive load (Sweller & Chandler, 1994) that split the attention of the learner (see 2.5.3).

Nevertheless, the results suggest that educational designers, who seek to foster learning, should incorporate interactive transfer questions in all their e-learning systems.

In the context of the experiment the use of ISAQs clearly emphasize the importance of the learning effect obtain by using interactivity. The ISAQs provide reflections on the new material and allow the amalgamation of the new and the existing knowledge by providing constructive feedback

7.2 Interactivity in Audio Feedback

The second empirical study (Chapter 5: Interactive Audio Feedback) relates to enhancing teacher capabilities to produce effective and quicker interactive feedback using audio**.** Due to the fact that for most people speaking is a much quicker form of communication than typing, the speed enhancements of speaking rather than typing are expected to be carried over to the process of creating feedback to enhance learning related activities.

The study involved determining whether the speed enhancements of speaking rather than typing are carried over to the process of creating feedback. Therefore, the investigation sought to test the hypothesis that suggests that creating feedback in audio form is quicker than creating feedback in typewritten form. The investigation also analysed if the phonetic benefits of audio over typewritten feedback are carried over to the learner. The study thus also sought to test the hypothesis that feedback received in audio form is better quality than feedback received in written form. Several experiments were designed to test these hypotheses under slightly different conditions. The results suggest that audio recording can decrease the time it takes to create feedback by 40-63%. There are significant differences in the production of audio versus written feedback.

The availability of pen and paper in contrast to technological devices is controversial and not related to the study. However, it will be interesting to evaluate the production of feedback using literally writing feedback (pen and paper) and compare the results to interactive audio feedback to determine the quicker method. In this study writing feedback is synonymous for typing feedback since a computer and word processor are used to produce it. According to Sweller and Chandler (1994) who compare teaching how to use CAD/CAM systems with and without a computer using a technological device doesn't always produce a speeding effect or lead to a better understanding. Whatsoever the interactivity component that definitely is part of this study will be lost in the process independent of the results which are the subject of another study.

In addition, there is an additional increase in the reduction of the time with the introduction of the guiding template in the experiment #4 (Figure 34 and Figure 35) that direct the procedure of taking notes when evaluating the presentations. According to the tutors, the guiding template helps to create a mental structure to follow while developing the audio feedback to keep consistency when developing all of the audio feedbacks. Lecturer attention is held by this guideline that signals the structure that should be consistent when producing the audio feedback. The behaviour is related to the signalling principle (see 2.5.3) that recommends hints and cues in the organisation of a presentation (Mayer, 2005). It is also related to the multimedia principle of coherence (Moreno & Mayer, 1999) and the cognitive theory of multimedia learning (Mayer, 2005) since the template and the mental structure help to keep attention and the sequence required for developing the audio feedback.

Tutors reported there was a significant time saving in the process of creating the feedback. All tutors producing feedback preferred recording audio feedback because speaking is a more "natural" and effortless process than typing.

The use of interactive technology to create the audio feedback creates a kind of "speeding effect" in the production of the audio file. The effect was persistent across all the experiments. The creation of audio feedback can offer significant time savings for tutors compared to typed text. Modern developments in recording and delivering audio mean that providing audio feedback is now a real possibility for tutors. Not only does it appear to reduce the time taken for them to record the feedback, but it also appears to be a more natural and liberating process.

Although based on the results we can conclude that the production of interactive audio feedback is a more efficient method, it is important to evaluate if content quality doesn't deteriorate during the process. Students' opinions validate that it doesn't deteriorate but on the contrary it is improved because of the added gains introduced by phonetics and personalisation. From the learners' perspective, audio feedback is richer and more authentic than written feedback. It appears to personalize the feedback relationship between tutor and learner, reducing the social space that often divides them. The use of interactivity creates a communicational effect because the students perceived have received a more complete message when have listened the voice of the lecturer. This is consistent with the voice principle (see 2.5.3) that recommends it is better if words are spoken in a standard-accent by a human (Mayer, 2005). The human voice triggers a social response in the learner that encourages them to make sense of the information presented. It also added a personalised connotation to the feedback.

The experiments were developed following the nature cycle of the action research approach (Figure 5). After a sequential evaluation of each experiment (action evaluation), the results trigger a reflection and planning (action planning) work for the next phase to follow that seek for validation (action taking). The reflections on the pros and cons of the approach were taking into consideration when designing and implementing the subsequent experiment.

7.3 Interactivity in Texting Feedback

The latter study focused on the system that mediates the relation between the two main agents of the educational triangle: the teacher and the learner. The empirical study used texting messages (SMS) supported by a web based response system to provide formative feedback to a student audience after educational content has been delivered. The system's feedback employed to communicate with teachers and learners is an easy to set up mechanism to integrate technology with pedagogical practices and learning activities.

The objective of this experiment was to determine if Interactive Texting Feedback is a valid and effective pedagogical approach to enhance the learning experience. Inferential analysis demonstrates good correlations among the variables analysed that indicates that a learning effect have taken place.

The use immediate interactive feedback as part of the particular technological setting in this research is innovative. It involves a large audience that contribute to validate the collective understanding of the lesson. The immediate feedback helps students to create concrete mental associations (schemata) between his prior experience (stored in LTM) and the new information taught (Wittrock 2010; 1974).

Significant results indicate that students consider the use of this approach as a viable contribution to learning, and it should spread to other modules in Brunel University. This is a cost-effective approach to learning since it is a new educational strategy where the students receive immediate constructive feedback and it motivates them to react in real time to the lesson presented.

Some considerations made regarding the willingness for the students to contribute with their messages (SMS) are important because it raise some ethical issues. However, giving the nature and cost-effective of the approach it is recommended they are managed by the administrative instances of the academic institution. It can provide some kind of reward or compensation.

7.4 Limitations of this Research

There are several limitations of this research that should be taken in consideration.

