A comparative analysis of performance and cognition in multimedia learning between ESB and NESB students in higher education

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Abstract
The inspiration to conduct the present study was the rapid spread of multimedia and Internet technologies becoming integrated into education systems intended to facilitate teaching and learning of students studying in Australia from both English speaking backgrounds (ESB) and non-English speaking backgrounds (NESB). With the development of communication technologies, multimedia resources have increasingly been integrated within all levels of educational systems. Text, audio, image, animation and video are the most frequently used elements included in multimedia contexts for instructional purposes in authentic learning environments. However, the previous findings indicated that in comparison with ESB individuals, NESB individuals prefer to access learning content via visual sources because English is their second/third language spoken and they experience more difficulties in learning from verbal-related cognitive contexts. Therefore, it is important to identify the differences that exist between ESB and NESB individuals in comprehending different formats of learning materials in order to be able to fulfil their different needs and maximise their potential for academic success.

The present study has employed a hypermedia system as the medium to present the experimental multimedia context aimed at investigating the influence of different types of multimedia formats on learners’ comprehension performance and recognising the diversity of performance in comprehending learning materials between ESB and NESB sample groups and within each sample group respectively. Fifty-four participants took part in the experiment. They were randomly recruited from undergraduate students enrolled in the unit of Professional Communication Practice (LPR100), and were assigned into two different experimental groups depending on their language backgrounds, ESB or NESB. All participants were required to comprehend five different formats of multimedia learning materials presented through linearly structured
hypermedia contexts and answer comprehension questions to measure their comprehension performance. There five formats of learning materials were: hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links.

The present study employed a quantitative research method for data analysis. The results confirmed that there is a difference in performance between ESB and NESB students within some of the experimental learning contexts. The results showed that the ESB students’ performance was maximised using hypermedia materials with audio links while NESB students showed maximum performance when interacting with hypertext materials containing text links.

Based on the results of the present study, the practical evidences for multimedia learning and the most effective multimedia structure(s) for instructional and educational purposes to meet the needs of students across different language backgrounds have been provided. The findings could be incorporated into multimedia, hypermedia and/or e-learning contexts in the future in order to maximise students’ potential for academic success.
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Finally, I would like to express my special sincere gratitude to my parents, Yanfu Wang and Yunhui Li, for their endless love and support.
Declaration

I hereby declare that this thesis is the presentation of my original research work and I am the sole author of it. It contains no material that has been accepted for the award to the candidate of any other degree or diploma. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public. The total number of words is under 100,000.

The work was done under the supervision of Dr Elena Verezub and Dr Robert Gill from Swinburne University of Technology.

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Signature:

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Chapter 1
Introduction

1.1 The background of the present study

Multimedia is a powerful means of communication due to its unlimited methods and availability for use. It was firstly presented as an art form to express an unscripted presentation incorporating music, dance, spoken words, visual arts and slide projections by John Cage in 1952 (Burke 1972). Over the last few decades, multimedia as a phenomenon has evolved and grown very quickly, increasing productivity and retention rates due to the extensive use of multimedia applications in industries as an effective instructional medium for delivering information (McMaster & McMaster 2002; Rahman 2008).

Multimedia has been used extensively in many fields, particularly in the field of education. Nowadays, multimedia technologies have permeated the educational system as an effective tool for facilitating both teaching and learning (Oshinaike & Adekunmisi 2012). Reviewing its history, multimedia was initially applied to enhance teaching as a ‘sample’ one-hour lecture in 1953, using a string of separate films, multiple screens of slide shows, audio tapes and controlled incense odours to supplement the central message presented (Burke 1972; Rahman 2008; Rapaport & Stayton 2001). These days, multimedia is used as an effective medium to distribute instructional information over a large population (Oshinaike & Adekunmisi 2012).

In recent decades, with the tremendous impact of improvements in cutting-edge information and communication technologies, multimedia has expanded into a wide variety of approaches and information formats (Oshinaike & Adekunmisi 2012). Particularly, access to computers has enabled users to work at their own pace and level. As well, a number of
resources and various types of equipment have emerged from the computing sector which provides the effective instructional multimedia products used to reinforce teaching and learning. For example, multimedia learning materials can be presented digitally as on-screen text, still photos and video and audio clips (Rahman 2008).

The Internet is a powerful platform that has potentially maximised the function of multimedia for sharing of resources and expertise for instructional and educational purposes amongst learners. As multimedia has been tightly integrated with the Internet to deliver information over the World Wide Web, new forms of interactions have emerged and accelerated between humans and a variety of high-speed, media-rich multimedia resources (Oshinaike & Adekunmisi 2012). Hypermedia and web multimedia are typical examples which have combined the Internet and multimedia (Walker 2010).

Indeed, education systems have been significantly expanded by intertwining with technologies. The development of both computers and the Internet has enabled multimedia resources to be increasingly integrated within all levels of educational systems, especially in western English speaking countries (Clark & Mayer 2008; Fan 2009). E-learning has been recognised as an important innovation in virtual multimedia classrooms. With the development of information and communication technologies (ICT) and the availability of the World Wide Web (WWW), e-learning provision has improved education systems at all levels, including schools, higher education and vocational training. Thus in many countries, especially in the English-speaking countries, education has substantially changed from a national focus to a global focus, becoming more internationalised (Altbach, Reisberg & Rumbley 2009; Clark & Mayer 2008; Oshinaike & Adekunmisi 2012; Walker 2010). The education sectors in Australia, particularly higher education, have closely embraced e-learning and web multimedia to support instructional context delivery.
In addition, multimedia contexts for electronic instructional delivery have been applied to supplement teaching and learning in classrooms. They have significantly improved learners’ ability to study. However they have also produced challenges as differences between individuals who come from different regions exist. Thus for instructors, it is important to adapt to different kinds of strategies in order to effectively provide assistance for students (Carstairs et al. 2006; Ramburuth & McCormick 2001).

1.2 The impacts of globalisation and internationalisation

Despite being related, globalisation and internationalisation are two different things with different meanings and purposes. Globalisation is a key fact in the 21st century and refers to a cluster of related changes that are ‘reality shaped by an increasingly integrated world economy, new information and communication technology (ICT), the emergence of an international knowledge network, the role of the English language, and other forces beyond the control of academic institutions’ (Altbach, Reisberg & Rumbley 2009, p. iv). Internationalisation then refers to a variety of policies and programs that have been made by governments and universities aiming to respond to globalisation (Altbach, Reisberg & Rumbley 2009).

In Australia, due to the ongoing migration and the internationalising trend of many universities, students who enrol in higher education programs, come from different cultural and language backgrounds (Australian Bureau of Statistics 2005; Byers-Pevitts 2008; Carstairs et al. 2006).

English as a foreign language sometimes creates a critical challenge or
difficulty in academic learning for international students, particularly those who come from non-English speaking backgrounds (NESB) (Carstairs et al. 2006). In this respect, the performance of ESB and NESB students in comprehending learning materials is likely to differ and thus they would better instructed in different ways (Carstairs et al. 2006; Ramburuth & McCormick 2001). Therefore it is important to recognise whether there are differences between ESB and NESB students in comprehending when using various types of learning contexts.

1.3 A brief overview of the present study

This study investigates the differences between ESB and NESB students’ performance in comprehending various formats of multimedia learning materials presented in the hypermedia environment, namely: hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links. The aims of the study are as follows:

- To investigate the influence of various formats of multimedia learning materials (presented in hypermedia / hypertexts associated with different media links, namely: image, audio, video, animation and text) on learners’ comprehension performance; and
- To recognise the diversity of performance in comprehending each format of learning materials between the ESB and NESB sample groups and the diversity of performance in comprehending all five formats of learning materials within the ESB and NESB sample groups.

This study employs a quantitative research methodology to investigate the effects of five different types of multimedia formats on ESB and NESB
students’ comprehension performance. It compares ESB and NESB students’ comprehension performance when comprehending each format of learning material, as well as comparing the performance in comprehending the five given multimedia formats within each sample group. It will further explore the main factors that may lead to the diversities in the students’ performances.

Students undertaking the undergraduate unit Professional Communication Practice (LPR100) were recruited as participants. They were divided into two sample groups based on their first language, being an English speaking background (ESB) sample group and a non-English speaking background (NESB) sample group. The present study had five one-hour reading comprehension sessions that provided reading content designed according to the lecture topics.

In session 1, the students were asked to read hypermedia materials with image links. In session 2, they were assigned to interact with hypermedia materials with audio links. In session 3, the students were presented with hypermedia materials with video links. In session 4, hypermedia materials with animation links were provided to students to read. In session 5, the students were asked to read hypertext materials with text links. Both sample groups were asked to complete the same materials and the related comprehension tasks at the same time and under the same conditions. The learning materials for each reading session had a similar length of approximately 1,250 words and contained five hyperlinks. This was followed by a task of completing nine comprehension questions.

The overall design of the instructional hypermedia materials followed a number of existing theories which were organised according to the rationality principles proposed by Fastrez (2002). Jonassen’s (1986) principles of hypertext design procedures were used to connect the nodes of information. The overall
interface screen display pattern followed Hemard’s (1997) suggestions. The hypermedia format's design was to some extent instructed by Sweller's (1988) cognitive load theory and Mayer’s (2009) cognitive theory of multimedia learning. Furthermore, a readability test of the given learning materials for each session was completed in order to make sure all content was adequate for the participants’ levels of competency to comprehend written texts in English. The above theories and principles involved, are elaborated in Chapter 5.

1.4 Delineation of thesis

This study is divided into nine chapters. The overall structure of this thesis is as follows:

**Chapter 1** Introduction;

**Chapter 2** Multimedia technologies and their features and the effects on performance;

**Chapter 3** Multimedia learning and learners’ cognition;

**Chapter 4** English speaking background (ESB) students and non-English speaking background (NESB) students and their learning performance in reading and listening comprehension;

**Chapter 5** Overview of the present study and the research methodology;

**Chapter 6** Presentation and analysis of the empirical data;

**Chapter 7** Discussion;

**Chapter 8** Design and delivery of instructional materials; and

**Chapter 9** Conclusions, limitations, recommendations and future works.

Chapter 1 outlines the present study by providing some background knowledge, relevant literature and setting the focus of the study. The main aim
of Chapter 2, Chapter 3 and Chapter 4 is to introduce and discuss a variety of key concepts in the pertinent literature of multimedia learning, cognitive activities, ESB and NESB students and their performance in comprehending multimedia contexts, and then establishing the gaps which the present study will fill.

Chapter 5 sets out the research methodology used to guide the study, and outlines the process of data collection and analysis. In this chapter, the aims and hypothesis of the current study are presented. The underpinning theories of multimedia learning contexts, hyper-document design and comprehension task design are discussed in conjunction with their relevance to the current study. The overall research design is also presented, including participants and experimental instruments as well as a detailed description of the data collection procedures.

Chapter 6 presents the analysis of the data. The statistical analysis conducted on data, includes an independent samples t-test and paired samples t-tests. Interpretation of the data analysis is included in this chapter as well.

Chapter 7 discusses the findings of the empirical data and indicates the relevance of previous research studies. There is a discussion of the influence of language backgrounds on comprehension performance between ESB and NESB students and then connections between the present results and previous research findings are discussed in terms of the ESB and NESB students’ comprehension performance across the various formats in multimedia learning.

Chapter 8 recommends an effective design approach to deliver instructional multimedia learning materials based on the experiment and the research findings of this study. This approach is particularly presented in the
Chapter 9 summarises the key findings of the present study and as well provides a series of recommendations based on the experiment and the research findings of the present study. This chapter also highlights the limitations of the current study and suggests future research directions.

The literature review starts from Chapter 2. In this chapter, an extensive literature review is presented with the focus on the historical developments and the definitions of multimedia, various media elements commonly included in multimedia, various types of multimedia resources and general design approaches. In particular, this chapter discusses hypermedia and e-learning and the features and benefits of e-learning in facilitating learning performance.
Chapter 2

Multimedia technologies and their features and the effects on performance

The purpose of this chapter is to briefly review the history of multimedia development, and summarise and evaluate the recent literature related to multimedia. It will further reveal the special features of multimedia and the various media elements which are usually associated with multimedia, including text, audio, image, animation and video. It will also concentrate on analysing multimedia resources from three different views, and discuss the technology-centred and learner-centred design approaches to multimedia. In addition, this chapter will discuss the various classifications of multimedia resources. Finally, it will present relevant literature about e-learning and some critical factors that can determine the success of e-learning.

This chapter is divided into six main sections:

| Section 2.1 | History and definitions of multimedia |
| Section 2.2 | Different types of media elements included in multimedia |
| Section 2.3 | Different views of multimedia resources |
| Section 2.4 | Two approaches of multimedia design |
| Section 2.5 | Different types of multimedia presentations |
| Section 2.6 | E-learning applications in the educational fields |

2.1 History and definitions of multimedia

The definition of multimedia has evolved over time. The word ‘multimedia’ derives from the Latin words ‘multum’ and ‘medium’, meaning a combination of multiple media file formats (Burke 1972; Rahman 2008). After several decades,
‘multimedia’ was defined by the unabridged second edition of The Random House Dictionary of English Language (1987). According to this definition, multimedia is a noun which combines various types of media elements.

2.1.1 History of multimedia

Reviewing the history of multimedia, this term initially came into use in 1961 as the phenomenon of multimedia rapidly expanded in the American culture of the 1960s. The original multimedia event was staged by musician John Cage at Black Mountain College in Asheville, North Carolina, in the summer of 1952. He held a mixed media ‘happening’, titled ‘Theatre Piece No. 1’ which combined music, dance, spoken words, visual arts and slide projections (Burke 1972; Kostelanetz 1968; Lyons & Plunkett 2007; Rahman 2008).

In the late 1940s and throughout the 1950s, the United States was going through the Cold War. The Cold War affected almost all aspects of American political and cultural life. Cage’s creation presented radical changes in people’s conceptions of history, time, speed and attention. These changes were brought about by technological developments and made evident by the Cold War and the danger of nuclear attack. In later years, his multiple media presentation achieved renown (Lyons & Plunkett 2007; Sexton 2007).

Cage’s presentation was accepted by the majority of professionals in the field of multimedia as the first example of a ‘happening’ with mixed media and was also multi-disciplinary and anti-establishment. Furthermore, Cage’s innovation made multimedia formats possible and opened up another space for thinking about ways of presenting by combining different types of media elements. Thus it seems certain that the field of multimedia did begin with John Cage (Burke 1972; Lyons & Plunkett 2007; Nadeau 2006). Moreover, Cage’s work is an example of what would be included or presented in happenings, theatre pieces

There is also a sample lecture that a rank in importance with Cage’s ‘happening’ in the history of multimedia development. The one-hour lecture was presented by Charles Eames, George Nelson and Alexander Girard in early 1953, and it followed the same format as Cage’s by encompassing films, multiple screens of slides, audio tapes and controlled incense odours. The content of the lecture was presented with a string of separate films and slide shows that added up to one central message (Burke 1972; Nelson 1954; Rapaport & Stayton 2001). Cage’s piece was germinal for the use of multimedia formats in artistic performances. Similarly, Eames, Nelson and Girard’s lecture was a presentation which influenced multimedia applications in educational environments. Thus, multimedia presentations in education owe a significant debt of origination to Eames, Nelson and Girard (Burke 1972; Shepherd 2003).

In early 1961 multimedia technologies were reintroduced into educational fields by the Multimedia Instructional Laboratory at University of Wisconsin. Multimedia as a word initially appeared and originated from the Wisconsin Laboratory (McMaster & McMaster 2002). In 1968, the University of Michigan Episcopal Student Centre organised a multimedia worship service. This event resulted in the term multimedia emerging for the first time in print media (Burke 1972).

2.1.2 Definitions of multimedia

For an audience uneducated in true multimedia, almost any display of visuals and sounds was considered ‘worthwhile’ and ‘impressive’ (Mayer 1997, 2009). Schlesinger’s (1979, p.1) article notes the ‘use of the word multimedia is discussed in terms of cultural history, English grammar, classical rhetoric,
communication technology, and recent articles by audiovisualists’. In fact, multimedia content has seen explosive growth and is discussed even today after forty years. However, the term multimedia is ambiguous. The term means different things to different people. Indeed, multimedia can be an artistic medium for performance, a communication tool for social networks and an educational tool for academics. Reviewing the relevant literature, the word multimedia has been defined in various ways:

- Multimedia is defined as ‘multiple forms of media in a presentation’ (Schwarts & Beichner 1999, p.8);

- Multimedia is ‘information in the form of graphics, audio, video, or movies. A multimedia document contains a media element other than plain text’ (Greenlaw & Hepp 1999, p.44);

- Multimedia is the way for ‘combined use of several media, such as movies, slides, music, and lighting, especially for the purposes of education and entertainment’ (Brooks 1997, p.7);

- Multimedia is computer programs that include ‘text along with at least one of the following: audio or sophisticated sound, music, video, photographs, 3-D graphics, animations, or high-resolution graphics’ (Maddux, Johnson & Willis 2001, p.253); and

- Multimedia is ‘the use of a variety of artistic or communication media; (Computing) incorporation of a number of media, such as text, audio, video and animations, esp. interactivity’ (Oxford English Dictionary Online 2008).

In recent decades, with the evolution of new information technologies, notions of multimedia have been expanded. Mayer’s focus of multimedia research was
on verbal and pictorial channels. Mayer built his works based on an integration of Baddeley’s dual-channel assumption, Baddeley’s model of working memory, Paivio’s dual-coding theory and Sweller’s theory of cognitive load (Baddeley 1986, 1992, 1999; Chandler & Sweller 1991; Clark & Paivio 1991; Mayer 2009; Paivio 1986; Sweller 1999) suggesting:

Multimedia as the presentation of material using both words and pictures...thus the definitions of multimedia I use...is narrower than some other definitions...I have opted to limit the definition to just two forms – verbal and pictorial, because the research base in cognitive psychology is most relevant to this distinction (Mayer 2009, p.3).

Mayer’s definition is a good start with its association of multimedia with human cognitive activities. However, the main weakness of this definition is that it is too narrow and limits the media elements that can potentially be employed. Also, this explanation does not provide a deep insight into the essential factors that ensure the effectiveness of multimedia.

Neo and Neo (2001, p.20), from the faculty of the Multimedia University in Malaysia, extend this definition. They refer to multimedia as ‘the combination of various digital media types, such as text, images, sound and video, into an integrated multisensory interaction or presentation to convey a message or information to an audience’.

Neo and Neo (2001) emphasise the multiplicity of multimedia in terms of multiple technical resources, multiple formats and multiple sensory modalities. This definition was developed from Mayer’s definition and thus takes into account the media used as well as the influence of media on learners’ cognitive processes.
By reviewing all the definitions of multimedia and the recent relevant literature, the definition of multimedia has been significantly enlarged to refer to:

- A combination containing more than one media element (generally includes image, audio, video, animation and text);
- An electronic tool used to present information;
- A computer-based program;
- An instructional / educational tool used to achieve academic goals or improve the performance of learning; and
- A system-integrated multisensory interaction that may influence users’ cognitive processes.

In the field of education, multimedia is closely related to instructional materials in terms of adaptive computer-based instructional materials, programs, presentations and so forth, used to reinforce and supplement knowledge acquisition. The multimedia content can vary in different contexts and disciplines (Mayer 2001).