First, the Interactive pedagogical Feedback study used a limited number of ISAQs for each of the conditions (memory and transfer) because the main objective was to determine the

existence of a learning effect. The addition of more ISAQs could show a different degree of the learning effect observed.

Second, the pedagogical design implemented is related to the heart and circulatory systems. Different subject will require specific pedagogical design. Therefore, there is a limitation in using only one subject. The effect of interactivity may be affected to a greater or lesser degree by the introduction of different pedagogy. However, it needs to be investigated.

Third, ethical considerations were taken into account to avoid the application of an innovative way of learning to only a particular part of the sample. This limited the ability to implement a pure experimental design.

Fourth, the level of actual interactivity manipulated in this study was useful at the time the study was conducted. Future research may need to revise other types of interactive elements incorporated in a lesson.

Fifth, the primary research was limited to Brunel University. Industry and others academic sector interested in the research have to take into account this limitation. It could be useful to see the relationship between different institutions.

Sixth, the size of the sample may be considered a limitation. Since, the size of the example was approximately 30 students. Hence, it is possible that some selected samples may not be the most appropriate representatives for this study. However, statistically speaking the use of T-test and other tools allow us to validate the results.

Seventh, the only reported downside of audio feedback (from the students' perspective) was that it was more difficult to navigate and focus on particular aspects of the narrative. However most believed this was more than compensated for by the richness of audio feedback.

Eighth, the contribution made by the interviewees influence the quality of the research conducted. In order to get honest and precise responses the process was managed carefully. Lack of experience by the interviewer can affect the results. However the questions in all the interviews were designed to be straightforward and avoid little intervention of the interviewer. Further studies needs to interview as many staff and students as possible.

Ninth, time was limited in the students interview as a result of the especially with the demand placed on students. Thus participating in an interview was not part of their priority tasks leading them to rush the interviews and giving some short answers

7.5 Conclusion

Significant differences were found in all the experiments that demonstrate that interactivity used in different contexts produce conclusive effects that enhance the leaning experience in all the scenarios investigated (educational triangle).

A learning effect was recognized among all empirical studies in a greater or lesser degree. It was first observed when pedagogical feedback in the form of ISAQs was incorporated in an academic lesson to determine the impact that different levels of interactivity have on students' memory and understanding. A learning effect was also reported on the reception of personalised audio feedback. Lecturers and learners using the texting feedback approach also noticed that comprehension of the material taught was improved. It gives lecturers the ability to perceive immediately if the learning message was delivered as intended. It is considered that interactivity used in the context of this research has the ability to help connectivity between new information and existing knowledge stored in LTM. Thus, it is easily retrievable. The ISAQ helps to create the appropriate individual schemata generating a learning effect. Meaningful learning takes place when relevant information in the ISAQs makes connections with corresponding representations in the individual cognition (LTM) according to the generative theory of learning (Wittrock, 2010; 1974)

These findings contribute with evidence to support the long debate about the lack of demonstration to corroborate the effectiveness of interactivity in e-Learning systems. Moreover, they will serve as guidelines for instructional designers to maximise students learning by using the appropriate type of interactivity related to the specific activity. Furthermore, the results indicates that some types of interactivity produce the effect of increasing the learner's cognitive ability to remember information (memory effect) while other types of interactivity increase the learner's cognitive ability to understand the learning message (transfer effect). Adding interactivity of the two types will magnify the effects because it will increase memory and deep learning.

Feedback plays a fundamental role in the learning process providing diagnosis and remedial suggestions for changing future actions (Kumar & Stracke, 2011; Wang & Wu, 2008). However, the time when feedback is given is vital. Lack of timing indicates that the potential benefits of feedback are often not attained (Chanock, 2000; Duncan, 2007; Hounsell et al., 2008). Embedding Interactivity to feedback mechanisms has proved to be effective in the production and delivering of feedback to learners in e-Learning systems.

7.6 Future Recommendations

Several recommendations have been already identified in the discussion of the findings. They are summarised and main recommendations are presented in the following paragraphs.

It is recommended to implement the ISAQs within others educational subject but taking into consideration the pedagogical design inherent to each topic. For example there is a difference between the approaches used to teach mathematics and music. However, keeping in mind the constructive feedback within each ISAQ must be related to the lesson and should be part of the distracters. Therefore, the difference between the correct answer and the distracters should be recognized by knowledge acquired when learning the lesson.

Future research will incorporate a set of retention ISAQs with another set of transfer ISAQs combined into one system. Retention questions will create a basic knowledge that supports the deeper knowledge reinforced by the transfer ISAQs.

Interactivity performance was determined based on results that evaluated short term memories (Engle et al., 1999). The post-tests implemented were taken immediately after the conditions were applied. Assessments taken after a week and longer period of time are recommended because they can provide information to how long learning last to be compared with relevant literature. Knowledge acquisition and how long the information remains in memory (STM) and how it is degrading with time are important considerations to be studied. An additional post-test could be applied at a later time to determine how long the information learned from the lesson lasts.

Another recommendation is related to the amount of material in the lesson and the number of ISAQ questions. Although they serve for the purpose of this particular experiment, the size of the lesson and the number of questions could be increased for getting a broader perspective of the phenomena.

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9 Appendices

9.1 Appendix A: Experiment 1 Audio feedback recording times

Individual Audio feedback recording times			
student #	time	student #	time
1	2,45	5	2.3
2	2.12	6	2.35
3	2.01	7	2.5
4	3.25	8	2.44
		Total time	16.97

9.2 Appendix B: Experiment 1-Student writing feedbacks.

9.2.1 Student # 1

Your argument is that overall, globalisation can have catastrophic effects on small firms, local cultures and on the environment; nevertheless that globalisation is 'inevitable'. This is how I read your essay, though you do not state this argument as directly and as simply as I have expressed it on your behalf.(Incidentally, it is quite difficult to define globalisation. Is it a process, a cause, or an effect of something? I find writers VERY unclear on this point. What type of 'globalisation' do they mean?)