**2.2 Different types of media elements included in multimedia**

There are various media forms that have arisen from communication processes (Thompson & McGill 2008). Different media have different characteristics and their own ways to store and deliver information. As a media combination, multimedia usually contains at least two different media components and flexibly incorporates the media files in varying quantities (Thompson & McGill 2008; Wong 2009). As Norman (1988) stated, each individual element within multimedia contexts may have some influence of ‘affordances’ and ‘constraints’ on learners’ cognitive processes and academic achievements.
The following sections discuss five types of media elements, including text, audio, image, animation and video, which are the most frequently used elements for instructional purposes in authentic learning environments (Furht 2008; Mayer 2009; Wong 2009). Their definitions, special features and effects on learning are elaborated and evaluated below.

2.2.1 Text

Text is the simplest communication type and also the most commonly used media element for daily communication in human society. In addition, text is able to encapsulate complex information and is easily controlled for information storage and transmission which is vital for people’s information management (Vaughan 2008).

Text consists of letters, words, sentences and paragraphs to tell a story, state a fact, express an idea or report an event. As a basic media element, the nature of text is that it is made up of a limited symbol set of codes. The definitions of text have varied over the past decades (Cranny-Francis 2005; Gupta 2002b). According to Chambers 21st Century Dictionary (2009), ‘text’ can be defined as follows:

- A short passage from the Bible taken as the starting-point for a sermon or quoted in authority;
- A theme or subject;
- The main body of printed words in a book as opposed to the notes and illustrations, etc;
- The actual words of an author or piece of written work as opposed to commentary on them;
- A book, novel or play, etc that forms part of a course of study as a set text;
Text was treated as a single medium for paper-and-pen technology to transmit messages however since the recent explosion of information technologies, text communication is becoming more prevalent and important than before which can be easily seen through its varied definitions.

Text may have more roles to play in multimedia (Cranny-Francis 2005). In multimedia systems, text is able to assist in navigating, explaining pages and pictures, and presenting the content included in a program. Factors including fonts, sizes and colours can affect readability of text while processing information. Thus, clarity and readability have to be taken into account when designing text for any intended communication (Cranny-Francis 2005; Steinmetz & Nahrstedt 1995, 2004; Vaughan 2008). In this sense, clear and readable text will contribute to comprehension and communication.

The text presented in multimedia environments is delivered by electronic means. Computer-based text is the simplest digital media element used to code and store information. Electronic text should be clear and readable, which is consistent with the presentation of text in print-based texts. The text is generally associated with other media elements such as audio and images, to serve readers in a multimedia system in order to supplement the information presented and effectively keep readers engaged with the content (Cranny-Francis 2005; Steinmetz & Nahrstedt 1995, 2004; Vaughan 2008).

2.2.2 Audio

Audio or sound is the natural analogue usually heard by the ears (Vaughan 2008). Audio is a predominant component used to create meaning and present
information which can direct attention, express emotions and provide feedback in people’s daily communication. As a result, audio is an increasingly popular media type integrated in multimedia applications (Vaughan 2008). Audio can be used in more complex and varied ways in comparison with text, such as speech, music, sound effects and voice-overs, thus making multimedia products come alive (Gupta 2002a). Generally, all sounds are categorised into two broad catalogues, which are content sound and ambient sound.

Content sound is used to deliver information or messages to audiences (Gupta 2002a; Sloane 2005). Typical examples of content sound are speech, narration, testimonials, voice-overs and music.

- Speech is the most natural, powerful and expressive sound medium and is used in instructional messages. The speech uses spoken words, varying the qualities of loudness, pitch and tone, to motivate and inform audiences. As Winn (1993) noted, ‘human speech is the most powerful and expressive medium the designer has available for use in instructional message’ (p.117);
- Narration provides information in storytelling and illustrates content on computer screens;
- Testimonials consist of auditory or sound clips which are the most common medium applied in presentations or movies;
- Voice-overs are used for short instructions, for instance, voice-overs provide commands to navigate in multimedia programs; and
- Music is in generally used in communication as in a song.

Ambient sounds are sound effects intended to present an environment and are usually composites consisting of an array of background sounds and sound effects, used for message reinforcement, background music and sound effects.
- Message reinforcement is the use of background sounds or background sound overlaid with real life, such as the hustle and bustle of crowds in a football match, to reinforce communication effectively (Gupta 2002a);

- Background music contributes to increase audiences' mood by creating a conducive environment and enhancing presentations; and

- Sound effects are used to make a presentation come to life, which can lift up the mood of audiences and add interesting effects to catch people's attention, such as sound attached to bulleted lists.

In addition, audio can be presented in a number of different types of digital auditory files applied to computer environments, such as Musical Instrument Digital Interface (MIDI), wave files (WAV), MPEG Layer-3 files (MP3), Audio Interchange File Format (AIFF) and Windows Media Audio/Active Streaming Format (WMA/ASF) which can be played using programs like QuickTime or RealAudio etc. (Rahman 2008).

Currently, aural information is increasingly applied in educational programs for instructional purposes. There are three audio elements primarily used in educational technology: music, speech and sound effects (Beccue, Vila & Whitley 2001). A study of audio application in learning programs was conducted in which twenty three instructional designers were invited to complete a survey. Twenty two respondents claimed that they would use audio to varying degrees when designing instructional multimedia lessons (Calandra, Barron & Thompson-Sellers 2008). Audio has generally been put into courses in the form of narration (Barron & Calandra 2003). All of the respondents reported that their courses would be associated with audio narration (Calandra, Barron & Thompson-Sellers 2008).

Tindall-Ford, Chandler and Sweller (1997) proposed that ‘when students are faced with intellectually different materials requiring mental integration between
multiple sources of information, results suggest that mental integration may be easier if written information is transferred into an auditory form’. Alternatively, Tindall-Ford, Chandler and Sweller (1997, p.285) state that ‘when information is not intellectually challenging, the mode of presentation may be of less importance’. Also, according to Mayer (2001, p. 134), ‘Students learn better when words in a multimedia message are presented as spoken text rather than printed text’. Many research studies have been conducted in the field of multimedia learning regarding auditory stimuli incorporated with other media elements in multimedia systems as the basis of the modality principle of multimedia learning which will be presented in the next chapter (refer to Section 3.2.11).

2.2.3 Image

The saying, ‘A picture is worth a thousand words’ emphasises that a picture can represent a large amount of information in a compact way. Image is perhaps the most important component of multimedia (Bhatnagar 2002). Multimedia information is predominantly presented in images. Text-only presentation formats are not actually the preferred way to process information for most people, especially in computer-based environments. By contrast, materials presented with pictorial information are easier to comprehend and retain, and text accompanied by images is one of the most commonly used presentation formats in multimedia learning programs (Clark & Mayer 2008).

The images that people see everywhere in everyday life can be generally formed in different ways – real and virtual. To be more specific, images consist of two types: photographic-type images and design-type graphic images (Bhatnagar 2002; Pazzaglia 2008). The photographic-type images are typically captured from the real world by a camera, such as photographs. Graphic images are created and generated using computers or with the assistance of
scanners to convey specific messages to the targeted audiences, such as logos or other artworks (Ranjan 2006; Sloane 2005). Samples of a photographic image and a graphic image are shown in Figure 2.1

**Figure 2.1 A bitmapped photographic image (left) and a graphic image (right)**

Recently, with the development of advanced technologies, image outputs can support advanced high-quality display modes to represent objects in a spatial representation with more colours and higher resolution. Therefore, images can be generated as flat (two-dimensional), such as drawings, pictures and photographs, or as solid (three-dimensional) (Bhatnagar 2002; Pazzaglia 2008).

Images can also be divided into two broad categories: as printer-generated images and computer-generated images (Rahman 2008). In recent years, the imaging advances of electronic devices have developed rapidly. The majority of digital cameras can take pictures with millions of pixels used to store the digital images (Bhatnagar 2002; Rahman 2008; Sloane 2005).

In the field of education, image elements have provided the most significant possibilities by using multiple image types, such as drawings, pictures and photographs, to enhance the qualities of teaching and learning. With the
assistance of computers, a massive range of colours, formats, lines, dimensions, textures and visual rhythms are available to represent image information. Also, design graphs can be derived from spreadsheets and pictures can be delivered on CD-ROMs or pulled from the Internet. In the case of a multimedia learning program, instructional designers often use an image-based interface as a backdrop to present teaching materials (Rahman 2008). In fact, many studies investigating the effects of images or graphics to improve learners' learning outcomes have been completed by researchers in multimedia learning environments. These will be elaborated in Chapter 3.

Furthermore, images can be used to create animations. Motion pictures and video clips are the most common ways to present images (Bhatnagar 2002; Desmarais 1994; Ranjan 2006; Sloane 2005). The relevant information and background knowledge about animations and videos will be respectively discussed and evaluated in the following sections.

2.2.4 Animation

Animation is using pictures which give an illusion of motion through the sequencing of a series of static pictures in a rapid succession (due to the phenomenon of persistence of vision). Animation generally relies on drawn pictures which can be two-dimensional or three-dimensional. In this way, animation is similar to video, which also relies on the inability of human eyes to pick up the difference between the separate images. Each picture that flashes on the screen is slightly different from the previous one (Bhatnagar 2002; Desmarais 1994; Ranjan 2006; Sloane 2005).

In comparison with static images, animated ones typically incorporate three main types of changes, including:
1) Form changes (Transformations) that involve alterations to graphic entities with respect to properties such as size, shape, colour and texture;

2) Position changes (Translations) that involve the movement of whole entities from one location to another and can be perceived with respect to the border of the animation or other material within the animated display; and

3) Inclusion changes (Transitions) that involve the appearance or disappearance of entities (either fully or partly). This can occur in various ways such as entities edging in and out of the display at its borders, or entities being added or removed in other parts of the display (Lowe 2003, p.159).

In the last two decades, a considerable amount of literature has been published investigating the effectiveness of animation and narration for enhancing learning outcomes which is the basis of the modality principle of multimedia learning. The literature has conclusively shown that in authentic multimedia environments, learning performance can be effectively improved by multimedia presentation formats that combine animation and narration (Mayer 2005b). The detailed explanation of the modality principle of multimedia learning and other studies about animations will be reviewed in Chapter 3 (refer to Section 3.2.11).

On the other hand, different findings have conflicted with the above with regard to the advantage of using animations for improving conceptual learning (Hegarty 2004; Hutcheson et al. 1997), as the pace and order of animations cannot be controlled when presenting (Clark & Mayer 2008).

In comparison with static images, animations have been shown to be visual resources that potentially increase cognitive demand for learners (Ayres et al. 2005; Ploeetzner & Lowe 2004), which is consistent with the findings obtained by
Vogel-Walcut and his colleagues (2010). This study set out to determine the impacts of static pictures and animations on increasing learning efficiency. The participants were clustered into two groups and respectively presented with static pictures and animated video clips in order to evaluate their performance in procedural knowledge acquisition, conceptual knowledge comprehension, conceptual knowledge application, perceived cognitive load and learning efficiency. The results indicated that the group who interacted with static images performed significantly better in acquiring procedural and conceptual knowledge. The findings also indicated that static picture illustrations provided better support in learning acquisition, application and short-term retention. This may be because ‘an animation is composed by several static pictures displayed in sequence and each frame is only available for a short period of time’ (Vogel-Walcut, Gebrim & Nicholson 2010, p.165).

The benefits of static illustrations have also been proved by another study (Lin, Chen & Dwyer 2006) which indicated that static illustrations have a facilitative role in improving understanding and retention for learners who learn English as a foreign language, as compared to computer-generated animations. The relevant information about students who learn English as a second language is presented in Chapter 4 (refer to Section 4.2 for more details).

2.2.5 Video

Video is the component which has substantially contributed to the delivery of information on television. Videos contain a series of still pictures that display rapidly in succession on scenes and narrations (Rahman 2008; Vaughan 2008). In multimedia learning environments, video elements have been increasingly used to reinforce knowledge acquisition for educational purposes (Rahman 2008; Vaughan 2008). According to Mayer (2001), narrated videos provide spoken words as an expert-level explanation which also directs attention. In
comparison with a narrated video, a non-narrated animation provides little
guidance so the learners have to produce self-explanations which may be
overwhelming for learning (Lewis & Barron 2009). Another research study also
found that groups presented with narrated videos learned deeper than groups
presented with non-narrated learning materials (Wittwer & Renkl 2008). The
narrated explanations may be more helpful for constructing accurate mental
representations. Furthermore, self-explanations may produce higher cognitive
demands for the learners (Paas et al. 2003; Renkl & Atkinson 2003). From a
different perspective, the self-explanations extracted by the learners
themselves may be not accurate which may lead to incomplete or incorrect
information, thus impairing their comprehension of the learning materials
(Renkl 2002).

Some researchers proposed that video may influence learners’ responses,
especially for engagement, effective change and impressions of quality, as
opposed to reading a text format alone. However, the existing research failed to
support this view (Swisher 2007).

Much of the recent research has been conducted to compare the influences of
video and text resources on individuals’ cognitive achievements. These tests
looked at individuals’ abilities to recall information and summarise main ideas;
the tests indicated that the variances or differences between text and video
formats were relatively small. In essence, video formats may influence learners’
way to perceive the learning materials, but videos did not actually improve their
learning performance (Swisher 2007).

Butcher (2006) showed that in some cases illustrations presented in simple line
drawings were more effective in improving understanding than detailed ones
with colour drawings or photos. In his experiment, the participants were asked
to learn a lesson about the human heart which contained text and illustrations.
One group of participants was presented with text and simple illustrations and the others with text and detailed illustrations. He found that the participants who interacted with the text and simple drawings format understood how the heart worked better than those who learned from text and complex illustrations. Therefore simplified visual materials may be more effective in promoting the mental processing of information and thus the acquisition of meaning (Butcher 2006).

Similar findings were revealed by Chun and Plass (1996) in their study on second language vocabulary acquisition in which students presented with text and picture annotations, obtained a significantly higher mean score on the follow-up vocabulary test than students presented with text and video annotations.

Multimedia contains different types of media elements and each individual element functions differently. From a general perspective, multimedia resources can be viewed on three different levels. The following section will give a brief overview of these levels.

**2.3 Different views of multimedia resources**

The word ‘multimedia’ means different things on different levels. Schnotz and Lowe (2003) emphasise that a multimedia document can be considered on three different levels – the technical level, the semiotic level and the sensory level.

**2.3.1 Technical Level**

The technical level focuses on the technical systems, such as slide projectors, video recorders, blackboards, computer screens and loudspeakers used to
present multimedia content. These technical devices can be considered as different types of multimedia information carriers or products (Cuban 1986; Mayer 2005a, 2009; Schnotz 2001, 2005; Schnotz & Lowe 2003).

2.3.2 Semiotic Level

The second level of multimedia resources is based on the effects of the different types of resources used (such as text, audio, video, images or animations). These forms of representation can be viewed as various types of signs used to represent information in the users’ information processing system. For instance, in a computer-based multimedia environment, multimedia presentations can be presented verbally as on-screen text or narrations, or pictorially as animations or static graphics (Mayer 2005a, 2009; Schnotz 2005).

2.3.3 Sensory Level

The sensory level focuses on the human sensory modalities used to process information. There are two senses frequently devoted to receiving multimedia presented materials: the visual sensory channel (eyes) and the auditory sensory channel (ears). For example, in a computer-based multimedia environment, on-screen text presented visually will initially be processed by the visual sensory channel (eyes) and a narration or speech presented in an auditory form will be processed by the auditory sensory channel firstly (ears) (Mayer 2001; Mayer & Moreno 1999). Baddeley’s dual-channel assumption and working memory theory provides the solid and coherent theoretical basis for this idea (Baddeley 1992, 1999; Cuban 1986; Mayer 1997, 2009; Schnotz 2001, 2005), which will be discussed in detail in Chapter 3 (refer to Section 3.2.1).
In multimedia environments, the technical effects of multimedia are very important because media functions as a device to deliver and present information. A considerable number of studies have focused on the medium-effects (technical level), such as comparing the effectiveness of computer screen-based text with printed text (Erwin & Ricardo 1999; Mayer 1997; Quealy & Langan-Fox 1998; Williams et al. 2001). According to Mayer and Moreno (1998), learning can be more effectively improved by computer-based multimedia rather than paper-based materials.

On the other hand, the weakness of these studies is that the physical effects and effectiveness of different multimedia resources have been solely evaluated in applications without taking their semiotic and sensory influences on users into consideration. The investigations were on the technologies only (Mayer 1997, 2005a, 2009; Mayer & Moreno 2003; Schnotz 2005; Schnotz & Lowe 2003). The perceptual and cognitive activities involved in processing multimedia information may not simply be impacted by different types of delivery devices, but may also be influenced by the types of resources presented and the way information is processed (Erwin & Ricardo 1999; Mayer 1997, 2009; Schnotz & Lowe 2003; Williams et al. 2001).

2.4 Two approaches of multimedia design

Multimedia technologies have the potential to significantly improve the quality of information processing. As Norman (1993, p.3) stated, technological devices are mental tools that can make people ‘smart in the sense of being better able to think’ and can expand their capabilities to process information. In practice, the design principles of multimedia devices are determined by the goals and objectives of multimedia studies (Mayer 2009).
Multimedia design principles can be generally structured using different approaches. Historically there have been two main approaches used to inspire collaboration between multimedia technologies and instructional practices: a technology-centred approach and a learner-centred approach (Mayer 2009).

2.4.1 Technology-centred approach

The nature of the technology-centred design approach is technology. The multimedia designers who take the technology-centred design approach generally put their focus on the functional capabilities of cutting-edge multimedia technologies. Thus, the interest of the technology-centred designers is how to effectively utilise the advanced information technologies to present multimedia information. For instance, designers sought ways to exchange multimedia resources over wireless networks in the 1990s (Mayer 2009; Ross 2008). Many recent studies to date have investigated the power of multimedia technologies for educational purposes, intending to determine the most useful technical devices for presenting instructional materials (Khosla, Sethi & Damiani 2000; Mayer 2009; Ross 2008).

2.4.2 Learner-centred approach

During the last few decades the concept of learner-centeredness has been taken into account by instructional designers, which is counter to the technology-centred approach. The term ‘learner-centred’ is somewhat similar to ‘user-centred’. A learner-centred approach refers to a design method that takes into account users’ experiences and cognitive activities when processing multimedia information (Ayalew 2007; Mayer 2009; McDaniel & Brown 2001). The designers who take a learner-centred approach have concentrated on users in order to meet their needs, skills, interests and cognitive processes when interacting with multimedia resources. Thus the core of the user-centred
design approach is generally based on how users’ minds work when processing multimedia information. In this sense, multimedia technologies are used as a medium to present information in a way that aids human cognition (Mayer 2001). Unlike the technology-centred approach, learner-centred designers have sought effective ways to enhance users’ information processing with multimedia technologies rather than focusing on the technologies themselves (Bransford, Brown & Cooking 1999; Mayer 2009; Norman & Spohrer 1996).

To date, the learner-centred approach has focused on investigating the relationship between design elements and individuals’ cognitive processes in a multimedia environment (Mayer 2009; McDaniel & Brown 2001). Computers are an example of the learner-centred approach. As the most intelligent cognitive invention, computers have the potential to facilitate users’ cognition (Mayer 2009; Norman 1993).

Currently, the focus of multimedia instructional design is more heavily centred on the learner-centred approach than the technology-centred approach. Designers prefer to use cutting-edge technologies to create meaningful multimedia instruction for users. Advanced technologies have been applied to interactive games, simulations, the World Wide Web (WWW) and Web 2.0 which are adapted to correspond with the way people learn (Mayer 2009).

In comparison with the learner-centred approach, the technology-centred approach is a more problematic method of design. The driving force of the technology-centred approach is based on the power of technologies but not the learners’ needs when processing information with multimedia systems. In this sense, the technology-centred approach is solely a conceptual design so that it may be impossible to attain (Clark & Mayer 2008; Khosla, Sethi & Damiani 2000; Mayer 2009).
On the other hand, the learner-centred approach is designed to help learners achieve better understanding. With the influence of the learner-centred approach on designing, multimedia messages are actively manipulated and adjusted by designers. What should be presented and how to present it are determined by the learners’ cognitive demands. The knowledge or information acquisition will be significantly facilitated with strategies that can best fit learners’ requirements (Ainsworth & Van Labeke 2002; Mayer & Moreno 1999; Schwan 2002).

Since 2002, with the influence of the learner-centred approach, a considerable amount of cognitive science and educational psychology literature has been published on the effects of different conditions under multiple types of representations of specific media forms on users’ comprehension performance in multimedia environments. Thus, a number of studies have focused on exploring e-design principles for optimal presentation formats in order to maximise the potential of multimedia to improve understanding (Kirschner 2002; Paas & Kester 2006; Paas, Kester & Sweller 2004; Schnotz 2005; Schnotz & Lowe 2003; Van-Merrienboer & Sweller 2005). Detailed discussions and evaluations of these previous research studies on multimedia learning and human cognition are further elaborated in Chapter 3.

2.5 Different types of multimedia presentations

From an academic perspective, multimedia resources are generally placed into two main categories being linear and non-linear. Hypermedia and website multimedia are usually viewed as their own classification. They are in fact additional categories of multimedia and are an extension of the non-linear category (Walker 2010).
2.5.1 Linear

Linear multimedia materials generally refer to those presentations designed for sequential viewing and reading of information (refer to Figure 2.2). These presentations usually progress linearly without elements of interactivity or navigation (Walker 2010). Linear multimedia programs normally ‘begin from a predefined starting point and conclude at a logical ending location’ (Dowling 2012, p.12) (refer to Figure 2.2). Linear multimedia programs are intended to control the program users. Movies and television shows are typical examples of linear multimedia presentations.

Some linear multimedia programs may be designed with minimal control options to serve either presenters or users in computer-based environments. For example, navigational devices, such as arrows can be either clicked or touched and may be employed on computer screens in order to help users to move back or forward in the processes of viewing (Dowling 2012). Linear multimedia is the preferential choice to present simple entertainment and familiar viewpoints as individuals are more inclined to give attention to the materials being presented without diversions from other elements.

**Figure 2.2 Linear multimedia**

![Linear multimedia diagram](source: Dowling 2012, p.11)

2.5.2 Non-linear

Non-linear multimedia materials are non-sequential presentations which allow viewers to interact with the computer program. Non-linear presentations
provide viewers with the opportunity to control and navigate through their own experience to decide on what and how of the information presented to arrive at their final destination (Dowling 2012; Walker 2010). Non-linear multimedia content is inherently interactive and requires viewers to actively participate in the programs with a range of pathways available. Thus, viewers are able to make choices from different categories of information which can lead to various outcomes (Dowling 2012) (refer to Figure 2.3).

Interactivity is the key element of non-linear programs which allows the viewers to determine and control the presentation content at their own pace which can effectively connect the viewers and the presentation by engaging the viewers to participate in the program (Dowling 2012). Because non-linear multimedia uses a navigation structure, this creates different navigational paths to process information. Navigation refers to the users’ activities and decisions to determine individual pathways through the information (Furht 2008).

In comparison with linear presentations, non-linear multimedia can be more effective in presenting computer-based learning materials. Multimedia applications in the educational field will be further examined in Section 2.6.

**Figure 2.3 Non-linear multimedia**

![Diagram of non-linear multimedia structure](Source: Dowling 2012, p.11)
With the popularisation of the computer and Internet technologies in recent years worldwide, a number of new concepts, such as hypermedia, have been developed. Hypermedia is a member of the non-linear multimedia classification (Walker 2010). The essence of hypermedia is linked to information through nodes which may contain text, images, or video or audio content. Since there are various types of media that can be linked by hypermedia documents, hypermedia therefore is multimedia by nature (Dillon & Jobst 2005). However the users of hypermedia experience more interactivity in comparison to multimedia users (Jonassen & Reeves 2001).

The navigational properties of hypermedia have led it to become an essential element for web pages which is best represented on the World Wide Web (WWW). Hypermedia offers millions of web pages, multiple forms of inter-linked media content and electronic delivery to users worldwide via web servers (Walker 2010).

Hypermedia is actually an extension of the term ‘hypertext’, meaning linkable text content which can be clicked on and navigated with links to other pages or windows by users (Jonassen 1989; Walker 2010). ‘Hypertext’ was a term initially coined by Ted Nelson around 1965, which ‘refers to “non-sequential” or “non-linear” text where authors and readers were free to explore and to link information in ways that made personal sense for them’ (Dillon & Jobst 2005, p. 569). Salmeron, Canas, Kintsch and Fajardo (2005) define the term ‘hypertext’ as a text-based information system displayed on a computer screen or other electronic device which includes organised presentational documents in an interrelated network. The relationships among these interrelated materials are maintained by the established hyperlinks included in the documents.
Hyperlinks are a key element of hypertext systems since they link different information together and enable users to explore information by following the links on demand (Mazzali-Lurati 2007; Verezub & Wang 2008). If two pieces of information are connected with a hyperlink, then they become hypertext nodes. These nodes may contain some textual information plus other information, such as pictures, tables, diagrams, videos or audio clips (Dillon & Jobst 2005; Mazzali-Lurati 2007; Slatin 1990). Hyperlinks provide routes to a variety of nodes, and the node resources can be accessed by clicking on different hyperlinks (Verezub & Wang 2008).

2.5.3.1 Different types of hypermedia/hypertext structures

Since hypermedia is an extension of hypertext, the structures used to organise hypermedia are same as the structures of hypertext. The structures of hypertext are the different hypertextual frameworks which are used to organise the hyperlinks and present the connected nodes included in the target textual content (Oliver & Herrington 1995). There are three types of hypertext structure: a linear structure, a hierarchical structure and a referential structure (refer to Figure 2.4).

Linearly structured hypertexts have been widely used in the field of education for instructional purposes, allowing readers to click on links included in a node, read information which is presented in new nodes or pop-up windows and then return to the main reading content again. In other words, the links are only presented in the main texts and there are no further links included in the new nodes or pop-up windows (Lawdow 2006; Oliver & Herrington 1995).

Hierarchically structured hypertexts allow readers to click on any embedded link into another hypertext, and then access infinite information further and further by selecting links presented in following nodes as wished. Wikipedia is a
typical example of hierarchically structured hypertexts. Users are able to seek out information as long as they keep clicking on any links involved in the new web pages or windows (Lawdow 2006; Oliver & Herrington 1995).

Referentially structured hypertexts are hardly structured at all. Referential materials provide the users complete freedom to establish connections between any given nodes by clicking on any links to get information. For example, Internet surfing illustrates how individuals can use referentially structured hypertexts (Oliver & Herrington 1995). In fact, with the availability of the Internet, hypertexts are a new medium that offers open and endless text for readers once they click through the links (Lawdow 2006).

**Figure 2.4 Different types of hypertext structures**

(Source: Oliver & Herrington 1995)

2.5.3.2 Interactions with hypermedia resources

Hypermedia/hypertexts are non-linear electronic documents containing hyperlinks. In order to carry on interacting, users are required to make their own decisions in choosing hyperlinks. Also the search functions of the Web enable users to access information in their own ways. In this respect, users need to
have the skills to master information searching.

The interaction of hyper-documents is associated with navigation. Navigation, similar to non-linear multimedia navigation, refers to users’ individual patterns of searching and browsing information throughout a hypermedia-based system (McNabb 2005 - 2006).

Hypermedia content can be organised and presented in different structures based upon the structure of the hypertext. Oliver and Herrington (1995) suggest that linearly-structured hypertext and hierarchical-structured hypertext should be used when structuring hyper-documents for educational and instructional purposes. The hypermedia used in this study is linearly structured. According to Astleitner and Leutner (1996), compared with linearly-structured hypermedia, hierarchically-structured hypermedia may lead to more navigation behaviour, navigation errors and orientation problems for learners, such as ‘lost in hyperspace’, which would influence learners’ perceptions on comprehending the materials.

The promise of hypermedia is its ability to include multiple media elements in a unified and easily accessible hyperspace and provide a flexible formation for adapting materials which can be applied to many different fields, particularly in authentic learning environments for instructional and educational purposes (Charleson, Moxley & Batten 2011; Randall & Kyle 1992).

Mixed media has also brought potential problems for users, such as appropriate combinations, but formal theories of hypermedia learning combination principles have not yet developed substantially (Akbulut 2008; Dillon & Jobst 2005; Erçetin 2010). Thus, several theories in the field of multimedia learning have been taken as the theoretical basis when structuring the hypermedia formats (Chandler & Sweller 1991; Mayer 1997; Paivio 1986),
such as Paivio’s (1986) dual-coding assumption, the dual-channel assumption (Baddaley 1986), cognitive load theory (Sweller 1999) and the modality principle of multimedia learning (Dillon & Jobst 2005; Mayer 2005b; Moreno & Mayer 1999). The literature related to multimedia learning and the relevant theories will be examined in the next chapter (refer to Section 3.2).

From a different perspective, there are two major ways in which embedded hyperlinks contribute to comprehension (Lawdow 2006). Firstly, hyperlinks allow the readers to preview and predict upcoming information which is labelled clearly. Secondly, different link behaviour associated with hyperlinks can be created including pop-up windows (Lawdow 2006).

More information about the hypermedia experimental materials of the present study is elaborated on in Section 5.7.2 and a further discussion is given in Chapter 4 (refer to Section 4.4) reviewing previous research studies related to hypermedia/hypertext associated with reading comprehension in first or second languages.

2.5.4 Website multimedia

Website multimedia is so called ‘online multimedia’. Website multimedia refers to multimedia content that is electronically presented to end users through a web server or website pages and it is generally categorised into the non-linear multimedia classification (Walker 2010). At present, website multimedia is increasingly used in an object-oriented and data-driven way which can include a combination of text, audio, still images, videos and animations, but can also contain interactivity elements in order to effectively engage users in information processing (Walker 2010).

Currently, developments of information technologies have built an alternative
way of facilitating the processes of creating and sharing multimedia content in web-based environments, such as social networking, wikis and blogs (Hausenblas 2008). In fact some of these technologies, such as blogs, have already been integrated into learning processes (Hourigan & Murray 2010).

According to Farmer, Yue and Brooks (2007), blogs refer to ‘online journals where an author (or authors) publishes a series of chronological, updateable entries or posts on various topics, typically of personal interest to the author(s) and often expressed in a strongly subjective voice, on which readers are invited to comment’ (p.262). Blogs have features that belong to distinctive hyper-documents, such as links and multimedia resources, to enable readers to comment on posts (Williams & Jacobs 2004).

A study conducted by Strampel and Oliver (2008) used blogs to facilitate students’ deep reflection in learning. They employed blogs into an online accounting subject and students were required to post a blog on a weekly basis throughout one semester. The data came from the students’ weekly blog writing, the subject convener’s comments and pre-and-post questionnaires from students and the convener. The results showed that high levels of reflection in students’ learning had been successfully achieved. However the reasons for the high level of reflection was disputed as other instructional instruments and technologies were used as well, including Elluminate chats, a wiki, group presentations and support from the convener. It was argued that it was the combination of all the instructional instruments rather than the blogs alone which resulted in the higher reflection levels (Strampel & Oliver 2008).

Farmer, Yue and Brooks (2007) propose several pedagogical benefits from the use of blogs for educational and instructional purposes. Blogs may help students to become subject-matter experts by participating in posting, updating and replying to comments on posts on a regular basis. Secondly, blogs may
enhance students’ interests in learning due to the distributed ownership of bloggers. Lastly, blogs potentially offer a learning community for students to exchange opinions on the same topic and actively engage in learning from each other.

2.6 E-learning applications in educational fields

The Internet is extremely effective in the way it enables multimedia materials to be embedded on web pages thus engaging and maintaining users’ interest and attention (Lian 2009). Web-based multimedia educational resource distribution is referred to as e-learning (Holmes & Gardner 2006) and so the following sections will focus on this. E-learning is a typical example of a favoured instructional model within current educational multimedia applications.

In order to improve learners’ satisfaction, reinforce learners’ information processing and serve the increasing number of learners who are based in different regions worldwide, e-learning has been embraced as a primary mode for teaching and learning within education systems to facilitate education quality (Mason & Rennie 2006). E-learning provisions practically draw multimedia and Internet services together (Dowling 2012).

2.6.1 Definitions of e-learning

The term ‘e-learning’ has been defined by different scholars. According to Rosenberg (2001, p.28), e-learning refers to ‘the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance’.

This definition highlights the power of e-learning. With the aid of computer applications and Internet technologies such as web browsers and media players, learners are able to access instructional information on computer
screens. Also the information can be delivered via the Internet to a wide population which ensures that a large number of learners are able to be instructed (Rosenberg 2001).

Holmes and Gardner (2006, p.14) defined e-learning as ‘online access to learning resources, anywhere and anytime’. This definition emphasises the convenience and flexibility of e-learning programs rather than the importance of technologies and facilities. It implies that e-learning facilities bring convenience and flexibility to learners which can effectively eliminate the limitations of time, distance and space (Holmes & Gardner 2006).

According to Clark and Mayer (2008, p.11), e-learning is also defined as ‘a wide range of applications and processes designed to deliver instruction through electronic means’. A comparison of the two definitions above shows that Clark and Mayer’s (2008) definition is more general and does not mention any features of e-learning. Instructional materials or programs can be presented through electronic devices that do not necessarily involve the Internet, however the Internet should be highlighted due to its flexibility and convenience.

With the aid of the Internet, e-learning can be reached universally by a broad body of learners. As long as they have access to the Web, they are able to receive learning materials online via their computer screens (Rosenberg 2001).

Kiliç-Çakmak (2010, p.193) defines e-learning as ‘learning environments in which students and teachers come together at certain times online, in synchronised or asynchronised activities’. Furthermore, ‘course content is presented with special techniques; and students, in general, perform learning duties and activities individually.’ According to Kiliç-Çakmak (2010), e-learning communities are designed with a learner-centred approach and provide each learner an independent and self-directed structured lifelong learning
opportunity, minimising the limitations of time and space. This view is supported by Sacchanand (2002). He suggests that in the e-learning process, learners should be self-directed and independent with control over their learning. Thus e-learners must learn how to learn in order to reach successful e-learning outcomes (Sacchanand 2002).

There are three aspects of e-learning, students, teachers and technologies, covered in this definition. Also, compared to the other definitions of e-learning mentioned before, Kılıç-Çakmak’s (2010) definition in particular takes the activities of teachers into consideration which implies interactions between teachers and students in e-learning environments.

In general, e-learning has embraced advanced information technologies to provide self-directed opportunities to learners to reach lifelong learning. E-learning has also brought flexibility and convenience for both teachers and learners to interact, deliver and receive educational materials since it decreases the constraints of time, distance and space. Indeed, e-learning has generated remarkable breakthroughs in pedagogical approaches in the educational environment worldwide because of its benefits. In this regard, it is necessary to discuss the benefits of e-learning.

### 2.6.2 Benefits of e-learning programs

There are many advantages of online learning when compared to traditional face-to-face educational modes. According to Holmes and Gardner (2006), e-learning programs have four major benefits.

First, e-learning serves learners of different backgrounds and expectations. E-learning communities provide learning opportunities to all categories including e-learners, students, trainees and lifelong learners. Learners with
disabilities or other special needs are also included. They can be provided with various types of materials and information to fit their individual needs, regardless their geographic, location, physical or social circumstances (Holmes & Gardner 2006).

Second, e-learning programs allow the latest update of knowledge and materials to be available online so as to cater to the demands of various groups of learners. In fact, learners from diversified backgrounds may have different demands and expectations that need to be accommodated. Also, learners from different backgrounds may bring different perspectives and expertise to the information and knowledge for educational or training purposes. Contrary to more traditional approaches, e-learning is an innovative shift in the educational field, offering online rapid access to specific knowledge and information demanded by various e-learners (Holmes & Gardner 2006).

In addition, e-learning has user-friendly tools and offers learner-centred learning modes. Learners are allowed to conveniently acquire knowledge at any time and read the content anywhere the learners are located. Also learners are able and encouraged to build subject-based learning communities to exchange individual opinions with experts and their peers (Holmes & Gardner 2006).

Finally, e-learning can help improving the quality of teaching and learning. A learner-centred approach provides more holistic learning opportunities to meet the needs and preferences of different individuals, which also enables learners to more effectively learn whenever and wherever they want. E-learning has been integrated with advanced technologies, such as the WWW and multimedia which not only reinforce knowledge acquisition in the domain of education, but also enhance interactions between learning peers, as well as between learners and teachers in the online environments (Holmes & Gardner
2.6.3 Critical success factors of e-learning systems

The categories of 'Critical Success Factors' (CSFs) in McPherson and Nunes' (2006a) study identified various broad factors gathered into five categories to determine the success of e-learning strategies, including (refer to Figure 2.5):

- Issues of organisational setting;
- Issues of technological infrastructure;
- Issues of curriculum development;
- Issues of institutional design; and
- Issues of delivery.

Figure 2.5 A framework for e-learning strategies

CMC = Computer Mediated Communication; VLE = Virtual Learning Environment

Figure 2.5 reveals that the five categories included in the CSF analysis are not necessarily linear but influence and interact with each other. Figure 2.5 demonstrates this with the vertical axis showing the organisational factor rates of e-learning and the horizontal axis representing the extent of academic involvement varying from low to high (McPherson & Nunes 2006a).

As a practical matter, the organisational setting needs the highest involvement of organisational strategies and administrative management, but requires the lowest involvement of academic contribution. The administrative involvement declines as more technological knowledge and practical knowledge are required to develop e-learning strategies. Amongst these five categories, delivery issues rely on the highest level of contribution from academic staff but the lowest level of administration (McPherson & Nunes 2006a). These five issues will be elaborated in the following sections.

2.6.3.1 Issues of organisational setting

Stakeholders are involved in all aspects of e-learning strategies and include educational practitioners, researchers, administrators and technologies (McPherson & Nunes 2006a). Stakeholder involvement in the implementation and management of e-learning programs in education sectors is critical to success. According to McPherson and Nunes (2006a), organisational issues revolve around management development and organisational strategies which are the keys to leadership development and balancing all stakeholders’ needs and expectations.

As McPherson and Nunes (2006a) stated, organisational issues are vital for every aspect of e-learning and should be initially considered by managers when commencing e-learning programs. For instance, the organisational structures, culture, pedagogies and facilities adopted may affect the
conveyance of e-learning. Also the attitude of academic staff is another key factor to ensuring that e-learning is implemented smoothly, as are good communication skills to balance diversified opinions crucial for organisational leadership (McPherson & Nunes 2006a).

Furthermore, support and facilitation from managers and administrators to implement e-learning design are required. In academic institutions, e-learning programs embracing advanced information technologies are used to reinforce knowledge acquisition for educational and instructional purposes (Clark & Mayer 2008) so they call for collaboration from specialists at both educational and technical levels, as well as subject matter experts to support the instructional content (McPherson & Nunes 2006a).

Moreover the challenges produced by the rapid evolution of information technologies have to be faced by e-learning providers to determine the resources, technologies and other facilities used to implement e-learning (McPherson & Nunes 2006).