It is fine to make the argument you wish to make, and use the definition you prefer. This is what is known as a 'thesis' and if you have something to say, then your thesis deserves to be stated in your Introduction, and then supported by what follows.

But it is a thesis which carries an implication: the best that small firms and local cultures can do is to mount resistance, so that their defeat is slower than would otherwise be the case.

It would be good to have heard from you what forms of resistance to globalisation can be identified. Perhaps strategic alliances between small firms in the same sector, or across sectors, or even between small firms and large firms (Teece)… or perhaps the formation of 'inter-firm networks' (Aoki).

I found your writing a bit difficult to understand in places, however I think I have understood you.

Lastly, consider the evidence of your own experience.

9.2.2 Student # 2

Mmmmm…. The 'change literature' and indeed most students think of change as something imposed from the top and resisted from below (dictatorship). This leaves out many other possibilities, including change from below and resistance at the top (revolution); democratic change created through a majority and imposed on all and change that is unanimous. Of course changes can also be insane, and to be resisted by anyone 'in their right mind'.

In other words the change literature is very partial and why? Because it is written for the consumption of managers on the assumption that they will face resistance.

I think it is understandable that you have accepted the literature as it stands and it is legitimate to play safe.

But I am left wondering what you really think. What is the evidence of your own experience of change? And does it support or contradict the argument which I think you are making. If you have something strong to say, why not state it as a 'thesis' in the Introduction, and come out of your corner of the boxing ring ready to launch a powerful punch on the opposition?

Fair use of the literature. Try the literature on 'story-telling in organisations' as a way of creating change in a non-coercive way… (for example work by David Sims)

9.2.3 Student # 3

I like the way you begin with a quote and I think it deserved to be tied with your sentence about 'it depends on the situation'. If one wants to change the course of history, then yes a highly determined group can make a disproportionate difference. To develop this essay into a discussion of that group's decision making quality (and why not?) it might have been good to look at evidence of living within a revolutionary elite, which has changed the history of a technology, organisation or country…. And to look at the relationship between the leadership of that group and the decisions which group members contributed towards.

However you are not quite so courageous to make this your argument and instead fall into the temptation of trying to list ideas from the literature without steering your argument to its logical destination.

I liked the Challenger illustration, as that could have been worked into a discussion about groups which changed history, not by creating successful outcomes, but by taking decisions which led to disaster.

Closer analysis of the Challenger case would indicate that it was not a group decision as such, as the Engineers know of the danger, but were intimidated into silence by the launch controllers and higher officers.

Finally your point about feelings deserves to be enlarged. Aristotle pointed out that there can be no ethics without feelings, and this has big implications for the ethical decisions which groups make, and the feelings which the group can create within itself.

PS I would not make as much use of web sources as you. They are often 'non-refereed' and can be of low quality, having not been exposed to (group!) criticism.

9.2.4 Student # 4

Hi. I hear you. This is good; you are not afraid to develop and express an argument. Your main point revolves around 'type and circumstance' and you provide examples which illustrate the range of outcomes and approaches, drawing careful distinctions as you go.

You pick up on the ideology of panic that pervades our organisations and the literature about them. Perhaps there is a larger argument winking at you here. Can you see what it might be?

I like your distinction between 'resistance to change' and 'people not necessarily disliking change in principle'.

Finally, then, why is change almost always represented as a 'top down initiative met with bottom up resistance'?

See what the 'story-telling' literature has to say about non-coercive change (David Sims). It is refreshingly different to so much change management literature!

9.3 Appendix C: Experiment 1- Lecturer Interview transcript

AUDIO VERSUS TEXT FEEDBACK

Steve Interview transcript

1. Describe the main reason to consider audio versus text feedback

I feel more comfortable working with audio than with text feedback

2. What were your expectations about the possibly outcome?

Completely positive. ….I thinks that will reduce and facilitate my job

3. Do you feel the expected outcome was achieved and why?

Yes….because I could produce more student feedbacks in shorter amount of time

4. Did you expect any drawback, explains?

Yes….the transformation of the files to MP3 files and the whole process until they are inserted in the system ready for the student to hear it, It will be cumbersome.

5. Do you think, if any, the drawback(s) were as you expected?

No ….because the Dictaphone facilitated the recording task and he managed to upload all 8 MP3 files.

6. Do you think audio is more successful than text feedback?

Yes, because help me to save time

7. Were there any problem(s) that you didn't expect?

After listening to the first he noticed quite a few 'ums' and 'ers' that he expect to avoid with more practice.

8. Would you do anything different if you do it again?

No many things….the practice will help to improve the procedure and I feel that I can do it faster

9. Would you do audio feedback for real in the future?

Yes, absolutely

10. Do you have any additional comment or suggestion

I must say that I felt very at ease giving audio feedback. It felt very unconstrained, like free-wheeling down a hill with plenty of elbow room either side. After an hour I did not experience any flagging of energy and certainly no sudden sag in enthusiasm which I admit to getting when marking conventionally…

9.4 Appendix D: Experiment 3- Surveys

Audio Feedback for final assignment SURVEYS that was applied to the students in the module "Managing for the Future" - MB5526

9.4.1 MB5526 - Abdullah Baissa_1_ (1016087)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: _26/06/2011_Module _MB5526_ Native Language _Arabic_Age _32__Gender: M _x_F __Country of origin: ___Saudi Arabia_____

1. Have you experienced audio or video feedback in the past?
   Audio __x__
   Video ____
   Both ____
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop __x__
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately __x__
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No__x__
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written __x__
6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __x__
   e. Strongly agree ____

7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree __x__
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree __x__
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree __x__
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree __x__
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____

9.4.2 MB5526 -Ashish Bangera_2_ (1030424)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: 12/08/2011 Module MB5526 Native Language Hindi Age 28 Gender: M √ F __Country of origin: India