Lastly, delivery of e-learning instruction is also important (Kearns 2010). An appropriate approach to the delivery of e-learning instruction needs to be devised in order to ensure that it is consistent with the facilities used, pedagogical approaches, organisational behaviour and staff attitudes (McPherson & Nunes 2006). In this regard, e-learning management has a significant role in determining how to successfully facilitate the implementation of e-learning.

2.6.3.2 Issues of technological infrastructure

The technological issues of e-learning refer to the infrastructure that enables e-learning to be effectively implemented and consists of three major
components: learners and teachers’ individual work stations; appropriate network access; and the enabling tools used to convey a subject’s context. As technologies can underpin the successful establishment and implementation of courses and programmes of e-learning, the technological issues are important (McPherson & Nunes 2006).

According to McPherson and Nunes (2006), three critical technological factors can influence the success of e-learning: organisational issues, design issues and delivery issues. Administrators determine the technologies used to implement e-learning, as well as the support costs associated with professional development, purchase of software and infrastructure, and repair and maintenance. With respect to the aspects of course design and delivery, technologies also offer platforms to organise and convey the content of curricula online (Abdel-Wahab & El-Masry 2011).

Moreover, efficient and reliable technologies ensure the overall e-learning quality. Educational hypermedia resources enhance the quality of both learning and teaching processes by engaging students and teachers in coordinated efforts to design their own adaptive e-learning experiences (Brady et al. 2008).

2.6.3.3 Issues of curriculum development

Issues of curriculum development are related to pedagogy, content, and selection and organisation of curriculum design (McPherson & Nunes 2006b). An effective, organised pedagogical approach is required when facing a major curriculum design task (Nunes & McPherson 2007). To be more specific, the selection of a pedagogical approach generates a list of selections used in the program, focusing on the actual content, content structure and update, the use of educational hypermedia and the design activity used to formulate the content of e-learning. The success of a design is dependent on contributions from
academics, technologists, subject matter experts, alumni and student representatives in the particular domain or area, collectively developing not only well-organised content structuring, but also constructing new pedagogical models and strategies, and corresponding learning and teaching approaches (Balatsoukas, Morris & O’Brien 2008; Chou 2010; McPherson & Nunes 2006b; Nunes & McPherson 2007).

2.6.3.4 Issues of institutional design

When constructing an effective e-learning environment, these issues comprise a framework with three fundamental aspects: technological, pedagogical and organisational components (McPherson & Nunes 2006). In order to ensure positive interactions between teachers and learners, and the structure and interrelationship of materials, the roles of e-learning technologies and subject experts are critical and can lead to a significant correlation between student achievements and effective e-learning contexts (McPherson & Nunes 2006a).

2.6.3.5 Issues of delivery

The four critical factors that have been identified with regard to issues of delivery are: attributes of teachers and learners; models of delivery; training for teachers and learners; and leadership, to determine the success of e-learning (McPherson & Nunes 2006a).

First, the attributes of teachers and learners refers to learning and teaching experience, and motivations when interacting with e-learning contexts. Also, in order to achieve the desirable academic outcomes of teaching and learning in e-learning, sufficient preparations from both teachers and students are required, relevant to e-learning contexts, to accomplish the effective delivery of information (McPherson & Nunes 2008). Second, according to McPherson and
Nunes (2008), pedagogically sound e-learning materials are necessary to
determine appropriate and consistent delivery models for e-learning courses.
Third, web-based training and e-learning support significantly impact on
e-learning delivery, as both teachers and learners in e-learning environments
have to be familiar with the latest technologies and systems.

Finally, recognising all stakeholders and balancing their needs is crucial when
developing curricula. Correspondingly, the guidelines offered by leadership
need to change and develop in response to stakeholders’ expectations in order
to satisfy different institutional purposes (McPherson & Nunes 2008).

When delivering e-learning solutions, researchers are an important resource in
testing the feasibility of pedagogical approaches and in seeking ways to adapt
and innovate in response to new technologies in the e-learning environment
(McPherson & Nunes 2008), for example, by identifying what is lacking in
current e-learning systems as well as what benefits and barriers existing in
online learning contexts (Christiansen & Anderson 2004).

Overall, the array of critical success factors provides the framework that
determines the success of e-learning from various perspectives. In
consequence, effective planning, organising and delivery of e-learning courses
have to be supported by appropriate resources from the collaborative
contributions of educational experts, subject matter experts and technologists.
Besides this, more information relevant to the preparations of both instructors
and students is required.

2.6.4 Instructor and learner preparation

Preparation by instructors and students is essential for effective engagement
with e-learning. In comparison with traditional face-to-face instruction, online
instructing and learning requires additional skills to ensure desirable outcomes from the e-learning process (McPherson & Nunes 2006b; Siemens & Yurkiw 2004).

2.6.4.1 The instructors

Instructors play a critical role in an e-learning community. They are needed to (possibly) minimise the adventures and to maximise the effectiveness of e-learning courses (Gerrard 2002; Siemens & Yurkiw 2004). In order to ensure learners’ success, certain skills are necessary.

First, it is important for instructors to recognise learning objectives and outcomes to ensure that the delivery approaches are well planned and effectively organised (Gerrard 2002). Second, it is necessary for instructors to understand their students by identifying the diversity of learning performance, attitudes and learning styles in order to meet the needs of individual participants. Third, it is critical for instructors to create a collaborative e-learning community where facilities such as online conferencing can be used. Furthermore, instructors need to encourage learners’ participation in constructing knowledge through online interactions such as discussions, activities and debates. In addition, instructors are expected to develop and implement the means to assess learners’ performance to provide corrective feedback and reinforcement. Finally, it is vital for instructors to present well-organised learning materials and advice so as to avoid cognitive overload and information anxiety (Gerrard 2002; McPherson & Nunes 2006b; Siemens & Yurkiw 2004).

2.6.4.2 The learners

Preparation by instructors is not enough to ensure the success of e-learning
courses; learners also need preparation (McPherson & Nunes 2006b). In fact, learners are expected to be able to develop advanced cognitive skills across the curriculum. Traditionally the basic educational skills required by higher education students were reading, writing, spelling, handwriting and numeracy (Bramley 1991). These skills alone are insufficient to enable them to maximise their potential in e-learning environments which require additional skills such as web searching and navigation processing (Ho 2011). The skills, essential to successful participation in e-learning contexts, have been identified by Networked Information and Communication Literacy Skills (NICLS) (Nunes et al. 2000, cited in McPherson & Nunes 2006b).

First, NICLS cites new cognitive skills required for information processing and communication literacy (McPherson & Nunes 2006b), as ‘recognising information needs, distinguishing ways of addressing gaps, constructing strategies for locating information, locating and accessing information, comparing and evaluating information, as well as organising, applying and synthesising information’ (Webber and Johnson 2000, cited in McPherson & Nunes 2006a, p.7). Second, in order to implement successful communication, adaptation and changes in human behaviour are required. In the e-learning environment, there is no opportunity offered for face-to-face interactions. The individuals involved in e-learning usually communicate online (Musselbrook et al. 2000, cited in McPherson & Nunes 2006a).

Lastly, students need to develop critical skills in negotiation/communication to engage in online activities related to learning such as forum discussions regarding projects in order to acquire information through social negotiation, experience and reflection (McPherson & Nunes 2006a).

In general, NICLS are divided into two classifications: information skills and Computer Mediated Communication (CMC) skills. Information skills are related
to the cognitive skills to process learning resources and CMC skills concern the interactions among the students within the learning community. According to Hara and Kling (1999), advanced cognitive skills need to be in place prior to participation in e-learning activities so as to eliminate frustration for participants and ensure the effectiveness of online learning courses. Learners’ participation is another key factor to determine the success of e-learning systems.

2.6.5 Factors impacting e-learners’ participation

Currently many education sectors have embraced e-learning which has evolved as a mode of delivery for instructional educational materials (Vonderwell & Zachariah 2005). Indeed, e-learning provides students with flexibility and convenience. According to Vonderwell and Zachariah (2005), there are four major factors that can affect e-learning participation, identified as being:

- Technology and interface characteristics;
- Content area experience;
- Learners’ roles; and
- Information overload.

2.6.5.1 Technology and interface characteristics

Technology and interface characteristics refer to the e-learning interface design. Learners’ participation rates may be influenced by the interface design of e-learning programs. According to Vonderwell and Zachariah (2005), an active interface design results in a high participation rate.

2.6.5.2 Content area experience
Content area experience refers to learners' background knowledge about the content within the e-learning program. Learners may tend to be more active and frequently take part in the e-learning processes if they have sufficient background knowledge which is relevant to the content. Also, if the content is presented using learners’ preferred modes, such as auditory or visual, learners may be more easily engaged in the e-learning processes (Vonderwell & Zachariah 2005).

2.6.5.3 Learners’ roles and tasks

Learner’s roles and tasks refer to the specific roles and tasks they are assigned in the e-learning environments. According to Vonderwell and Zachariah (2005), learners who are assigned specific roles and tasks tend to be more active in the processes of learning than others. In this respect, specifically assigned roles and tasks may help learners to acquire more knowledge and skills.

2.6.5.4 Information overload

Information overload is related to learners feeling overwhelmed by the amount of time required for online reading, discussion and assignments. Vonderwell and Zachariah (2005) found that the factor of information overload could potentially affect the way e-learners think about e-learning and their attitudes to participation as they found a number of learners negotiated with teachers to reduce the number of assignments and discussions, displaying a negative attitude towards e-learning education models.

Overall, many factors could impact e-learners' participation. In order to ensure the final success of e-learning programs, all critical factors should be taken into consideration by designers, including technology and interface characteristics, content area experience, learners’ roles and information overload.
2.7 Concluding remarks

In this chapter, definitions and features of multimedia and its different media elements were discussed. This chapter also analysed three views of multimedia resources and two approaches of multimedia design. In addition, there are two typical types of multimedia resources, known as linear and non-linear. Hypermedia and e-learning were discussed as typical examples of multimedia resources applied in the educational field. Also this chapter analysed and discussed the benefits and several critical factors that may influence e-learning success.

First, the term multimedia has been defined in various ways. In general, multimedia has been described as: a combination containing more than one media element (generally includes images, audio, video, animations and text); an electronic tool used to present information; a computer-based program; an instructional and educational tool used to achieve academic goals or improve the performance of learning; and a system which integrates multisensory interaction to present information to users which may influence users’ cognitive processes.

Second, multimedia resources have been generally viewed at three levels – the technical level, the semiotic level and the sensory level. The technical level view focuses on the technical systems used to present information; the semiotic view is about the various types of signs used to represent information in the users’ information-processing system; and the sensory level view refers to the sensory modalities used to process information.

Third, two approaches to multimedia design were discussed in this chapter: the technology-centred approach and the learner-centred approach. The focus of the technology-centred approach is on the technologies used to present
multimedia information. In comparison with the technology-centred approach, the learner-centred approach proved to be more effective in designing multimedia as this approach accounted for the needs of learners.

Furthermore, this chapter reviewed the different classifications of multimedia information, including linear multimedia resources without any interactivity (such as television shows and movies) and non-linear multimedia resources presented in a multi-level sequence allowing control and navigation (such as hypermedia). Some background knowledge of hypermedia and hypertext were presented. Hypermedia/hypertext can be structured in a linear structure, a hierarchical structure or a referential structure.

In addition, this chapter reviewed recent literature relevant to e-learning giving an insight into multimedia applications within the educational field. In general, e-learning is an online environment employing cutting-edge technologies for learning and teaching, which distributes knowledge and instructional materials via the Internet.

Finally, this chapter provided an array of factors critical to the effective construction of e-learning systems divided into organisational issues, technological issues, curriculum design and development issues, institutional issues and delivery issues. Critical factors further pointed to the need for the preparation of teachers and students and the role of learners’ participation in achieving desirable learning outcomes in an e-learning community.

Overall, multimedia technologies provide many options for presenting information for instructional and educational purposes, however academic difficulties or challenges may arise from multimedia provision. The following chapter will give an insight into learners’ cognitive processes and the relevant theories in the field of multimedia learning.
Chapter 3

Multimedia learning and learners' cognition

This chapter will present some theories about learning and review the literature relevant to cognitive theories of multimedia learning. Also it will discuss and evaluate other factors which may influence learners' comprehension performance in multimedia learning.

This chapter will be divided into three main sections:

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3.1 Learning and its dominant paradigms

Learning is generally defined as 'a persisting change in human performance or performance potential … (which) must come about as a result of the learner's experience and interaction with the world' (Driscoll 2000, p.11). This definition describes learning as a lasting changed circumstance and the possibility of its occurring to a person cannot be stated independently. It may be as a result of different factors, such as emotion, physiology, prior experiences, interactions between learners and learning materials, or between learners and other people. Specifically, learning can be viewed with different pedagogical approaches, including behaviourism, cognitivism and constructivism. These three dominant paradigms have been widely presented in literature in multiple disciplines (Rogers 2003).
3.1.1 Behaviourism

Behaviourist psychology has become the dominant theoretical position applied to educational practices since the early decades of the twentieth century (Gagnon & Collay 2006). The behaviourism learning theory is generally described as a bridge which operates on a model of ‘stimulus-response’. Behaviourists consider learning is ‘nothing more than the acquisition of new behaviour based on environmental conditions’ (Shah & D'Souza 2009, p.154).

The behaviourism experiments were initially conducted on animals to investigate their responses in different conditions. The classical example was the experiments on dogs. For instance, several dogs were trained to learn a desired behaviour. They would be rewarded with water or food immediately when the dogs were able to successfully respond to the expected behaviour independently (Farenga & Ness 2005).

In recent decades, the focus of behaviourism experiments has shifted from animals to human beings. For example, the participants were assigned to complete certain tasks and they were rewarded upon the appropriateness of their response. Sometimes the tasks were repeated until the participants responded to the given tasks independently or automatically (Baum 1994; Kennedy, Johnson & Tipps 2007). Without any doubt, learning also can take place with a considerable amount of stimulus for repetition and reinforcement (Mergel 1998).

The traditional classroom instructional modes, such as lecture, tutorial or assessment methods, are typically teacher-directed, employing the features of behaviourism (Bayer 2001, cited in Fears 2008). Specifically, in a classroom, the desired behaviours are decided by the teachers who give students instructional materials, help them to understand and organise a reward system
to reinforce information acquisition and encourage the desired behaviours. The role of the student is in fact to learn the response to match the stimulus given by teachers in a correct and consistent way (Bayer 2001, cited in Fears 2008).

3.1.2 Cognitivism

Since the mid 1970s, an increasing number of cognitive scientists have taken cognitive science into consideration when investigating learning. Human cognition functions as an individual’s information system to process the content they take in. In this sense, learning is classified as a brain-based process. This point has attracted many researchers intent on exploring cognitive science, particularly on human intelligence and the mind, in a variety of disciplines including psychology, artificial intelligence, linguistics, neuroscience, anthropology and philosophy (Thagard 2005). In recent decades, cognitivism as a theoretical and computational model has already been taken into consideration when investigating human learning activities in many situations (Thagard 2005).

In comparison with behaviourism, the emphasis of cognitivism is on the richness of human mental activities that occur at an unobservable level, concerning how people make responses to environmental stimuli which are presented to their cognitive and perceptual systems. There are five key components included in human cognition: attention; perception; reasoning; memory; and problem-solving. Thus, the central aim of cognitive science is to explain how people compute procedures and organise their mind when dealing with mental tasks (Thagard 2010).

Educators believe that it is necessary to recognise how people’s minds work. Thus, a considerable number of studies have attempted to identify the nature of individuals’ more complex cognitive processes, such as thinking,
problem-solving, language, concept formation and information processing, in order to assess and monitor their performance and devise effective ways to maximise their potential for academic success. Cognitivism teaching instruction refers to pre-instructional strategies based on human cognitive structures rather than simply presenting materials themselves then observing people’s behaviours (Thagard 2005; Thompson & McGill 2008).

Cognitivism researchers have suggested that the different preference styles of individuals who are from different language backgrounds (e.g. English speaking backgrounds and non-English speaking backgrounds) or cultural backgrounds should be taken into consideration when examining the operations of the human mind. Therefore, numerous studies have been conducted to examine the diversity of thinking modes or preference styles among people from a wide range of regions (Thagard 2010).

Different from cognitivists, cultural anthropologists prefer to investigate human thinking from ethnographic perspectives. In these studies, participants worldwide from various countries were invited to live and interact with each other, and from this the diversity between them emerges. For instance, people who are from English speaking backgrounds (ESB) have similarities, but they perform differently to individuals from non-English speaking backgrounds (NESB) (Thagard 2010; Thompson & McGill 2008). In fact, a considerable number of studies categorise individuals into these two crude categorisations – English Speaking Background and Non-English Speaking Backgrounds. The knowledge and relevant literature on this will be presented in Chapter 4 in more detail.

3.1.3 Constructivism

The premise of constructivism is that ‘to know is to relate and that to know
better, or gain deeper understanding, is to grow-in-connection’ (Ackermann 1996, p. 25). In other words, individual knowledge construction is a mental process which is closely connected to the individual’s existing knowledge and prior experiences. This approach is a valuable learning model which is widely accepted and cited in a large amount of literature. According to constructivists, any learner is an active participant involved in a learning process. They usually associate their past experiences and the knowledge with their own ‘rules’ or ‘mental models’ to develop new knowledge or information in their mind (Wittrock 1974; Hand & Tregust 1991; Duffy & Jonassen 1991, all cited in Demircioğlu, Özmen & Demircioğlu 2004).

In contrast to behaviourists, constructivists put the focus on how human memory works by evolving over time and its influence on learning. From the constructivists’ perspective, learning is not as simple as stimulus-response, but is an active process. A learner plays an active role in the process of constructing knowledge through reflection and the interaction between prior knowledge and the environmental stimuli (Murphy 2003).

Von Glaserfield (1989, 1992) emphasises that individual’s new knowledge construction heavily relies on their pre-existing knowledge which is used to explain or test the new concepts. Then, when the new concepts are constructed, people will actively employ what they have learned in new contexts, constructively integrating the new acquisitions with previous intellectual constructs (Connolly, Stansfield & Boyle 2009; Kridel 2010; Ryu & Parsons 2009).

In practice, constructivists have insisted on implementing their experiments in classrooms to gather more empirical evidence to explore learners’ performance (Kridel 2010). According to constructivism, relevant knowledge or
ideas are primarily derived from an individual’s comprehension abilities, their problem-solving skills and their critical thinking skills in the learning process (Connolly, Stansfield & Boyle 2009; Kridel 2010; Ryu & Parsons 2009).

In comparison with behaviourism, constructivism assumes that learners prefer to play the roles of creators by attempting to actively construct knowledge and meaning, rather than being empty vessels just waiting to be filled with knowledge. Constructivists state that constructivist learning can potentially foster critical thinking and active creating, thus stimulating learning performance (Connolly, Stansfield & Boyle 2009; Kridel 2010; Ryu & Parsons 2009).

In fact, a considerable amount of literature has attempted to approach the nature of how human brains work and how to effectively improve teaching and learning. Behaviourism, cognitivism and constructivism attempt to describe and explain how learning processes occur in individuals. However, differences exist between them. Behaviourist theories are relatively simple in comparison to the others. Behaviourism explains that learning is a simple process of stimuli-response. In addition, behaviourism teachers generally help students to perceive the knowledge they provide but do not consider their personal needs or what occurs inside the students’ minds. As a result, behaviourism has been criticised for its narrow view. It proposes that human minds are like muscles to be strengthened through repetition and exercises. Technology-supported learning strategies, such as programmed learning, drill and practice, and mastery learning are typical examples developed upon behaviourism learning theories (Alessi & Trollip 2001; Kennedy, Johnson & Tipps 2007; Tracey & Morrow 2006). Indeed, behaviourism has placed particular emphasis on observable and measurable human behaviours to investigate human learning activities but ignoring cognitive processes.
By contrast, cognitivism concentrates on the unobserved human cognitive processes. Philosophers state that human thinking modes cannot be empirically observed or computationally constructed in a general way. Cognitivism has significantly contributed to the field of cognitive sciences by providing experimental and computational works as the theoretical basis to describe the working processes of human minds, thus leading to deeper insights into the nature of how people think (Thagard 2010).