1. Have you experienced audio or video feedback in the past?
Audio No
Video No
Both ____
2. What device you use to listen your audio feedback?
a. i-phone √
b. Brunel computer ____
c. PC computer ____
d. Mac computer ____
e. Laptop √
f. Blackberry ____
h. other ( ) ____
3. How long after you received the audio feedback file did you wait before listening to it?
a. immediately √
b. same day ____
c. Next day ____
d. 2 to 7 day ____
e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No √
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
Audio √
Written ____

6. "I found the use of audio feedback accessible"
a. Strongly disagree √
b. Disagree ____
c. Neutral ____
d. Agree ____
e. Strongly agree ____
7. "I found the use of audio feedback a valuable contribution"
a. Strongly disagree √
b. Disagree ____
c. Neutral ____
d. Agree ____
e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
a. Strongly disagree √
b. Disagree ____
c. Neutral ____
d. Agree ____
e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
a. Strongly disagree √
b. Disagree ____
c. Neutral ____
d. Agree ____
e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
a. Strongly disagree √
b. Disagree ____
c. Neutral ____
d. Agree ____
e. Strongly agree ____

9.4.3 MB5526- Ankit Mundra_3_ (1039472)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment
Date: **16/08/2011** Module **MFF** Native Language **Hindi** Age **25** Gender: **Male** Country of origin: **India**
1. Have you experienced audio or video feedback in the past?
Audio **No**
Video **No**
Both **No**

2. What device you use to listen your audio feedback?
a. i-phone ____
b. Brunel computer ____
c. PC computer ____
d. Mac computer ____
e. Laptop **Yes**
f. Blackberry ____
h. other (_____) ____

3. How long after you received the audio feedback file did you wait before listening to it?
a. immediately ____
b. same day ____
c. Next day ____
d. 2 to 7 day **Yes**
e. after a week ____

4. Did you face any technical problems listening to the file? **No**
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
Audio **Yes**
Written ____

6. "I found the use of audio feedback accessible"
a. Strongly disagree ____
b. Disagree ____
c. Neutral ____
d. Agree **Yes**
e. Strongly agree ____

7. "I found the use of audio feedback a valuable contribution"
a. Strongly disagree ____
b. Disagree ____
c. Neutral ____
d. Agree **Yes**
e. Strongly agree ____

8. "I would like to see continued use of audio feedback for my coursework"
a. Strongly disagree ____
b. Disagree ____
c. Neutral ____
d. Agree **Yes**
e. Strongly agree ____

9. "I found the use of audio feedback contributed to my learning "
a. Strongly disagree ____
b. Disagree ____
c. Neutral **Yes**
d. Agree ____
e. Strongly agree ____

10. "I would like to see audio feedback used for other courses at Brunel"

a. Strongly disagree ____
b. Disagree ____
c. Neutral ____
d. Agree **Yes**
e. Strongly agree ____

9.4.4 MB5526 - Shivaday Shetty_4_ (1034482)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment
Date: _13/08/2011 Module _MFF_Native Language _English_Age _26__Gender: M Country of origin: India

1. Have you experienced audio or video feedback in the past?
   Audio ____
   Video ____
   Both
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes_No____
If yes, please specify__the feed back was contrary to the grade i was given, if all i hear in the feedback was good , i cant fathom the reason of getting a bad grade!

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written ____

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____

9.4.5 MB5526 - Pauline Kolajo_5_ (0834732)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment
Date: _15th Sept _ Module _MB 5526 _Native Language __English_Age _39__Gender: _F _Country of origin: UK

1. Have you experienced audio or video feedback in the past?
   Audio ____
   Video __
   Both _X__
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer __X__
   c. PC computer __X__
   d. Mac computer ____
   e. Laptop __X_
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ___X_
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No__X__
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written ___X_

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral __X__
   d. Agree ____
   e. Strongly agree ____
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral __X__
   d. Agree ____
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral __X__
   d. Agree ____
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral _X___
   d. Agree ____
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral __X__
   d. Agree ____
   e. Strongly agree ____

9.4.6 MB5526 - Olga Rangel_6_ (1043678)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date:	16.09.11	Native Language	Spanish
Module	MB5526 Managing for the Future	Gender	Female
Age	34	Country of origin	Colombia

1. Have you experienced audio or video feedback in the past?
   Audio ____
   Video ____
   Both ____
   No __X__

2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer X
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____

3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately _X_
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No_X_
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio _X
   Written ____

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6. "I found the use of audio feedback accessible"				**X**	
7. "I found the use of audio feedback a valuable contribution				**X**	
8. "I would like to see continued use of audio feedback for my coursework"				**X**	
9. "I found the use of audio feedback contributed to my learning "				**X**	
10. "I would like to see audio feedback used for other courses at Brunel"				**X**	

9.4.7 MB5526 -Chandrasekharan Priyanka_7_ (1032081)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: _16/9/2011_____Module _____Native Language _English_____Age _27__Gender: __F __Country of origin: _India_____

1. Have you experienced audio or video feedback in the past?
   Audio __NO__
   Video ___NO_
   Both ___NO_
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer __Yes__
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately _YES___
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? No____
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio __YES__
   Written ____

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __YES__
   e. Strongly agree ____
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __YES__
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __YES__
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral __YES__
   d. Agree ____
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
    a. Strongly disagree ____
    b. Disagree ____
    c. Neutral __YES__
    d. Agree ____
    e. Strongly agree ____

9.4.8 MB5526 - Muhammad Patel_8_ (1031718)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: 15/09/2011 Module: MFF Native Language: Urdu Age 28 Gender: M _X _F __Country of origin: Pakistan

1. Have you experienced audio or video feedback in the past?
   Audio ____ X
   Video ____
   Both ____
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop _X___
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day _X___
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No_X___
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____ X
   Written ____

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __X__
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ___X_
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____X
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____X
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____X

9.4.9 MB5526 - Mona Varzandeh_9_ (1028138)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: _15 Sep 2011 Module Managing for the future Native Language Farsi Age 27 Gender: Female
Country of origin: Iran

1. Have you experienced audio or video feedback in the past? NO
   Audio ____
   Video ____
   Both ____
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No____
If yes, please specify it wasn't clear for me where should I go to open the file and listen to it

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written ____

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____

9.4.10 MB5526 - Mayank Vats_10_ (1034633)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: 16/09/2011_____ Module – MB5526____ Native Language – Hindi____ Age - 29 ___Gender: M __ __Country of origin: India_____

1. Have you experienced audio or video feedback in the past?
   Audio √ ____
   Video ____
   Both ____
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop √____
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day √____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? - No
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio √ ____
   Written ____

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree √____
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree √____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree √____
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree √____
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
    a. Strongly disagree ____
    b. Disagree ____
    c. Neutral ____
    d. Agree ____
    e. Strongly agree √____

9.4.11 MB5526- May Aba Alkhayl_11_(1032413_)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment
Date: ___15/9/2011___Module ___MFF__Native Language ____arabic____Age _30__Gender: M __F _x_Country of origin: saudi_____

1. Have you experienced audio or video feedback in the past?
   Audio ____
   Video ____
   Both ____
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop __×__
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately __×__
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No__×__
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio __×___
   Written ___

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __×__
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ___
   e. Strongly agree __×___
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __×__
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __×__
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __×__

9.4.12 MB5526 - Giri Suhardi_12_ (1034634)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: 2011 Module: MB5526 Native Language: Indonesia Age: 27 Gender: M Country of origin:Indonesia

1. Have you experienced audio or video feedback in the past?
   Audio ____ No
   Video ____ No
   Both ____ No
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer _x___
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately __x__
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ **No__x__**
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written __x__

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __x__
   e. Strongly agree ____

7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral __x__
   d. Agree ____
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree __x__
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral _x___
   d. Agree ____
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
    a. Strongly disagree ____
    b. Disagree ____
    c. Neutral __x__
    d. Agree ____
    e. Strongly agree ____

9.4.13 MB5526 - Moumita Nag_13_ (1024765)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: 15-09-11Module: MFF Native Language: Hindi Age:28 Gender: F Country of origin: India

1. Have you experienced audio or video feedback in the past? NEVER
   Audio ____
   Video ____
   Both ____
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop _ X
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately X
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No__X__
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio _X___
   Written ____

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __X_
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __X_
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree __X_
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __
   e. Strongly agree __X_
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree _X_

9.4.14 MB5526 - Mengru Han_14_ (1028059)

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: ___18/09___Module ___5526__Native Language _____Chinese _Age _35__Gender: M __F _*_Country of origin: _China_____

1. Have you experienced audio or video feedback in the past?
   Audio ____
   Video ____
   Both ____
   No *
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer __*__
   c. PC computer ____
   d. Mac computer __*__
   e. Laptop __*__
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day _*___
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No_*___
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio __*__
   Written ____

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __*__
   e. Strongly agree ____
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __*__
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree _*___
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree _*___
10. "I would like to see audio feedback used for other courses at Brunel"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree ____
   e. Strongly agree ___*_

9.4.15 MB5526 - Festus Igunsabi_15

The purpose of this survey is to identify the effectiveness of Audio feedback in the final assignment

Date: _21/09/2011_____Module __MB5526___Native Language ___yoruba and English_____Age _32__Gender: M M__F __Country of origin: _____

1. Have you experienced audio or video feedback in the past?
   Audio _yes___
   Video ____
   Both ____
2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ____
   e. Laptop _Laptop___
   f. Blackberry ____
   h. other (_____) ____
3. How long after you received the audio feedback file did you wait before listening to it?
   a. immediately ____
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ___yes_

4. Did you face any technical problems listening to the file? Yes____ No__NO__
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written _yes___

6. "I found the use of audio feedback accessible"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral _Neutral___
   d. Agree ____
   e. Strongly agree ____
7. "I found the use of audio feedback a valuable contribution"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree _Agree___
   e. Strongly agree ____
8. "I would like to see continued use of audio feedback for my coursework"
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree __Agree__
   e. Strongly agree ____
9. "I found the use of audio feedback contributed to my learning "
   a. Strongly disagree ____
   b. Disagree ____
   c. Neutral ____
   d. Agree _Agree___
   e. Strongly agree ____
10. "I would like to see audio feedback used for other courses at Brunel"
    a. Strongly disagree ____
    b. Disagree ____
    c. Neutral ____
    d. Agree _Agree___
    e. Strongly agree ____

9.5 Appendix E: Experiment 3- Text/Audio feedback recording times

Experiment 3-Individual Audio feedback recording times					
Text(T) condition			Audio(A) condition		
Evaluations	time(min)	time(sec)	Evaluations	time(min/ sec)	time(min/ sec)
1	5.53	353	1	2.3	123
2	5.40	340	2	1.58	118
3	10.01	601	3	3.57	237
4	6.11	371	4	2.37	157
M	6.8	416.25	M	2.5	158.75
SD	2.19	123.82	SD	.82	54.96893

9.6 Appendix F: Experiment 3- Text/Audio feedback t-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Equal variances assumed	2.299	.180	-3.801	6	.009	-257.50000	67.73693	-423.24630	-91.7530
Equal variances not assumed			-3.801	4.138	.018	-257.50000	67.73693	-443.11520	-71.88480