Constructivism is similar to cognitivism in that it also emphasises individuals’ inner mental processes. In the learning process, people can not only link new information to their prior knowledge and experiences, but can also develop their own understanding and meaning in different ways (Cooper 1998, cited in Shaffer, Doube & Tuovinen 2003). However, constructivism has been criticised since the constructivism learning approaches may lead learners to reach different outcomes. In this regard, learning seems to be a self-directed process without any expectations or instructions. It is suggested that learners should be instructed by teachers on expected outcomes (Cooper 1998, cited in Shaffer, Doube & Tuovinen 2003).

Both cognitivist and constructivist learning theories are taken into consideration in the present study. During multimedia learning processes, different types of media stimuli may influence the learners’ cognitive activities. On the other hand, multiple media resources allow learners to develop their own meaningful interaction with the presented materials. They are able to actively construct meaning based on multimedia inputs, selecting information, processing the selected content, organising them and integrating them with their prior knowledge and experiences. Thus, it is necessary to discuss information relative to multimedia learning. The related content will be presented and evaluated in the follow sections.
3.2 Multimedia learning and the relevant literature

Background knowledge and recent relevant literature on the definitions and history of multimedia are discussed in Chapter 2 (refer to Section 2.1.1 and Section 2.1.2). In fact, there are numerous empirical research studies that have investigated the effects of multimedia from different perspectives over the last decades which have reinforced our understanding of multimedia technologies and the influence they have on learners’ comprehension and learning (Lemercier & Tricot 2004).

Simply, multimedia learning is defined as learning with multimedia (Mayer 1997). In the field of cognitive psychology, processing multimedia materials is often considered a natural process of interacting with information (Lemercier & Tricot 2004). Mayer’s cognitive theory of multimedia learning was first presented in literature in 1997, which was generated based on several theories, including the dual-channel assumption (Baddeley 1986, 1999), the limited capacity assumption (Baddeley 1986, 1999), the dual-coding assumption (Paivio 1986) and Sweller’s (1988) theory of cognitive load and generative theory (Wittrock 1992). The following section discusses these theories.

3.2.1 The dual-channel assumption

Baddeley (1986, 1999) proposed the dual-channel assumption which states that humans usually possess two separate information-processing channels to deal with visually presented information and auditorily presented information respectively (Mayer 2001). Thus, there are two channels contained in human information-processing systems: the visual channel (eyes) and the auditory channel (ears). Visual information such as on-screen text, video, image and animation is usually presented to the eyes. Auditory information such as narration and background sound is presented to the ears (Mayer 2001).
During cognitive processes, multimedia resources are recognised as visual and auditory inputs based on the dual-channel assumption (Baddeley 1986, 1999). Thus, the information is separately received via eyes and ears respectively. In this case, spoken words or aural stimuli will be processed by the auditory sensory channel (ears), while on-screen text or illustrations will be processed by the visual sensory channel (eyes). These channels function independently when learners are processing different types of multimedia resources so that neither sensory channel will be overloaded. The dual-channel assumption is also consistent with the modality principles of multimedia learning which are supported by evidence from prior research studies. The modality principle of multimedia learning will be elaborated later in this chapter (See Section 3.2.11.2). Furthermore, according to Baddeley (1986, 1999), the amount of information that can be processed in each channel by learners at any one time is limited. A discussion of the limited capacity of working memory follows.

3.2.2 The limited capacity assumption

In the field of psychology, the concept of limited capacity in consciousness has a long history. Typical modern examples are Baddeley’s theory of working memory and Sweller’s cognitive load theory. The limited capacity assumption is developed upon Baddeley’s (1986, 1999) theory of working memory which assumes that each sensory channel has a limited processing capacity so the amount of information processed at any one time by learners is limited in multimedia environments. In other words, only a few images may be able to be retained. Specifically, when an animation is presented, the learners may be able to hold in working memory only a few images at any one time. Similarly, when a narration is presented, the learners may be able to hold just a few words at any one time (Baddeley 1992).
The limited information processing capacity of each sensory channel is due to the limited capacity of learners’ working memory. As working memory is an essential part of Sweller’s cognitive load theory the details of working memory will be further discussed in this chapter in Section 3.2.5.2.

The benefits of the dual-channel assumption were initially proved by Hebb’s (1949) study. It claimed that different stimuli presented to the two sensory channels simultaneously may more effectively activate the human brain. The study indicated that learners who interacted with bi-sensory formats showed better recall performance than those who interacted with a one-sensory format since the dual-mode presentation effectively avoided any information delay on any one sensory channel, either ears or eyes. Penney (1989) also found that words presented in two modalities could facilitate learners’ memory recall in comparison with words that were presented in the visual modality alone. Treisman and Davies (1973) further indicated that multiple stimuli were able to be effectively and simultaneously processed by two sensory channels (ears and eyes), which was better than any one channel alone. As Broadbent (1956) assumed, any resources that are presented to one sensory channel may lead to competition as a learner’s capacity for each sensory channel is limited to receive information (Baddeley 1986, 1992). For example, concurrent text and animations may produce competition in a learner’s visual channel.

Similar findings have been obtained by Lewandowski and Kobus (1993) through an experiment to indicate the effectiveness of the dual-channel assumption. The participants were split into two groups and placed under different experimental conditions. One group was presented with words that were concurrently presented in both the auditory and visual channels. The other group was presented with words via the visual channel only. The results showed that the participants who received the information in dual-mode presentation recalled more words than the other group. Lewandowski and
Kobus (1993) further stated that these findings could be applied to more complex situations (Lewandowski & Kobus 1993).

3.2.3 The dual-coding assumption

The dual-coding theory was developed by Paivio (1986, p.53), proposing that:

Human cognition is unique in that it has become specialized for dealing simultaneously with verbal and with visual objects. Moreover, the verbal system is peculiar in that it deals directly with linguistic input and output (in the form of speech or written words) while at the same time serving a symbolic function with respect to visual objects, events, and behaviours. Any representational theory must accommodate this dual functionality.

According to Paivio (1986), cognitive processing occurs with two separate sub-systems. One is specialised for dealing with non-verbal inputs (such as events and imagery), the other deals with verbal inputs. The verbal and non-verbal information is given equal weight to process (Clark & Paivio 1991; Paivio 1986; Paivio & Begg 1981). The concepts and related theories of verbal and non-verbal processing are presented in the next chapter (refer to Section 4.3.2.2). Figure 3.1 shows the cognitive processes of dual-coding.
Figure 3.1 A dual-coding theory of learning from visual and verbal materials

Paivio’s dual-coding theory has been applied in multimedia learning studies over several decades. As Figure 3.1 shows, it assumes that visual and verbal representations exist in two separate information-processing sub-systems which complement each other in facilitating information retention. The nonverbal (or visual) system functions to analyse scenes and information and to generate mental images. By contrast, the verbal system deals with language. A considerable number of multimedia studies have proved that learning performance may be improved when verbal information is accompanied by relevant imagery, such as images accompanying text, rather than text or narration information presented alone. They also indicate that participants can better recall information when mixing animation and auditory narration synchronously, as opposed to animation or auditory cues presented alone (Anderson & Bower 1973; Faraday & Sutcliffe 1997).

3.2.4 The dual-channel assumption versus the dual-coding assumption

Differences exist between Baddeley’s dual-channel assumption and Paivio’s dual-coding assumption. In fact, they are two different ways of conceptualising
channels: Paivio’s dual coding assumption is based on presentation modes; Baddeley’s dual-channel assumption relies on sensory modalities (Mayer 2005a).

The presentation mode pays attention to the format of the materials presented, that is, verbal or non-verbal. Its focus is on whether the presented content is verbal (such as spoken, printed or on-screen words) or non-verbal (such as images, animation, video or background sounds). Thus, one channel deals with verbal stimuli, while the other one processes imagery stimuli and non-verbal sounds. In contrast, the sensory-modality approach focuses on the representations of the stimuli presented to learners’ sensory channels. In this regard, the sensory modality approach pays attention to whether the learners initially process the represented materials with their eyes (such as images, animation, printed or on-screen words) or ears (such as spoken words or background sounds). The sensory-modality approach shows that the visual sensory channel of the learner processes the visually presented stimuli and the auditory sensory channel processes the aurally presented stimuli (Mayer 2005a).

In the present study, the multimedia resources are presented as visual and auditory stimuli. Thus, Baddeley’s dual-channel assumption has been primarily taken as the theoretical basis.

3.2.5 Cognitive load theory (CLT)

In recent decades, investigations on the effectiveness and efficiency of instructional design strategies in the field of education and training has seen important breakthroughs in the cognitive science disciplines regarding the mental processes of learning, memory and problem-solving skills.
Cognitive load theory (CLT) is an instructional theory developed by Sweller (1988) which was generated from relevant fields. The theory describes learning structures in terms of an information processing system involving a limited capacity sensory memory, a limited capacity working memory and a powerful long-term memory which illustrates the way human memory works from a range of sources in an integrated way (Cooper 1998, cited in Shaffer, Doube & Tuovinen 2003) as shown in Figure 3.2.

**Figure 3.2 A simple model of how memory works**

![Figure 3.2 A simple model of how memory works](image)

(Source: Shaffer, Doube & Tuovinen 2003, p. 2)

Cognitive load theory seeks to create a unified model to explain how human memory works. In this model, information is initially received by sensory memory and then processed by working memory. Finally the information is stored in the long term memory (Sweller 1988).

**3.2.5.1 Sensory memory**

Sensory memory is the first level of memory which processes stimuli from the external environment via the senses, including sights, sounds, smells, touches and tastes, and acts as a buffer to taking information from stimuli, and then retaining them as a brief impression, often less than one second but long
enough to connect with the next level (Kridel 2010; Shaffer, Doube & Tuovinen 2003).

Sensory memory allows individuals to experience a steady flow of information. Visual information appears as a scene that is moving smoothly through their eyes. Similarly, auditory information, listening to something, seems to move smoothly through the auditory field (Kridel 2010). In fact, the information received by sensory memory is abstract, the meaning of which is interpreted elsewhere. Also, the amount of information that can be received and held is limited as the capacity of human sensory memory is limited (Kridel 2010; Shaffer, Doube & Tuovinen 2003).

If the received information is not immediately encoded or converted into a more durable form, it will fade away. Alternatively, if the received information is processed further, it will be captured and transferred to working memory – the next level of memory (Kridel 2010).

3.2.5.2 Working memory

Working memory, or short-term memory, is an influential portion of human memory which contains the information used for thinking, performing intellectual activities and solving problems (Bernstein et al. 2008). Working memory is defined as ‘an active memory system that is responsible for the temporary maintenance and simultaneous processing of information’ (Dehn 2008, p.2). Baddeley (2000) proposed that working memory is a crucial link located between sensory memory and long-term memory, and is used for the short retention of information after being extracted from sensory memory and before being stored in long-term memory. Furthermore, studies suggest that multimedia information may be processed by different types of working memory depending on whether its modality is visual or auditory. Visual
information may be initially processed in visual working memory, and the auditory information may be initially processed in auditory working memory (Martin & Hamilton 2007; Mayer 2001; Moreno & Mayer 1999).

In addition, working memory provides human consciousness in some respects (Sweller, Ayres & Kalyuga 2011). As Baddeley (1993) suggests, conscious awareness may act as a function of the central executive component of working memory. According to Baars and Franklin (2003, p. 170) ‘all active components of classical working memory are conscious: input, rehearsal, visuospatial operations, recall and report’.

However, working memory has two shortcomings. First, human working memory has a very limited capacity for dealing with information. Although there are individual differences, generally it is able to process up to only five to seven chunks of information at any one time (Miller 1956). The capacity of working memory may be extremely limited while processing novel information. No more than three items of novel information can be processed at any one time (Sweller, Ayres & Kalyuga 2011). As Miller (1956) stated, the number of stimuli presented to people’s sensory channels is infinite, but only a very limited amount of information can be processed and stored by working memory.

Additionally, working memory can only hold information for a limited time (Cooper 1998, cited in Dehn 2008; Miller 1956; Shaffer, Doube & Tuovinen 2003; Sweller, Ayres & Kalyuga 2011). The information will be short-lived if it cannot be processed immediately. Information will be rapidly lost from working memory between a few seconds to twenty seconds. The limitation of working memory has to be taken into consideration when dealing with knowledge or information instructional procedures (Sweller, Ayres & Kalyuga 2011).
3.2.5.3 Long-term memory

The remaining information is encoded into long-term memory only after being processed by working memory when it will be held in long-term memory or transferred to the motor processor to arouse behaviours (Cooper 1998, cited in Dehn 2008; Miller 1956; Shaffer, Doube & Tuovinen 2003). Long-term memory is another structure important to human cognitive systems such as problem solving and thinking (Sweller, Ayres & Kalyuga 2011). Long-term memory serves as a massive storage unit for primary knowledge and skills that serve to govern further behaviours. Specifically, long-term memory holds a large numbers of schemas which can determine how to process incoming information during human cognitive processes (Sweller, Ayres & Kalyuga 2011).

3.2.6 Cognitive load construct

The construct of cognitive load is a multi-dimensional construct which refers to the cognitive demand induced by a complex task (Paas & van Merrienboer 1994). The construct is a mental experience, as demonstrated in Figure 3.3.
Figure 3.3 The cognitive load construct

As indicated in Figure 3.3, human cognitive load is mainly influenced by three causal factors, including subjective personal attributes, objective task characteristics and interaction between subject and task. Also, as Figure 3.3 shows, cognitive load can be assessed by measuring the mental load, the mental effort and performance (Paas & van Merrienboer 1994).

The multidimensional nature of the cognitive load construct was first conceptualised in literature by Paas and van Merrienboer (1994) who interpreted the relationship between cognitive load and various elements and demands imposed on individuals. Paas and van Merrienboer (1994) further emphasised that not all of the causal factors are steady during learning processes. For instance, task characteristics are likely to change from one learning situation to another. As Figure 3.3 demonstrates, task factors can affect human mental load, mental effort and performance. The task factors can
generally be manipulated by several elements: structure of task, novelty element involved (e.g. interaction), reward offering, time pressure and environmental effects (such as noise, temperature) (Paas & van Merrienboer 1994). The influence of task characteristics can be used in developing and assessing perceived learning contexts in human cognitive tests (Paas & van Merrienboer 1994). A similar finding has been proved by Brunken, Plass & Leutner (2003) in multimedia learning environments, which indicated that learners’ cognitive load might be influenced by the level of difficulty of the learning materials.

Human cognitive load can also be influenced by subject factors, including learners’ cognitive styles, prior knowledge and cognitive ability. Subject factors are relatively stable elements which can directly influence learners’ mental effort and learning performance (Paas & van Merrienboer 1994). Paas and van Merrienboer (1994) stated that there is a close relationship between cognitive style and human mental load. Such information about individual differences, like cognitive style and learning style will be elaborated on Section 3.2.12.1 and Section 3.2.12.2 respectively.

Subject-task interaction factors originate from the interaction between the subject and the task, which are motivation, arousal and optimum performance. These unstable factors have a small influence on learners’ performance (Paas & van Merrienboer 1994). Although these factors may occur, they are not the main focus of investigation in the present study. Thus, these will not be explored further.

3.2.7 Three types of cognitive load

Cognitive load theory (CLT) provides a framework to assist instructional material design. CLT originated in the 1980s. In the decades since, substantial
investigations on cognitive load have resulted in differentiating cognitive load into three types: intrinsic cognitive load, extraneous cognitive load and germane cognitive load (Sweller, Ayres & Kalyuga 2011).

3.2.7.1 Intrinsic cognitive load

Intrinsic cognitive load refers to the cognitive load placed on working memory due to the intrinsic nature (complexity or difficulty) of the instructional materials (Sweller, Ayres & Kalyuga 2011). In fact, the level of intrinsic cognitive load is assumed to be heavily dependent on the level of element interactivity for a particular task domain and knowledge level (Sweller 2010). Specifically, different learning materials differ in the degree of element interactivity. Materials with a large number of interactive elements are considered more difficult than materials that contain a smaller number of elements of interactivity (Sweller & Chandler 1994) which was proved in a study that was conducted by Pollock, Chandler and Sweller (2002), indicating that materials containing a high interactivity content consumed more available cognitive resources than those with low interactivity. Thus, when the level of interactivity is higher, the cognitive load will be greater (Sweller & Chandler 1994). Single, simple elements are low interactivity materials and can be learned in isolation, whereas the individual elements within high interactivity materials can only be understood in relation to other elements (Sweller 2010; Sweller & Chandler 1994; Sweller, van Merrienboer & Paas 1998).

3.2.7.2 Extraneous cognitive load

Extraneous cognitive load is caused by unnecessary formats or manners used to present instructional contexts which damage learning (Sweller, van Merrienboer & Paas 1998). According to van Merrienboer and Sweller (2005, p.150): ‘Extraneous cognitive load, in contrast, is load that is not necessary for
learning and that can be altered by instructional interventions’. The prior studies and investigations in this field have developed principles for decreasing extraneous cognitive load, which are about removing or minimising extraneous and irrelevant content in order to facilitate learning (Mayer 2001; Mayer & Moreno 2003; Moreno & Mayer 2002).

3.2.7.3 Germane cognitive load

Germane cognitive load is known as effective cognitive load, which is from the opposite of extraneous cognitive load. Germane cognitive load is the relevant mental activities which can directly contribute to learning involving interpreting, exemplifying, classifying, inferring, differentiating and organising (Mayer 2002; Sweller & Chandler 1994). Thus, in order to effectively facilitate learners’ learning, the main goal posed for instructional designs consequently is to optimise cognitive load by decreasing learners’ intrinsic cognitive load and extraneous load and increasing germane cognitive load in the learning processes (Gerjets & Scheiter 2003).

3.2.8 The effects of cognitive load theory

In fact, when interacting with complex dynamic learning situations, there are some other factors that may affect learners’ cognitive load. CLT describes a series of effects which effectively help with instructional material design. The following sections will elaborate the effects of cognitive load which are:

- The goal-free effect;
- The split-attention effect;
- The modality effect;
- The redundancy effect;
- The element interactivity effect;
• The isolated-interacting elements effect;
• The imagination effect;
• The worked examples effect;
• The problem completion effect;
• The expertise reversal effect; and
• The guidance fading effect.

3.2.8.1 The goal-free effect

The goal-free effect is the first instructional effect, which is ‘obtained when learners are presented the givens of a problem without the goal and asked to make as many problem moves as they can without reference to a goal’ (Seel 2010, p.604). Thus, under a goal-free condition, a conventional problem with a specific goal is replaced by a problem with a non-specific goal. A goal-free problem does not produce additional cognitive load imposed on learners’ working memory used to fit a specific goal, which may reduce extraneous cognitive load (Sweller, Ayres & Kalyuga 2011).