9.7 Appendix G: Experiment 3- Lecturer Interview transcript

AUDIO VERSUS TEXT FEEDBACK

Keir Thorpe Interview transcript

1. **Describe the main reason to consider audio versus text feedback**
   It is being increasingly used in the industry and I have seen both presentations on its use and examples at other universities especially in South Wales. In addition I am aware that Audacity is a supported package at this university and as I train academic staff it is important that I am familiar with the software that they may be thinking of or currently be using.
2. **What were your expectations about the possibly outcome?**
   That I would have an audio file of the kind which I have heard demonstrated at conferences and other universities. I did worry that I would make mistakes in what I was going to say.
3. **Do you feel the expected outcome was achieved and why?**
   Yes it was achieved; I have four files of feedback that I can now use. I was generally more fluent than I had anticipated though I realised I had made a mistake in one case not highlighting that the Participant (i.e. student) had not been told by me that they had passed the exercise. I found the exercise pretty tiring and would probably do this again in a more relaxed context such as at home. I have experience of radio broadcasting but I think the intensity of trying to ensure I spoke clearly and left nothing out was actually quite physically tiring.
4. **Did you expect any drawback, explains?**
   Just hesitancy and making mistakes or coming across as confused. I found this system far easier to use than podcasting software such as Camtasia which is very difficult to pause when recording and so as I recorded more feedback I felt confident that I could stop and start easily if I needed to.
5. **Do you think, if any, the drawback(s) were as you expected?**
   No because I communicated in a clear way as I hoped I would. I did become more tired than I expected but if I had considered it and reflected on previous similar experiences notably lecturing and radio broadcasting my expectations would have been better informed.

6. **Do you think audio is more successful than text feedback?**

   I guess this is not for me to judge as I do not know how the people I am providing the feedback to will see it. Even if I find this system as easy to use as I did it may be no use if everyone dislikes receiving audio feedback. I think I would have to take into consideration how tiring the exercise can be though this may reduce with increased usage of this approach. In future I would take steps not to 'burn out' especially if doing a larger number of feedback recordings.

7. **Were there any problem(s) that you didn't expect?**

   Starting the recording on a couple of occasions but that may have stemmed from this not being my own computer and me using the mouse in the opposite hand to usual.

8. **Would you do anything different if you do it again?**

   I would have a checklist of the elements that I must include in each feedback. I had done this to some extent by reading from a proforma but certainly could have had a reminder sheet of what must be in each feedback to make it equitable for all of those receiving the feedback.

9. **Would you do audio feedback for real in the future?**

   If I can persuade my manager to accept it and if I can get a work computer which has audio. I own an appropriate set of headphones and microphone but currently can listen to nothing on my office computer. I would also like to gauge the reaction of those people I teach to this approach to avoid indignation at change which is a very likely tendency with the people I feedback to.

10. **Do you have any additional comment or suggestion**

    This was an interesting experiment and I have learnt a lot from it.

9.8 Appendix H: Experiment 3- SURVEYS related to the Audio Feedback

9.8.1 Audio Feedback for Oral/Poster Presentation (Bob Gilmore)

The purpose of this survey is to identify the effectiveness of Audio feedback within an Oral/Poster presentation context

Date:	**29 Feb 2012**	**Native Language**	**English**
Module	**Oral Presentation for PDAP**	**Gender Male**	
Age	**50**	**Country of origin**	Northern Ireland

1. Have you experienced audio or video feedback in the past (tick one only)??
   Audio ____
   Video ____
   Both ____
   No _√___

2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer __√__
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____

3. How long after you received the audio feedback file did you wait before listening to it (tick one only)??
   a. immediately ____
   b. same day _√___
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No_√___
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio ____
   Written _√___

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
6. "I found the use of audio feedback accessible"					√
7. "I found the use of audio feedback a valuable contribution				√	
8. "I would like to see continued use of audio feedback for my coursework"			√		
9. "I found the use of audio feedback contributed to my learning "			√		
10. "I would like to see audio feedback used for other courses at Brunel"			√		
11. "I consider audio feedback deliver the message more accurately than written feedback"		√			
12. "Audio feedback is more personalised than writing feedback "			√		

9.8.2 Audio Feedback for Oral/Poster Presentation (Mauro Costantini)

The purpose of this survey is to identify the effectiveness of Audio feedback within an Oral/Poster presentation context

Date:14/02/2102		**Native Language**	Italian
Module PDAP		**Gender**	Male
Age 44		**Country of origin**	Italy

1. Have you experienced audio or video feedback in the past (tick one only)??
   Audio ____
   Video ____
   Both ____
   No ___x_

2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer ____
   c. PC computer ____
   d. Mac computer ___
   e. Laptop __x__
   f. Blackberry ____
   h. other (_____) ____

3. How long after you received the audio feedback file did you wait before listening to it (tick one only)??
   a. immediately _x___
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No__x__
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio _x___
   Written ____

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6. "I found the use of audio feedback accessible"					x
7. "I found the use of audio feedback a valuable contribution					x
8. "I would like to see continued use of audio feedback for my coursework"				x	
9. "I found the use of audio feedback contributed to my learning "					x
10. "I would like to see audio feedback used for other courses at Brunel"			x		
11. "I consider audio feedback deliver the message more accurately than written feedback"			x		
12. "Audio feedback is more personalised than writing feedback "			x		

9.8.3 Audio Feedback for Oral/Poster Presentation (Dr. Nuhu Braimah)

Luis Palacios (cbpglpp@brunel.ac.uk)

The purpose of this survey is to identify the effectiveness of Audio feedback within an Oral/Poster presentation context

Date:	**16/02/12**	**Native Language**

Module	**PDAP poster presentation**	**Gender**	Male
Age		**Country of origin**	

1. Have you experienced audio or video feedback in the past (tick one only)??
   No

2. What device you use to listen your audio feedback?
   N/A

3. How long after you received the audio feedback file did you wait before listening to it (tick one only)??
   a. **immediately**

4. Did you face any technical problems listening to the file? **No**
If yes, please specify___**N/A**_____

5. Which form of feedback would you prefer (tick one only)?
   Audio _x__
   Written ____

I think either of them is good and it rather depends on the circumstances the candidate or assessor finds him/herself in. There are a number of factors that make the use of each more convenient or otherwise, and all these factors much be considered before one can say the Audio is more preferable than Written option or vice versa.