3.2.8.2 The split-attention effect

The effect of split attention is an important substantiation of cognitive load theory. Split attention is a negative effect which can directly affect learners’ learning (Sweller 2003). If multiple sources of information are simultaneously presented to a learner’s one sensory channel, either eyes or ears, the learner has to split their attention between the different sources for understanding. Under the split-attention conditions, learners need to devote more cognitive resources to comprehension in comparison with conditions without split attention (Ayres & Sweller 2005).
The effect of split-attention was initially found by Tarmizi and Sweller (1988) for assessing the effectiveness of two different examples on improving learning in geometry. The examples are shown in Figure 3.4.

**Figure 3.4 Split attention effect in geometry**

The findings revealed that the pupils spent less time on comprehending the integrated example (refer to Figure 3.4: right) than the pupils who comprehended the separately presented example (refer to Figure 3.5: left), as the pupils had to split their attention between the figure and the separated text (Tarmizi & Sweller 1988). Thus, the pupils who learned with the integrated example showed a better understanding, as the integrated structure eliminated the negative split-attention effect that occurred in the first example (left) (Tarmizi & Sweller 1988; Tindall-Ford, Chandler & Sweller 1997).

Sweller (1999) proposed a first explanatory framework about the effects of multimedia sources on comprehension. According to Sweller (1999), the split-attention effect can directly influence learners’ comprehension. He believes that the split-attention effect is inherent when processing some multimedia information. In some conditions, learners have to split their
attention to process two or more sources of information to ensure understanding. Split attention may reduce the learners' ability to assimilate and acquire knowledge, and further impair their learning performance (Sweller 1999, 2003; Sweller & Chandler 1994).

In fact, Clark and Mayer (2008, pp. 89-90) also pointed out that ‘when texts and pictures are separated from one another on the screen or in time, people must use their scarce cognitive resources just to match them up … In contrast, when words and pictures are integrated, people can hold them together in their working memories and therefore make meaningful connection between them’.

The split-attention effect is not limited to geometry, it has been widely used in other disciplines since 1991 (Chandler & Sweller 1991). For example, in the field of computer science, similar findings were revealed by Betrancourt and Bisseret (1998). They found that the picture and text presented with integrated or pop-up display formats could more effectively improve learning than ones presented separately on the screen.

3.2.8.3 The modality effect

The modality effect emphasises how the instruction formats affect learning or comprehension. A dual mode presentation is superior to a visual or auditory only mode. Learners’ working memory can be expanded by processing both visual and auditory information (Sweller, Ayres & Kalyuga 2011). When various sources of information, such as animation and text, are both presented visually, the visual processor will become overloaded while the auditory processor is unused (Mayer 2009).

The modality effect is related to the split-attention effect. According to cognitive load theory, the split-attention phenomena is inherent when learning with some
poorly-designed instructional materials which can lead to working memory overload by processing the information presented with one modality (Sweller, Ayres & Kalyuga 2011). On the contrary, the modality effect can effectively improve learning. When one modality is overloaded, the effect would suggest that information be presented with more than one modality (Sweller, Ayres & Kalyuga 2011). Dual-mode presentations can engage learners’ different senses in information processing which avoids the competition between the various stimuli for any one sensory channel and ensures more available processing resources by using visual and auditory working memory (Baddeley 1993; Sweller, Ayres & Kalyuga 2011).

The modality effect is particularly important in the context of multimedia learning. The effect has been proven by a considerable number of studies indicating that instructional materials presented with visual and auditory modalities such as narration and animation could enhance learning and comprehension (Chandler & Sweller 1991; Jeung, Chandler & Sweller 1997; Mayer & Moreno 1998). More relevant studies will be elaborated in Section 3.2.11 when discussing some common multimedia learning principles.

3.2.8.4 The redundancy effect

Actually, the description of the redundancy effect in the literature is not clear. Mayer and Moreno (2003) redefined it from the perspective of multimedia learning, stating that ‘students understand a multimedia presentation better when words are presented as narration rather than as narration and on-screen text’ (p. 49). Also according to Kalyuga, Chandler and Sweller (1998, p. 2), ‘eliminating redundant materials results in better performance than when the redundant material is included’. In this regard, eliminating redundant information can effectively reduce the extraneous cognitive load that is caused by processing unnecessary or redundant information imposed on learner’s
working memory (Sweller, Ayres & Kalyuga 2011).

The redundancy effect may occur in some situations. When both written text and spoken text are used to present the same information but either one is sufficient to learn, this may lead to information redundancy on two sensory modalities, for example when both text and graphics are used to present identical materials, but either one alone is sufficient for instructing learners. In addition, the redundancy effect may happen to two different scopes, such as when a detailed and a summary text are both presented to learners which may lead to cognitive overload (Mayer 2005c). In this sense, the redundant information may produce a negative effect on learning, which is consistent with the findings revealed by Sweller (2005) and Kalyuga, Chandler and Sweller (1999, 2004). As cognitive load theory suggests, better learning performance may result from less redundant information presented rather than more (Mayer 2001).

3.2.8.5 The element interactivity effect

This effect suggests that the interactivity element should be used carefully in learning contexts as learning materials which contain a large number of interactive elements may increase demands on human cognitive processing (Marcus, Cooper & Sweller 1996; Sweller & Chandler 1994).

The effect of element interactivity is closely related to intrinsic cognitive load as materials that include a very high level of element interactivity may impose a heavy cognitive load (Sweller, Ayres & Kalyuga 2011). Similar findings also were found by Hofman and Van Oostendorp (1999).
3.2.8.6 The isolated-interacting elements effect

The isolated interacting elements effect is an instructional design strategy which uses to eliminate intrinsic cognitive load to improve learning. Under some conditions, both high element interactivity and the interactivities between different elements cannot possibly be dealt by learners due to the limited capacity of their working memory (Sweller, Ayres & Kalyuga 2011). Thus, multiple interactivity elements included in a learning text should be initially presented as isolated elements, ignoring the interactions between these elements (Pollock, Chandler & Sweller 2002). When the interactivity elements are considered as a single component, the cognitive load will be minimised. Thus, more available cognitive resources can be devoted to comprehending the content (Pollock, Chandler & Sweller 2002). The effect of isolated-interactivity elements has been proved in a prior study conducted by Pollock, Chandler and Sweller (2002).

3.2.8.7 The imagination effect

This effect emphasises a learner’s imagination inflation (Sweller, Ayres & Kalyuga 2011). Under some circumstances, students who were asked to imagine a procedure or a concept showed better learning performance than the students who were asked to learn with conventional instructions describing the procedure or concept (Leahy & Sweller 2005).

The imagination could be understood as self-explanation, which is an interactivity element so the learners are actively engaged in learning (Leahy & Sweller 2005). In the learning process, the learner’s cognitive resources devoted to intrinsic load resulted in the processing of the interactivity elements rather than the extraneous load that was caused by others. As a consequence, learners’ cognitive resources devoted to processing the extraneous aspects of
the learning contexts were reduced (Leahy & Sweller 2005).

3.2.8.8 The worked examples effect

According to Clark, Nguyen and Sweller (2006, p. 190), ‘a worked example is a step-by-step demonstration of how to perform a task or how to solve a problem’. Under such conditions, learners study from examples. The examples provide expert mental models which are used to explain the steps of a solution to learners (Sweller, Ayres & Kalyuga 2011). Thus, learning can be enhanced by providing instructional explanations via worked examples rather than leaving learners to organise information by themselves. However, this form of instruction is not appropriate for all learners. It is more suitable for novices. Learners who have sufficient prior knowledge of the subject consider worked examples as redundant information, which may lead to extraneous cognitive load (Sweller, Ayres & Kalyuga 2011).

3.2.8.9 The problem completion effect

The problem completion effect is closely related to the effect of worked examples. This effect refers to presenting a partially solved problem so the uncompleted part is required to be solved by the learners (Sweller, Ayres & Kalyuga 2011). The solved part serves as a model which can effectively instruct learners. Also, the partially unsolved problem may maximise the learner’s motivation to complete the problem. Thus, their germane cognitive load can be increased.

3.2.8.10 The expertise reversal effect

In comparison with the worked example effect which is best for novices, the expertise reversal effect concerns learners who have high levels of expertise
(Kalyuga et al. 2003). As expertise increases, learners may still require additional practices, but their sufficient knowledge can effectively help them to generate solutions by themselves without searching or learning how to solve the problem. Searching for problem solutions or learning how to solve problems from others may increase extraneous cognitive load (Kalyuga et al. 2003; McNamara et al. 1996).

3.2.8.11 The guidance fading effect

This effect is closely related to the expertise reversal effect, suggesting that novices are better to be instructed via worked examples whereas learners who have high levels of expertise are better to be instructed with full problems in order to decrease the extraneous load produced by example processing (Renkl & Atkinson 2003). Also, it is suggested that novices are to be instructed initially by worked examples, then completion problems and then by full problems, which may be best way to form instructions. Following this sequence, extraneous cognitive load may be effectively reduced (Renkl & Atkinson 2003; Sweller, Ayres & Kalyuga 2011).

Generative theory is also a theoretical basis of the cognitive theory of multimedia learning. It will be discussed in the following section.

3.2.9 Generative theory

Wittrock’s (1992) generative theory is a neural approach which describes how human brains generate knowledge. According to Wittrock (1992), learners are active in the learning process. In the learning process, learners play an active roles to generate (or construct) meaning.
According to Osborne and Wittrock (1985, p.64),

The generative learning model is centrally concerned with the influence of existing ideas on what sensory input is selected and given attention, the links that are generated between stimuli and aspects of memory store, the construction of meaning from sensory input and information retrieved from long-term memory, and finally the evaluation and possible subsumption of constructed meanings.

In this regard, knowledge is generated or derived from learner’s active selection of the visual and auditory stimuli presented to their senses, and their brains are not just a unit for receiving information but are actively involved in constructing meaningful relations between new concepts just acquired and prior knowledge or experience (Osborne & Wittrock 1985). In this sense, the generative learning theory is similar to the constructivism paradigm of learning since learners are not passive receivers in the learning process. They are able to determine their own individual reaction (to be ‘submissive’ or ‘assertive’) according to their priority or preference to frame and process information (Wittrock 1992).

Furthermore, Wittrock associated the point of generative theory with reading comprehension (Wittrock 1992). Wittrock (1992) found that learner’s reading comprehension could be improved if they are able to actively construct meaning by following their individual, idiosyncratic and preferred style in the reading process. The similar findings have been proved by Widdowson (1979), stating that meaningful comprehension was generated from an active reading process which could increase a learner’s ability to exchange and construct meaning between the target text and their prior knowledge (Mayer 1984; Wittrock 1990; Zaki & Ellis 1999).
So far, the theories used as the basis to develop the cognitive theory of multimedia learning have been discussed. The following section will elaborate on the cognitive theory of multimedia learning.

3.2.10 Cognitive theory of multimedia learning

Mayer (2003) draws a framework to interpret learners’ cognitive processes in multimedia learning which shows how learners process multiple sources of learning materials in a multimedia learning environment, as in Figure 3.5.

**Figure 3.5 A framework of multimedia learning**

(Source: Mayer 2003, p.129)

As seen in Figure 3.5, the processes that are likely to occur in multimedia learning include selecting relevant auditory/visual information, organising the selected information and integrating the selected information with prior knowledge. When multimedia materials are presented to learners, some material will be initially selected by learners and separately received by the learner's auditory channel (ears) and visual channel (eyes). The selected materials will be brought into the learner's working memory. Auditory information will be brought into the auditory working memory and the visual information will be brought into visual working memory. The selected auditory materials will be organised to create a coherent verbal model in auditory working memory and at the same time a coherent pictorial model will be
created in visual working memory. Then the relevant portions of prior knowledge stored in long-term memory will be transferred into working memory. Finally a connection will be built between the selected auditory information and the relevant portions of prior knowledge and a similar process will take place within the learner’s visual working memory where the selected visual information will be integrated with the learner’s prior knowledge (Mayer 2001, 2009).

In fact, during the process of multimedia learning, although the visual and auditory information are processed separately by the visual cognitive system and the auditory cognitive system, the information may be partially converted from one system to the other if the learner is an experienced reader (Mayer 2005a). For instance, when a learner hears some spoken words describing a cat, some relevant auditory information will initially be selected and received by the learner’s auditory sensory channel. Then the selected auditory materials will be processed and constructed in their auditory working memory, but meanwhile a corresponding mental image of a cat may appear in their visual cognitive system which will be processed and constructed in their visual working memory (Paivio 1986).

Arrays of principles have been addressed by Mayer (2001) in the field of multimedia learning. Among them, some are common and have been widely documented in literature. These principles will be elaborated in Section 3.2.11.

3.2.11 The common principles of multimedia learning

The common principles of multimedia learning have been frequently discussed in studies of multimedia learning. Some of them were developed from the effects of cognitive load theory. The common principles are:
• The multimedia principle;
• The modality principle;
• The redundancy principle;
• The temporal contiguity principle;
• The coherence principle; and
• The individualisation principle.

3.2.11.1 The multimedia principle

The multimedia principle simply proposes that learning materials involving words and images will be better for learning, retaining and transferring information than words or images only (Clark & Mayer 2008). The principle was proved by Mayer’s (1989, cited in Mayer 2003) two textbook-based experiments in the laboratory. In the first experiment, the two groups of participants were respectively presented with printed text accompanied by pictorial illustrations (the words-and-pictures group) and printed word only (the text-only group) materials which described how brakes work. The group which was instructed by words-and-pictures produced a significantly better performance than the text-only group in problem-solving, yielding an effect size of 1.50.

The second experiment was similar to the first one. The instructional materials described how pumps work. One group of participants were presented with words plus illustrations and the other group was presented with words only. The participants who were presented with words and pictures performed significantly better in creating solutions than the participants who were presented with words-only, yielding an effect size of 1.00 (Mayer & Gallini 1990, cited in Mayer 2003).
The multimedia principle was also applied to second language acquisition (Chun & Plass 1996; Jones 2004; Mayer 2001). Chun and Plass’s (1996) study found that students acquired greater vocabularies from materials presented with words and images rather than materials presented with text alone. The sufficient resources allowed the students to construct their own mental models from the text and images and to build connections between the text and images which helped with understanding and language acquisition (Plass & Jones 2005).

3.2.11.2 The modality principle

This principle is similar to the modality effect of cognitive load theory which proposed that learning may be effectively facilitated by dual-modality presentation. In multimedia learning, it is suggested that learning materials are better to be simultaneously presented with visual stimuli (such as animation) and auditory stimuli (such as narration) to learner’s visual and auditory channels, which may be more effective for improving learning than materials presented to one modality only (such as animation and text) (Mayer 2001).

Leahy, Chandler and Sweller (2003) conducted a study which indicated that learning materials presented with dual-modality were more effective at improving learning than materials presented with visual modality alone. Tindall-Ford, Chandler and Sweller’s (1997) study proved the benefits of multimedia learning materials presented with dual-modality.

Clark and Mayer (2008) also pointed that for the ‘words plus images’ instructions, spoken words were better than written words to present the instructional materials. According to Mayer (2001, p.134), ‘students learn better when words in a multimedia message are presented as spoken text rather than printed text’, as spoken words and images may be easier to
integrate rather than written words and images, as this can effectively reduce the competition for cognitive load in information processing (Tindall-Ford, Chandler & Sweller 1997).

Another study was conducted by Mayer and Moreno (1998). There were two groups of learners, one was presented with animation plus text and the other was presented with animation and narration. The text content that was used to instruct the first group was replaced with the narration. The learners who were presented with animation plus narration obtained a better learning outcome.

In the animation plus text group, the learning materials were all presented to the learner’s visual sensory channel which led to the competition between the two types of visual resources, while in the animation plus narration group, the learning materials were presented to both the learner’s visual and auditory sensory channels which avoided the competition in any one sensory channel and effectively better utilised the available cognitive resources of visual and auditory working memory. Therefore, the learning performance of the learners who were presented with animation plus narration was facilitated (Mayer 2009; Mayer & Moreno 1998).

In the multimedia learning environment, the materials that are presented with animation or diagrams accompanying text may constrain readers to split their attention between the various visual sources in order to understand which can increase the cognitive load imposed on the learner’s visual working memory (Sweller, van Merrienboer & Paas 1998). Using narration to replace written text to explain the diagrams can effectively avoid the negative effects of split attention between diagrams and texts (Erhel & Jamet 2006; Ginns 2005).

Mayer (2005b) concluded that a considerable number of studies have compared the effectiveness of ‘text (either on-screen or printed) and graphics’
with ‘narration and graphics’ in facilitating learning. In each comparison, the students who were instructed by ‘narration and graphics’ materials performed better than those who learned with ‘text and graphics’. The effect size of the difference was 0.97.

Ginns (2005) reviewed 43 relevant prior studies which indicated that the effectiveness of the dual-modality instructions on facilitating learners’ performance in multimedia learning was significant and the effect size was 0.72. From these studies, Ginns (2005) also found that the effect of the auditory mode on improving the learner’s performance in comprehending multimedia resources was positive.

A number of studies have been conducted to explore the effectiveness of the modality principle and have approved its role in facilitating learning. In addition, the strength of auditory stimuli to enhance learning performance has been proved. However, the factors of the learner’s language abilities have not been taken into account yet (Clark & Mayer 2008). In comparison with reading comprehension, listening comprehension is more difficult, in particular for learners who learn English as their second or third language. English as a foreign language produces many critical challenges and difficulties for them (Graham 2002, 2006).

Recent studies have confirmed the significant effect of the multimedia learning principles and the modality principle. However, for the multimedia principles in second language acquisition, the instructional materials in Chun and Plass’s (1996) study were used to test the learner’s vocabulary acquisition. Also the majority of the previous research that investigated the principle of modality followed a laboratory procedure and the instructional content provided was simple illustrations, such as describing the steps in lightning formation or how pumps work.
Additionally, the instructional materials used in the recent multimedia learning studies were mostly presented via print-based contexts. With the developments of information technologies, these days multimedia instructions are associated with computer and the Internet, such as hypermedia. In comparison with traditional print-based multimedia, hyper-documents bring more interactive experiences to learners in their learning process, as well as more cognitive demands imposed on their working memory (Dillon & Jobst 2005; McEneaney 2003). Therefore, more research in the field of multimedia learning is required in order to maintain the knowledge and competence within wider disciplines and pursuit of advanced technologies. The studies relevant to hypertext/hypermedia learning will be further discussed in Chapter 4.

3.2.11.3 The redundancy principle

This principle was developed on the redundancy effect of cognitive load theory. Similarly, this principle refers to identical information that is presented in two or more different media formats. Learning may be impaired since the cognitive load imposed on the learner’s working memory may be increased due to the redundant multimedia information processing (Mayer 2001).

In fact, in the learning environment, redundant information frequently appears. Sometimes the same information is simultaneously presented with two or more different formats (Kalyuga, Chandler & Sweller 2004). For example, in a lecture, when an instructor presents the text materials and reads from the projected text or television programs with closed captions (Kalyuga, Chandler & Sweller 2004).

Kalyuga, Chandler and Sweller’s (1999) study tested whether redundancy impaired learning and further suggested how to avoid the negative effects of split-attention. Thirty-four trade apprentices were split into two groups who
were presented with diagram-only materials and diagram plus on-screen text accompanied by spoken word materials respectively. The spoken text was the same as the on-screen textual illustration without any additional information. The findings showed that the diagram-only group obtained a significantly better performance and spent less time reviewing information than the diagram plus on-screen text accompanied by spoken words group.

However, the results of Kalyuga, Chandler and Sweller’s study were criticised as they were not conclusive enough to support the redundancy principle (Dillon & Jobst 2005). During the learning process, the on-screen text and diagrams were both presented with visual modality, so learners had to split their attention between these two visual resources in order to understand. Also the spoken information was duplicating the same content as was in the on-screen text (Dillon & Jobst 2005).