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
6. "I found the use of audio feedback accessible"				x	
7. "I found the use of audio feedback a valuable contribution				x	
8. "I would like to see continued use of audio feedback for my coursework"			x		
9. "I found the use of audio feedback contributed to my learning "			x		
10. "I would like to see audio feedback used for other courses at Brunel"		x			
11. "I consider audio feedback deliver the message more accurately than written feedback"		x			
12. "Audio feedback is more personalised than writing feedback "			x		

Comments: Yes, I found it very useful. For instance, the feedback is clear, it commented on relevant issues and straight forward to the point. The timing is also very good as I can easily relate it the poster.

9.8.4 Audio Feedback for Oral/Poster Presentation (Yanmeng Xu)

Luis Palacios (cbpglpp@brunel.ac.uk)

The purpose of this survey is to identify the effectiveness of Audio feedback within an Oral/Poster presentation context

Date:	**16/02/2012**	**Native Language**	**Chinese**
Module	**PDAP**	**Gender**	Male
Age	**40**	**Country of origin**	China

1. Have you experienced audio or video feedback in the past (tick one only)??
   Audio ____
   Video ____
   Both ____
   No _√___

2. What device you use to listen your audio feedback?
   a. i-phone ____
   b. Brunel computer _√___
   c. PC computer ____
   d. Mac computer ____
   e. Laptop ____
   f. Blackberry ____
   h. other (_____) ____

3. How long after you received the audio feedback file did you wait before listening to it (tick one only)??
   a. immediately _√___
   b. same day ____
   c. Next day ____
   d. 2 to 7 day ____
   e. after a week ____

4. Did you face any technical problems listening to the file? Yes____ No_√___
If yes, please specify_____

5. Which form of feedback would you prefer (tick one only)?
   Audio __√__
   Written ____

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
6. "I found the use of audio feedback accessible"					√
7. "I found the use of audio feedback a valuable contribution					√
8. "I would like to see continued use of audio feedback for my coursework"					√
9. "I found the use of audio feedback contributed to my learning "					√
10. "I would like to see audio feedback used for other courses at Brunel"					√
11. "I consider audio feedback deliver the message more accurately than written feedback"				√	
12. "Audio feedback is more personalised than writing feedback "				√	

9.9 Appendix I: Experiment 3- PDAP PRESENTATION EVALUATION

9.9.1 Presenter's Name: Dr. Nuhu Braimah.

Programme of Development in Academic Practice (PDAP)
POSTER

Presenter's Name: Dr. Nuhu Braimah **Date: 14/02/2012**
School/Unit: Engineering & Design

1 - unsatisfactory, 2 - satisfactory, 3 - impressive, 4 - outstanding

Criteria	1	2	3	4	Comments Identify particular strengths and suggestions for improvement
Presentation of information on the Poster itself is Clear e.g. clear to read, data easily comprehensible, appropriate use of colour for clarity		√			Though the three columns of information were clear. The poster suffered in particular from the bad positioning of one table which meant that it was not clear what the different columns were referring to as the text was chopped off. This undermined the information you were communicating.
Poster is Visually Interesting: e.g. not simply chunks of text or numerous tables, colour/images used to attract the eye			√		The use of colour and images was sensibly handled. There was quite a lot of text but it was not excessive. The presentation was eye catching and drew the audience in.
Content of the Poster is Informative: e.g. properly referenced, clear development of ideas, conclusions are apparent			√		The sections were clear and they were laid out sensibly in a logical way. The ideas were developed well across the poster and there was effective referencing.
The Poster is Original/ Innovative: e.g. in terms of original/innovative research and/or how it is presented on the poster				√	The focus on health and safety was a refreshing change and on a topic which is too often neglected. The research using personal visits combined with interviews with staff of all kinds as well as students was similarly seen as going beyond the usual approaches.

For PDAP Staff Only - Outcome: Pass / ~~Needs Further Work~~ [Circle as appropriate]
Moderator [Signature]: *Keir Thorpe* **Date: 15/02/2012**

[Name printed]: Dr. K.M. Thorpe

NB: A Pass is conditional until approved by the Moderation Board

9.9.2 Presenter's Name: Dr Mauro Costantini.

Professional Development in Academic Practice

Programme of Development in Academic Practice (PDAP)
ORAL PRESENTATION

Brunel UNIVERSITY LONDON

Presenter's Name: Dr. Mauro Costantini **Date: 14/02/2012**
School/Unit: Social Sciences/Finance & Economics

1 - unsatisfactory, 2 - satisfactory, 3 - impressive, 4 - outstanding

Criteria	1	2	3	4	Comments Identify particular strengths and suggestions for improvement
Presentation is Clear: e.g., audibility, pace, fluency, body language, eye contact			√		You spoke confidently and generally had good body language though this was undermined once the slides were used by you going backwards and forwards between them and the flipchart. It was actually better when you were still not using the slides due to the download. You spoke too fast especially to a non-specialist audience and you did nothing to confirm that the audience understood what you were saying. You can use interview presentation slides but for clarity these needed much more adaptation for this context.
Presentation is Engaging: e.g., suitable balance of oral and visual resource, interesting topic, appropriate to audience		√			There was confusion about what this presentation was meant to be about, whether it was about your career or whether it was around basic econometrics and this confusion put off the audience. The level was rather too high for this audience. The scribbling of illustrative diagrams did not help. It would have been better to have a handout listing the publications you were going to talk about and prepared slides with the charts that you wanted to use to illustrate the principles you ended up drawing very quickly and not clearly. It appeared as if you addressed the different topics at random. The whole presentation could have been clearer and more audience friendly.
Content is Informative: e.g., well organised, cohesive, focused, relevant to audience		√			The slides were simply bibliographical and had not been adjusted to be appropriate for this presentation. You quickly lost the audience as a result. The linkage between your career and explanation of the econometric principles could have been handled far better. You needed far tighter focus on one aspect or the other rather than jumping back and forth between the two both physically and intellectually.
Presentation is Original or Innovative: e.g. original research, innovative approach to research or presentation		√			Overall the presentation was confused. The slides were simply lists of publications and needed to be repurposed to be appropriate. The objective of this particular presentation needed to be far clearer.

For PDAP Staff Only - Outcome: Pass / ~~Needs Further Work~~ [Circle as appropriate]
Moderator [Signature]: *Keir Thorpe* **Date: 15/02/2012**

[Name printed]: Dr. K.M. Thorpe, FHEA

NB: A Pass is conditional until approved by the Moderation Board

9.9.3 Presenter's Name: Bob Gilmore

Programme of Development in Academic Practice (PDAP)
ORAL PRESENTATION

Presenter's Name: Bob Gilmore **Date: 14/02/2012**
School/Unit: Arts/Music

1 - unsatisfactory, 2 - satisfactory, 3 - impressive, 4 - outstanding

Criteria	1	2	3	4	Comments Identify particular strengths and suggestions for improvement
Presentation is Clear: e.g., audibility, pace, fluency, body language, eye contact			√		Well, delivered, engaging. Eye contact was reasonably good but you did not look at the Advisors. It was well summarised and the steps between you speaking and playing the recordings was well handled.
Presentation is Engaging: e.g., suitable balance of oral and visual resource, interesting topic, appropriate to audience				√	The presentation was very engaging even to audience members from very different subject areas. The balance was with audio rather than visual resources and this was handled well. The use of humour helped with the engagement and the whole presentation seemed to draw the audience in well.
Content is Informative: e.g., well organised, cohesive, focused, relevant to audience				√	This was informative both in showing what you provide to students and in simply informing this audience. At times there might have been a little too much content but in general it was handled well. In particular the line of argument and the theme were developed well for this non-specialist audience.
Presentation is Original or Innovative: e.g. original research, innovative approach to research or presentation			√		In many ways this was a traditional presentation but the use of audio resources and of the particular nature that you used was refreshing.

For PDAP Staff Only - Outcome: Pass / ~~Needs Further Work~~ [Circle as appropriate]
Moderator [Signature]: Keir Thorpe **Date: 15/02/2012**

[Name printed]: Dr. K.M. Thorpe, FHEA

NB: A Pass is conditional until approved by the Moderation Board

9.9.4 Presenter's Name: Yanmeng Xu

Programme of Development in Academic Practice (PDAP)
POSTER

Presenter's Name: Yanmeng Xu **Date: 14/02/2012**
School/Unit: Engineering & Design

1 - unsatisfactory, 2 - satisfactory, 3 - impressive, 4 - outstanding

Criteria	1	2	3	4	Comments Identify particular strengths and suggestions for improvement
Presentation of information on the Poster itself is Clear e.g. clear to read, data easily comprehensible, appropriate use of colour for clarity			√		Clear indication of the process is shown across the middle of the poster. The text at the top of the poster explaining the project could be larger at least the size of the title and your name.
Poster is Visually Interesting: e.g. not simply chunks of text or numerous tables, colour/images used to attract the eye			√		The poster is visually interesting with good use of colour and of appropriate images. The different sections of information are clearly boxed.
Content of the Poster is Informative: e.g. properly referenced, clear development of ideas, conclusions are apparent		√			There needs to be far more context about the module and the use of interim assessment in it especially as this is different from many other modules at this university. The 'problem' which you are addressing in the project also needs to be made much clearer on this poster. The models you are using and the likely impacts are clear.
The Poster is Original/ Innovative: e.g. in terms of original/innovative research and/or how it is presented on the poster		√			This is a standard approach and form of poster. The clearest innovation is in terms of developing the different models to apply to the analysis.

For PDAP Staff Only - Outcome: Pass / ~~Needs Further Work~~ [Circle as appropriate]
Moderator [Signature]: *Keir Thorpe* **Date: 15/02/2012**

[Name printed]: Dr. K.M. Thorpe, FHEA

NB: A Pass is conditional until approved by the Moderation Board

9.10 Appendix K: Correlations for the Undergraduate Course

		(E)	(CL)	(CU)	(VC)	(SM)
Entertainment (E)	Pearson Correlation	1	.531(**)	.572(**)	.637(**)	.716(**)
	Sig. (2-tailed)					
Contribute to Learning (CL)	Pearson Correlation	.531(**)	1	.642(**)	.752(**)	.643(**)
	Sig. (2-tailed)					
Continuing using in class(CU)	Pearson Correlation	.572(**)	.642(**)	1	.734(**)	.788(**)
	Sig. (2-tailed)					
Valuable Contribution (VC)	Pearson Correlation	.637(**)	.752(**)	.734(**)	1	.780(**)
	Sig. (2-tailed)					
Spread to other modules (SM)	Pearson Correlation	.716(**)	.643(**)	.788(**)	.780(**)	1
	Sig. (2-tailed)					

9.11 Appendix L: Correlations for the Masters Course

		(E)	(CL)	(CU)	(VC)	(SM)
Entertainment (E)	Pearson Correlation	1	.588(**)	.512(**)	.405(**)	.564(**)
	Sig. (2-tailed)					
Contribute to Learning (CL)	Pearson Correlation	.588(**)	1	.598(**)	.620(**)	.588(**)
	Sig. (2-tailed)					
Continuing using in class(CU)	Pearson Correlation	.512(**)	.598(**)	1	.544(**)	.698(**)
	Sig. (2-tailed)					
Valuable Contribution (VC)	Pearson Correlation	.405(**)	.620(**)	.544(**)	1	.597(**)
	Sig. (2-tailed)					
Spread to other modules (SM)	Pearson Correlation	.564(**)	.588(**)	.698(**)	.597(**)	1
	Sig. (2-tailed)					