The negative effect of the redundancy principle was also proved by Mayer and Moreno (2003; Mayer 2005b). They indicated that when employing both auditory and visual modes to present same content, another potential problem may be produced. Learners may waste cognitive resources to compare the spoken information with the textual information presented to them which may lead to additional cognitive load.

Furthermore, the redundancy principle was supported by Sanchez and Wiley’s (2006) study. The redundant information could impair learner’s learning particularly for individuals who had low learning ability or had difficulties in information processing. These learners would spend more time processing the materials which distracted their attention (Sanchez & Wiley 2006).

However, the positive effects of redundant information were also found by Moreno and Mayer (2002). Seventy-four college students aged between 18
and 26 were separated into four groups. They were assigned to comprehend instructional materials presented with narration-only (Group N, n=19), concurrent narration and on-screen text (Group NT, n=19), a portion of animations and preceding corresponding narration segments (Group A-N, n=18), and animations followed by corresponding narration and on-screen text (Group A-NT, n=18). The instructional materials described the process of lightning formation (refer to Figure 3.6).

**Figure 3.6 Selected animation frames about lightning formation**

(Source: Moreno & Mayer 2002)
The results indicated that the students who were instructed by animation and narration (Group A-N) comprehended the materials more deeply than the students who were presented with animation followed by the corresponding narration and on-screen text (Group A-NT). This resulted from the negative effect of split attention which was produced by the concurrently presented animation and text. Students had to split their attention between these two visual resources in order to understand (Moreno and Mayer 2002). Their visual working memory was overloaded (Mayer 2005b).

The students who were presented with narration and on-screen text (Group N-T) achieved a deeper understanding than the students who learned with narration-only (Group N). The correct answers provided by the N-T group reached approximately two times higher than the N group’s (Moreno & Mayer 2002). The instructional materials presented to the N-T group were redundant but according to Moreno and Mayer (2002, p. 161), ‘Words presented in both the visual and auditory modalities enhance learning as compared to words presented in only one modality’. They also concluded that ‘response times and memory are facilitated when redundant signal information is presented simultaneously in two sensory channels rather than in one’ (Moreno and Mayer 2002, p. 156). In this case, the redundant information was beneficial for learning.

Diao and Sweller (2007) also investigated the influence of the redundancy principle on the learning of students who spoken English as their second language. The two groups of learners were presented with read-only instructions and concurrent read/spoken instructions respectively. The spoken words presented to the learners were as same as the content they read. The results revealed that the read-only instruction group had a better performance in comprehending passage and lexical knowledge than the concurrent read/spoken group, and the mental load of the read/spoken group was higher
than the read-only group. In this case, the redundancy information produced a negative influence on second language learning.

According to Diao and Sweller (2007), students have more difficulties controlling the speed of second language listening which may produce extraneous cognitive load which is a detriment to their learning (Diao & Sweller 2007). Diao and Sweller (2007) also confirmed that learners have reduced capacity of working memory to comprehend the multimedia learning contexts presented in a second language as the second language speaker's schemas may not be developed as well as native speakers in multimedia learning.

Based on the findings, Diao and Sweller (2007) further suggested that when the tasks become more difficult, the second language learners will rely more on reading materials only as the spoken instruction seemed to be challenging and impaired their comprehension and knowledge acquisition in the second language.

3.2.11.4 The temporal contiguity principle

In the multimedia learning environment, the temporal contiguity principle states that people learn more deeply from multimedia materials which present words and images (or animation and narration) simultaneously. If the image shows after the words, the facilitative role is less (Mayer 2009).

As Ayres and Sweller (2005) found, in multimedia environments learners have to coordinate the multiple sources of information even though the capacity of their working memory is limited. If learners process images and the corresponding words that are presented sequentially, a high cognitive load will be imposed on their working memory (Ayres & Sweller 2005).
3.2.11.5 The coherence principle

This principle suggests that the extraneous words, sounds or pictures would be better eliminated from the instructional multimedia learning materials (Mayer 2009). The extraneous materials may compete for the learner’s limited sensory channel capacity with the information that is relevant and essential for understanding (Clark & Mayer 2008; Mayer 2009). Also, the extraneous materials may lead to extraneous load imposed on the learner’s working memory that will impair learning (Clark & Mayer 2008; Mayer 2009).

3.2.11.6 The individual differences principle

This principle is necessary to be considered as well when designing instructions in pedagogical contexts. It states that different individual learners may give different responses to multimedia stimuli, so all learners may not be instructed in one manner as everyone is unique (Clark & Mayer 2008; Mayer 2005b). It further suggests that the optimal benefits of multimedia learning contexts can be achieved by devising the learning to suit the learner’s specific needs (Mayer 2009). Thus, individual differences, such as cognitive abilities and personal preferences, should be taken into consideration when designing multimedia learning contexts (Clark & Mayer 2008; Mayer 2005b).

So far a number of prior studies have put the focus on investigating the influences of individual factors on learning which have demonstrated that learning could be affected by the student’s cultural background, personal preference, gender and age. According to Reid (1987), Korean, Chinese and Japanese students preferred to read and obtain information via visual stimuli. Another empirical study that focused on Chinese international learners and learning styles indicated that compared to English native speakers, Chinese learners preferred to use visual strategies more frequently and showed
relatively less skilled in using phonological strategies (Chen 1998).

With respect to personal preference, a comparative study by Ramburuth and McCormick (2001) found that Australian local students showed a strong preference to processing instructional content via the audio mode than the visual mode. However, Asian international students preferred to process learning materials via the visual mode over the audio mode as they experienced difficulties with listening comprehension of the English language (Ramburuth & McCormick 2001).

Soldan and Bowyer’s (2009) study indicated that gender had some influence on learner’s anxiety and apprehension. They found that female learners felt more anxious and apprehensive than males when interacting with other members in learning environments (Soldan & Bowyer 2009).

The strength of age was also revealed by Volet and Ward (2006) to have an impact. The study examined the influence of age on performance for group projects in marketing. The findings showed that the students who were older than 21 years learned more subject matter from the group assignments than the younger students (<21 years). They also found that male students were more positively inclined to participate in group projects than female students (Volet & Ward 2006).

Volet and Ward (2006) also found that the non-Australian students from English speaking backgrounds (ESB) who were multilingual gained greater knowledge than the non-Australian students from ESB who had monolingual backgrounds which may be because the students who have multilingual, non-Australian backgrounds have developed a capacity to learn with the learners who were from different cultural backgrounds (Volet & Ward 2006). According to McCorkle et al. (1999), the students who are from different
Cultural backgrounds may have different values, such as individualism or collectivism, which may influence their academic learning outcomes. For example, in comparison with ESB students, Asian international students preferred to learn independently rather than engage in group discussion (McCorkle et al. 1999; Volet 2001).

According to Soldan and Bowyer (2009), language backgrounds, nationality, English language proficiency and diverse group work experience all have some significant influence on learner’s bias, stereotyping, and anxiety and apprehension. Furthermore, in comparison with ESB students, NESB students were more likely to use stereotypes to predict other group members’ behaviours and attitudes and experienced a greater level of anxiety and apprehension when working with other learners (Soldan & Bowyer 2009).

Moreover, the previous study found that educational background also had a substantial influence on learner’s learning performance as high educational levels could lead to a greater ability to understand the learning materials (Ostrosky-Solis et al. 1998). The significant relationship between learners’ educational levels and their performance in verbal meaning tests was also found by Cornelious and Caspi (1987).

Students’ language proficiency is another individual factor which has been extensively documented in the field of education over the past few decades. The relevant information and prior studies will be discussed in detail in Chapter 4.

3.2.12 Cognitive styles versus learning styles

In fact, both learners’ cognitive styles and learning styles are individual factors which may affect learners’ learning performance. The relevant information will
be elaborated on in the following sections.

3.2.12.1 Cognitive styles

As cognitive load constructs reveal, cognitive style can also affect learners’ learning performance (Paas & van Merrienboer 1994). The term ‘cognitive style’ is ‘thinking style’ and refers to an individual’s preferred way to organise and represent information (Riding & Rayner 1998). Cognitive style is an important factor that should be taken into account when designing instructional multimedia materials in order to effectively meet learners’ needs and help them to acquire knowledge (Graff 2003; Riding & Rayner 1998; Riding & Staley 1998).

In fact, various models of cognitive styles have been identified in recent literature, broadly used as theoretical frameworks to instruct learning material design since the 1990s (Riding & Rayner 1998). Associated with the contexts of the present study, the most commonly used cognitive styles in the field of multimedia learning that will be discussed are as follows:

- Wholist-Analytic style and Verbal-Imagery style;
- Field-Dependence/Field-Independence;
- Reflective-Impulsive; and
- Rational/Analytical-Intuitive/Global.

Wholist-Analytic style and Verbal-Imagery style

Wholist-Analytic (W-A) and Verbal-Imagery (V-I) dimensions of cognitive style are multi-dimensional models which were initially proposed by Riding and Rayner (1998) (refer to Figure 3.7). They have been used to instruct learning material design frequently (Riding 2005a).
As Figure 3.7 illustrates, there are two main dimensions of cognitive style suggested which are the wholist-analytic cognitive dimension and the verbaliser-imager dimension (Riding & Rayner 1998). The W-A cognitive style reflects an individual’s tendency to organise and structure information. Learners who prefer to process information using the wholistic style habitually look at any context, condition or phenomenon within a situation as a whole (Riding & Rayner 1998). However this style has some negative attributes. The wholistic learners view any component in this situation equivalently, so they find it difficult to attend to a task and logically divide information into different constituents. The learners also have difficulty distinguishing what components are essential in this situation at the early stage (Riding 2003; Riding & Rayner 1998).

The learners who have analytic styles tend to process information sequentially from the different independent parts (Riding & Rayner 1998). The learners usually learn the constituent parts so they are probably able to identify the key points. They are also capable of detecting the similarities and differences
between different constituent parts. However, analytic styles may distort and exaggerate the learning contexts out of all proportion as the learners just concentrate on one aspect alone, ignoring the other content at any one time (Riding 2003, 2005a; Riding & Rayner 1998).

The Verbal-Imagery (V-I) dimension presents another way learners habitually process information. The imager learners usually prefer to process information through visual information rather than verbal content. On the other end, verbaliser learners tend to learn via verbal information and learn better from texts (Riding 2005b; Riding & Calvey 1981; Riding & Rayner 1998).

John and Boucouvalas (2003, cited in Strehler 2008) further developed a new mode of cognitive style by investigating individuals’ differences in perceiving multimedia content which indicated that the visual-audio dimension of cognitive styles were activated when users processed multimedia information. This style may be produced by multiple sources of information being presented in the multimedia learning environment which are simultaneously received, organised and processed by different parts of the human brain (John & Boucouvalas, cited in Strehler 2008). The findings were actually based on Mayer's cognitive theory of multimedia learning to fill the gap in Riding's works.

Field-Dependence/Field-Independence

Field-Dependence/Field-Independence (FI-FD) style was a bipolar model which was originated from Witkin in the 1950s (Gardner, Jewler & Barefoot 2007). It concentrates on the relationship between learners’ ways to process information and social interactions (Gardner, Jewler & Barefoot 2007). It proposed that the differences between FI and FD learners are the results of their different personalities. FD learners usually perceive things through social activities, such as interpersonal conversation, with a well-developed ability to
take social cues from interactions with others (Gardner, Jewler & Barefoot 2007).

On the contrary, FI learners tend to be more autonomous when viewing information. They prefer to process the learning contexts in a ‘field-free’ way (Ehrman, Leaver & Oxford 2003). This study indicated that FI learners had information restructuring and developing skills and higher levels of creativity, competence and potential so they could acquire better academic achievements (Miller 2007; Salmani-Nodoushan 2006; Siraji, Naimie & Shangholi 2007; Zhang 2004).

Reflective-Impulsive

The cognitive style that focuses on the Reflectivity-Impulsivity (RI) dimension estimates learners’ time used to respond to specific cognitive tasks under certain conditions (Vohs 2006). The reflective learners usually take a longer time to make responses, with pauses aimed at steadily diminishing errors, while the impulsive learners usually give responses speedily (Vohs 2006). The Reflectivity-Impulsivity cognitive style was initially measured by the Matching Familiar Figures Test (MFF). In that case, children were asked to identify objects which reflected their time to give a response (Kagan et al. 1964). The Reflectivity-Impulsivity style was also measured by Strack, Werth and Deutsch (2006, cited in Vohs 2006) in terms of comprehending the nature of mechanics.

Rational/Analytical-Intuitive/Global

The Rational/Analytical-Intuitive/Global (RA-IG) dimension cognitive style originated from Allinson and Hayes (1996). It reflects a fundamental left-right
A number of studies have measured learners’ cognitive styles on different dimensions. However, conclusive findings of different cognitive styles have not been resolved yet. A study was conducted by Parkinson and Redmond (2002) assuming that different cognitive styles may influence learners’ performance in comprehending computer-based learning materials presented with different media formats but the findings did not show any significant effect of cognitive styles on learners’ comprehension performance although the styles probably influence their ways of processing information (Parkinson & Redmond 2002).

Chen, Ghinea and Macredie’s (2006) study investigated the effect of cognitive styles on users’ preferences to structure and perceive multimedia learning materials presented with different formats. The findings revealed that all learners showed a higher level of understanding using content presented with video clips with weak dynamism although the learners said that they mostly liked to learn from the clips with moderate dynamism. Thus, a significant influence of learners’ cognitive styles on their learning performance was not found (Chen, Ghinea & Macredie 2006).

Another study conducted by Mitchell, Chen and Macredie (2005a) explored whether learners’ cognitive styles could influence their methods of information assimilation in a web-based learning environment, but a significant effect was not found (Mitchell, Chen & Macredie 2005a). According to Gulliver and Ghinea (2010), cognitive styles as an independent factor may affect learners’ preference but the influences of other factors that occurred in the learning process have also to be considered.

Cognitive style, in general, describes a personality dimension which influences personal attitudes, values and social interactions (Allinson & Hayes 1996;
Sadler-Smith 2000). In comparison with cognitive style, learning style is a cognitive parameter influencing learning. The relevant content will be elaborated on in Section 3.2.12.2.

3.2.12.2 Learning styles

In fact, learning style is a subset of cognitive style which is the complex cognitive parameters affecting learners’ learning processes (Triantafillou 2004, cited in Beres, Magyar & Turcsányi-szabó 2012). Each individual learner has their preferred way to access, process and perceive information (Corno & Snow 1986, cited in Felder & Brent 2005). In the relevant literature so far, seventy one models of learning styles have been identified by The Learning & Skills Research Centre, and thirteen of them have been categorised as major ones. Amongst the thirteen, the Felder–Silverman learning style has been frequently discussed and evaluated in numerous research studies (Beres, Magyar & Turcsányi-szabó 2012). The following content will discuss the Felder–Silverman learning style only in considering the contexts of the present study.

The Felder–Silverman (1988) learning style (FSLSM) is specified in four dimensions, being:

- Accessing (active/reflective);
- Perceiving (sensing/intuitive);
- Receiving (visual/verbal); and
- Understanding (sequential/global).
Accessing (active/reflective)

In the accessing dimension, active learners prefer to learn by active discussions with groups and tend to actively apply their prior knowledge in learning. On the other hand, reflective learners prefer to work alone or in small groups. They also prefer to think about the learning materials before discussion (Felder & Brent 2005; Felder & Silverman 1988).

Perceiving (sensing/intuitive)

In the perceiving dimension, sensing learners are more practical and realistic. They prefer to acquire facts and concrete content related to learning. They usually solve problems with standard approaches and are patient with the details of learning contexts (Felder & Brent 2005; Felder & Silverman 1988). In comparison with sensing learners, intuitive learners prefer to discover possibilities and relationships within the learning contexts. They are also able to grasp new concepts and the underlying meanings as the sources to perceive information (Felder & Brent 2005; Felder & Silverman 1988).

Receiving (visual/verbal)

In the dimension of receiving, visual learners usually receive information deeper from visual illustrations such as diagrams, demonstrations or flow charts. On the other side, verbal learners prefer to receive information through written and spoken explanations (Felder & Silverman 1988).

Understanding (sequential/global)

In the understanding dimension, sequential learners usually process the
learning materials in a linear and logical sequence to find solutions. By contrast, global learners show more interest in overviews. They view the learning content as a whole picture, without seeing the connections between the different elements within the learning contexts (Felder & Brent 2005; Felder & Silverman 1988).

In the field of multimedia learning, a substantial number of empirical studies have evaluated the influence of learners’ learning styles on learning performance. Plass et al.’s (1998) study proved that in second language learning, students preferred to look up graphic annotations to comprehend content rather than audio annotations, and their text recall can be facilitated when they have the opportunity to receive information via their preferred mode(s).

However, the investigations of learning styles in multimedia learning are still in the dissonance process as dissimilar results have been found. They show that learners have different individual/specific perceptual learning styles in terms of processing information through different preferred ways. According to the findings, some learners were categorised as auditory learners by tending to process information better via aural instruction such as tapes or lectures. Some learners preferred to process visual information that was presented with text, charts, images and graphs (Akbulut 2008; Clark & Mayer 2008; Kinsella 1995; Mayer & Sims 1994; Yeh & Wang 2003). As Kolb (1984, cited in Scott 2010, p.19) conceded, ‘Individual styles of learning are complex and not easily reducible into simple topologies – a point to bear in mind as we attempt to describe general patterns of individuality in learning’. In this regard, more research is needed in order to provide conclusive findings which indicate the influence of learning styles on multimedia learning.

In the field of multimedia learning, learners’ cognitive load has been measured
in different ways. The following contexts will be concentrated on reviewing the main direct methods.

3.3 Direct measurements of cognitive load in multimedia learning

Cognitive load as a theoretical rationale has been used to explain the differences in learning performance or outcomes for most of the studies into multimedia learning (Brunken, Plass & Leutner 2003; Brunken et al. 2002). However, cognitive load is the internal process of dealing with information by individuals which cannot be observed directly (Sweller 1999). Thus, there are various methods available for assessing cognitive load in multimedia learning which can be categorised as objectivity and casual relation (Brunken, Plass & Leutner 2003). The objectivity dimension is based on the methods used - whether ‘subjective, self-reported data, or objective observations of behaviour, physiological condition, or performance’ (p. 55). The casual relation dimension describes methods according to ‘the type of the relation of the phenomenon observed by the measure and the actual attribute of interest’ (p. 55). For instance, there is a direct interplay between cognitive load and the difficulty of the materials provided for learning as the difficulty has a direct effect on cognitive load imposed on learners’ working memory (Brunken, Plass & Leutner 2003).

Indirect, subjective measures, such as questionnaire surveys, have been frequently used in cognitive research studies as well which seem to be capable of exploring the subjective perception of invested effort reliably but it remains unclear about the relationship between mental effort and actual cognitive load (Brunken, Plass & Leutner 2003; Paas et al. 2003; Paas, van Merriënboer & Adam 1994). Other research studies indicate that a low amount of invested effort could lead to low cognitive load (Reed, Burton & Kelly 1985).
The direct subjective measure that used, for instance, the rating of the difficulty of the materials, has a direct influence on the cognitive load (Kalyuga, Chandler & Sweller 1999). According to Kalyuga, Chandler and Sweller (1999), differences of cognitive load could be potentially identified by scales of task difficulties, individual competency or different attentional processes.

Thus, in many studies, the effective way to measure learners’ cognitive load or levels of knowledge acquisition was tracking records of learners’ learning performance (Brunken, Plass & Leutner 2003). Similarly, in the field of multimedia learning, learners’ cognitive load or levels of knowledge acquisition can be objectively and directly measured through scores obtained from comprehension tasks (Brunken, Plass & Leutner 2003).

The typical method used in cognitive load measurement is to compare the differences of two or more different formats of multimedia instructions presenting the same material (Brunken, Plass & Leutner 2003). In this case, the presenting content is identical so the two formats will be the variant which may lead to different amounts of intrinsic load imposed on learners’ working memory (Brunken, Plass & Leutner 2003).

However, such point has been challenged by some empirical studies which found that the differences of cognitive load resulted not only from the instruction formats but also the instruments used to measure cognitive load. Cognitive load also can be produced by the medium used to present learning materials (Brunken & Leutner 2001; Mayer 2001). For example, learning materials presented with hypermedia contexts with navigation behaviour or navigation errors may require more cognitive demand from learners (Astleitner & Leutner 1996; McEneaney 2003). In addition, learning outcomes were significantly affected by individual differences such as learners’ traits (Blatchley & Lau 2010; Carstairs et al. 2006; Mayer 2001; Plass et al. 1998;
For direct and objective measures, neuroimaging techniques as a direct method have been increasingly used to measure learners' cognitive load. The methods have been frequently used to measure cognitive load in simple learning situations, such as word memorisation and sentence comprehension (Brunken, Plass & Leutner 2003; Just et al. 2001).

The method used to measure performance in the present study is direct and objective in order to measure the students' performance in comprehending various formats of learning materials. More information about the measurements will be presented in Chapter 5.

### 3.4 Concluding remarks

This chapter contained three main parts: learning and its dominant paradigms; multimedia learning and the relevant literature; and direct measurements of cognitive load in multimedia learning. First, this chapter presented and evaluated the definition of learning and its three dominant paradigms: behaviourism, cognitivism and constructivism. These three paradigms considered learning from different perspectives. Behaviourists suggested that learners are like empty vessels waiting to be filled with and to store knowledge. By contrast, constructivists considered that learners are creators, actively constructing knowledge and meaning. According to constructivists, learning is the learners' mental process of constructing knowledge by linking to their existing knowledge and prior experiences which potentially enhances the learners’ critical thinking and learning performance.

Second, this chapter discussed the cognitive theory of multimedia learning and
the relevant literature. According to Mayer, learners’ learning performance may be effectively improved by concurrent auditory and visual stimuli in multimedia environments. There were three assumptions of human information processing involved in Mayer’s cognitive theory of multimedia learning: the dual-channel assumption; the limited capacity assumption; and the dual-coding assumption. In other words, learners have dual sensory channels, both ears and eyes, to receive multimedia resources. The capacity of both sensory channels (auditory and visual) and working memory (auditory and visual) to access and process information is limited. Additionally learners have dual coding sub-systems to process pictorial and verbal information respectively.

Third, this chapter discussed Sweller’s cognitive load theory since this is the basis of Mayer's theory. Cognitive load theory presented three types of memory: sensory memory; working memory; and long-term memory. Information is initially collected by sensory memory, processed by working memory, and then stored in long term memory. Additionally, three types of cognitive load were presented in this chapter: intrinsic cognitive load; extraneous cognitive load; and germane cognitive load. It was confirmed that eliminating intrinsic cognitive load and extraneous load whilst increasing germane cognitive load, applied to learners’ available resources of working memory, may effectively facilitate learners’ learning performance which was also the main goal posed for instructional designers.

Furthermore, the effects of cognitive load theory were included in this chapter as well. These effects provided some practical suggestions for instructional material design in terms of avoiding cognitive overload and improving learning. Generative theory was also discussed in this chapter which is similar to the constructivism paradigm of learning. Learners play an active role to generate knowledge. Several common principles of multimedia learning were estimated
which effectively instruct multimedia learning material design.

This chapter additionally reviewed some prior studies relevant to learners’ individual factors. According to the findings, learners’ age, gender, cultural background and language proficiency could influence their learning performance. Cognitive style and learning style might affect learners’ comprehension performance as well, but conclusive findings in this area have not been provided so far.

Lastly, this chapter discussed the main methods used to measure learners’ cognitive load in multimedia learning. Associating with the contexts of the present study, the method used to measure learners’ comprehension performance is a direct and objective method as the students’ performance was measured by their scores obtained from comprehension tasks.

Today, many education sectors in English speaking countries are becoming more internationalised. More and more learners who learn English as a second language come to English speaking countries, such as Australia, to improve their education (Altbach, Reisberg & Rumbley 2009; Clark & Mayer 2008; Oshinaike & Adekunmisi 2012; Walker 2010). As previously discussed, comprehending information in English may be an issue faced by the learners who come from non-English speaking backgrounds in multimedia learning, in comparison with English speaking background learners. Thus, it is necessary to discuss the relevant literature about English speaking background (ESB) and non-English speaking backgrounds (NESB) students. The focus of the next chapter will be on the relevant literature of ESB and NESB students, their general diversity, and their reading and listening comprehension.
Chapter 4

English speaking background (ESB) students and non-English speaking backgrounds (NESB) students and their learning performance in reading and listening comprehension

The higher education systems in many countries have substantially changed from a national priority to a global priority due to globalisation over the last few decades (Byers-Pevitts 2008). In particular, in western English-speaking countries, universities have become more internationally open for a wide range of learners across borders (Marginson & van der Wende 2006). Thus, diversity has emerged due to the students’ various ethnicities, races, cultures, religions and language backgrounds, which has forced educators to rethink the existing notions of citizenship and nationality and of ways to ensure the effectiveness of teaching and learning (Banks 2004).

As more and more students from non-English speaking backgrounds have arrived in English speaking countries to improve their learning, English as a foreign language sometimes produces some critical challenges and difficulties for the students who have it as a second language (Carstairs et al. 2006). This chapter will briefly review the recent literature which concerns English speaking background (ESB) students and non-English speaking background (NESB) students, as well as evaluate some relevant literature about their abilities and performance in reading comprehension and listening comprehension, in order to understand the diversity of learning performance between ESB and NESB individuals and further identifying the main factors which may affect their learning.
This chapter is divided into five sections:

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4.1 Definitions of ESB students

ESB stands for English Speaking Background. Thus, a person who comes from an English speaking background is defined as someone who was born in an English speaking country or someone who has spoken English from his/her earliest childhood (Oxford English Dictionary Online 2008).

In the relevant literature, ESB has been interchangeably used with ‘native speaker of English’ (McKay 2002). According to the Longman Dictionary of Applied Linguistics (Richards, Platt & Weber 1985, p.185, cited in McKay 2002), a native speaker is defined as ‘a speaker of his or her native language’. A native language has been acquired in a person’s early childhood, is the language spoken in their family, and/or is the language used in the country where he/she is living (Richards, Platt & Weber 1985, cited in McKay 2002). As Davies (1991) states, to be a native speaker is:

Only partly about native naturalness, that is about not being able to help what you are, it is also, and in my view more importantly, about groups and identity: the point is of course that while we don’t choose where we come from we do have some measure of choice of where we go to. Difficult as it is, we can change identities, we can join new
groups (Davies 1991, p.ix).

According to Richards, Platt and Weber (1985, cited in McKay 2002) and Davies (1991), nationality is not the main criterion to establish someone’s first language spoken, as group identity or status may change the language he/she uses to communicate.

Furthermore, McKay (2002) suggests that the level of competence and linguistic intuition of the language should be taken into account as an important factor when defining a native speaker, since the first language spoken is not adequate to determine the language ability of a person (McKay 2002). In fact, a native language is not ‘inherited by genetic endowment’ (McKay 2002, p.30). A person might conceivably have used English to communicate since their early childhood, but still their English language may not achieve a high level of proficiency. As Tay (1982, p.67, cited in McKay 2002) proposed, it is ‘one who learns English in childhood and continues to use it as his dominant language and has reached a certain level of fluency. All three conditions are important’.

As such, someone’s fluency in the English language would be questionable if they learn English in their early life but they do not use it as a dominant language for their lifetime. Oppositely, the language proficiency of someone who acquires English in later life but then uses it during their life may possibly achieve the fluency standard of a native speaker (McKay 2002).

In this regard, a ‘native speaker of English’ has been defined variously as referring to an individual who speaks English as their first language; a person who continues to use English language during their life; or an individual who assumes a high level of language competence in English (McKay 2002).

Additionally, someone who learns or acquires English as a first language is
also called an ‘L1 user’ of English. In the literature, L1 is interchangeably used with ESB and native speakers of English (Jiang 2009).

Associating with the relevant literature, the definition of ESB students used in the present study refers to someone who was born in an English speaking country, someone who has spoken English from their earliest childhood and someone who has reached a high level of language competence in English. Specifically, the majority of the ESB students in this study were born in Australia. English is their mother tongue and is their dominant language used in daily communication. More demographic information related to the ESB sample who took part in the present study will be elaborated on in Chapter 5 - Research design and methodology.

4.2 Definitions of NESB students

In recent times, the investigations of individuals from non-English speaking backgrounds (NESB) have been increasingly widespread in various disciplines. With regards to the language spoken, in general, an NESB individual is defined as someone who was born in a non-English speaking country or someone who was born in an English-speaking country with one or both parents from a non-English-speaking country (Oxford English Dictionary Online 2008).

However, more contexts should be taken into consideration when defining NESB in Australia (Mulligan & Kirkpatrick 2000). With the ongoing migration to Australia, this country has been populated by people from different cultural and language backgrounds. The recent census report showed that one quarter of all people living in Australia were born overseas (Australian Bureau of Statistics 2005). In the Australian context, the Australian Department of Education, Training and Youth Affairs (DETYA) defined NESB students as
'those who were born overseas, speak a language other than English at home, and have been resident in Australia for fewer than 10 years’ (Mulligan & Kirkpatrick 2000, p.314).

In the relevant literature, NESB students have been interchangeably represented as students who learn English as a Second Language (ESL) or who learn English as a Foreign Language (EFL). Additionally, in language learning environments, ‘English Language Learner’ (ELL) has been often employed to describe those students who ‘have a first language other than English and is in the process of acquiring English’. Similar terminologies, such as LOTE (Language other than English), CLD (culturally and linguistically diverse), LEP (limited English proficiency) and L2 (second language) user of English, have been used interchangeably with NESB (The Knowledge Loom Literacy 2004, p.5, cited in Nallaya 2010).

The NESB students who took part in the present study mainly originated from Asian countries, including China, India, Vietnam and other non-English speaking countries and the language they use to communicate with their families is a language other than English. In the present study, NESB students are individuals who were born in non-English speaking countries, speak a language other than English at home, and have been living in Australia for less than 10 years.

The present study proposes to measure the diversity between ESB and NESB sample groups’ performance in comprehending the given learning materials. In order to understand differences in learning between ESB and NESB students, it is important to recognise the potential differences between them. The following section will clarify the main differences that have emerged between NESB and ESB individuals.
4.3 Main diversity between ESB and NESB individuals

This section will draw some prior findings together to give an insight into some differences that exist between ESB and NESB individuals. The differences will be discussed from two aspects, culture and language.

4.3.1 Culture

The meaning of culture refers to ‘the collective programming of the human mind that distinguishes the members of one human group from those of another’ (Hofstede 1980, p.21, cited in Wagner 2008). It is important to recognise that culture can be variously valued according to different orderliness, sense and environmental responses. Thus, ‘culture’ has been defined in multiple ways over time (Wagner 2008).

The term culture is defined as personal refinements in non-scientific usage, such as fine arts, classical music, literature and philosophy, which are the finer things accompanied with a high degree of taste. In the anthropological field, culture is ‘that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society’ (Tylor 1958, p.1, cited in Ferraro & Andreatta 2012). Culture was recently re-defined as ‘a mental map which guides us in our relations to our surroundings and to other people’ (Downs 1971, p.35, cited in Ferraro & Andreatta 2012). As well, culture is referred to as ‘the way of life of a people’ (Hatch 1985, p.178, cited in Ferraro & Andreatta 2012).

All people have culture, so people from different cultural backgrounds may have different values to believe in (Wagner 2008). According to Weiland and Nowak (1999, cited in Bretag, Horrocks & Smith 2002, p.3), ‘Cultural differences do have a considerable impact’. In the field of education, it has

The influence of learners' cultural backgrounds also was investigated in computer-based learning environments (Collis 1999; Lal 2003; McLoughlin & Oliver 2000; Milton & Vozzo 2010). Chisholm (1994) suggested that learners' cultural backgrounds should be taken into consideration when designing computer-based instructions as people who come from the same cultural groups, even from across different social classes, tended to show similar cognitive and motivational styles.

In order to eliminate the diversity between different culture groups, a series of guidelines and models have been proposed over the past decade, aiming at accommodating the needs of learners who are from varied cultural backgrounds, including:

- Guidelines for designing web based curriculum in order to fulfil various cultural differences (Collis 1999);
- Guidelines for designing websites in order to promote cross-cultural communication and interaction (Collis & Remmers 1997);
- Guidelines for selecting content and visual elements used in websites in order to serve different cultural groups (Collis & Remmers 1997);
- Guidelines for creating online course support sites in order to maximise cultural inclusivity (McLoughlin & Oliver 2000, cited in Lal 2003);
- Guidelines for developing websites in order to accommodate local cultures (Chen, Mashadi et al 1998, cited in Lal 2003);
- Guidelines for applying multi-cultural models in designing instructional computer-based learning materials in order to fulfil the needs of students
from various cultural backgrounds (Henderson 1996, cited in Lal 2003);

- Guidelines for designing an online learning community in order to improve cultural inclusivity according to constructivist principles (Holzl 1999, cited in Lal 2003); and,


These guidelines were developed based on empirical research which could effectively satisfy learners across different cultures. However, according to Lal (2003), there are two major assumptions that occurred in the literature concerning cultural differences in computer-based learning. One is that different cultural backgrounds may lead to different ways of thinking and use of computer technologies when interacting with instructional materials for learners. The other one was that the learners’ different needs could potentially be fulfilled by applying design guidelines and models to instructional materials. However, some shortcomings or disadvantages exist. As Lal (2003) stated, as although the cultural differences between learners might be in someway made invisible and deracialised by following the guidelines for instructional design, it could damage all the learners’ learning outcomes. Such a point in fact also was proposed by Henderson (1996, cited in Lal 2003). The reasons were as follows:

- A dominant knowledge for one cultural group may be contextualised and universalised by designers due to designers’ unintentionally being culture blind and the culturally homogeneous approach chosen;

- The phenomenon of deracialisation may be influenced by multiculturalism, cultural diversity and cultural pluralism by designers as they try to avoid the feelings and general controversy of racialisation; and
• The needs of cultural diversity may be ignored by designers due to a lack of sufficient background knowledge about social culture being used to reinforce learners’ learning (Henderson 1996, cited in Lal 2003).

Today, Australian classrooms are populated with people who come from various cultural backgrounds. Some students who are from minority ethnic groups, such as Aboriginal backgrounds, sometimes do not feel at ease with the Australian classroom culture (Lal 2003). Thus, it was required that instructional designers carry out appropriate teaching and learning strategies aiming at accommodating multiple cultures and supporting various learning styles and preferences for learners (Forster 1988, cited in Lal 2003). As a result, the designers should have enough knowledge about social culture contexts and individual differences to form a basis in order to effectively recognise the diversity between different cultural groups as well as the diversity of individuals within any one cultural group, including their abilities to learn and comprehend, preferred ways to think and do, and their sets of values, beliefs and worldviews. The knowledge was helpful for instructing design which could effectively ensure equity for students from different cultural backgrounds in computer-based learning (Lal 2003).

As previously presented, the influences of cultural factors on learners’ learning were indicated by several prior studies. Language also may be another important factor which could affect learning performance. The relevant literature will be elaborated on in Section 4.3.2.

4.3.2 Language

Language has been often considered as a key used to approach the world of culture (Macionis & Plummer 2010). Language is a system of symbols which
allows people who are from the same geographical area or the same cultural tradition to share opinions and communicate (Macionis & Plummer 2010).

There are many languages used worldwide. Three of them have been used most widely, namely: Chinese, English and Spanish. Chinese is used by 1.2 billion people as their mother tongue all over the world (about 20 percent of humanity). English is the official language spoken by approximate 600 million people (about 10 percent). There are nearly 350 million people speaking Spanish as their dominant language (about 6 percent). Some types of minor languages are used by approximately from 5,000 to 6,000 speakers in their daily communication, and another quarter of languages are used by less than 1,000 speakers (Macionis & Plummer 2010).

Language generally consists of spoken words/speech and written words/text (Stubbs 1980). The following section will discuss them in detail.

4.3.2.1 Spoken words and written words

‘Spoken words are sounds with a meaning: as sounds, they are produced in the respiratory tract; as possessing a meaning’ (Lonergan, Crowe & Doran 1997, p.14). Nowadays, recent instructional technologies have enabled spoken words to be delivered by electronic devices, which allow learners to listen through earphones or speakers (Clark & Mayer 2008).

When people learn language, written language is secondary and derivative, usually learned after speaking, as communities’ interactions in fact rely more on speech rather than on written words (Barber, Beal & Shaw 2009). In comparison with spoken words, written words are usually signed simply by presenting in characters as words or morphemes (Lonergan, Crowe & Doran 1997). In the field of education, written words are important. For example,
textbooks are always presented in written text (Sen 2006). In the e-learning environment, written texts are presented as web pages, emails, etc. on computer screens (Clark & Mayer 2008).

Written language and spoken language differ due to their linguistic features (Flowerdew & Miller 2005). In comparison with spoken words, written language is integrated and structured densely. Written text is also detached, which means it lacks interactions between words and readers. By contrast, as a type of audio file, spoken text is fragmented, loosely structured and more interactive for listeners (Flowerdew & Miller 2005). According to the functions of different types of words, the objects of written and spoken words imposed on human cognitive activities are different in reference to reading comprehension and listening comprehension (Flowerdew & Miller 2005). The relevant literature about reading and listening comprehension will be reviewed later in this chapter.

Language is the predominant medium used to communicate and consists of various alphabets and ideograms (Mohan et al. 2004). Generally, language communication is categorised as follows:

- Speech, relying on hearing and voice for communicating;
- Writing, relying on visual texts for communicating; and
- Signing, relying on manual contexts and body language, such as gestures, eye contact and facial expressions, for communicating (Mohan et al. 2004).

In this regard, communication can be generally split into two classifications depending on people’s communication behaviours, being verbal and non-verbal communication (Kirst-Ashman & Hull 2012). The following section will provide a brief discussion of verbal and non-verbal communication and
4.3.2.2 Verbal and non-verbal communication

Verbal communication is the most common and effective way to relay messages in people’s daily communication. It is usually presented with voice and spoken words to express meaning (Kirst-Ashman & Hull 2012). Non-verbal information is the other type of communication which is all communication other than spoken words (Kirst-Ashman & Hull 2012). According to Kirst-Ashman and Hull (2012), non-verbal messages are expressed through written words and body language, which are ‘any aspect of an individual presence that conveys ideas or information without being spoken’ (p.52).

Approximately more than 65 percent of daily interpersonal communication is transmitted through non-verbal communication (Mohan et al. 2004). However, the definitions of non-verbal communication have sometimes conflicted. Sometimes non-verbal communication is also explained as the process to share meaning via body language without any words stated - neither written nor spoken words included (Eundon 2008; Mohan et al. 2004; Rosengren 2000; Steinberg 2007).

In the field of multimedia learning, Baddeley (1986) proposed a dual-channel assumption which categorised multimedia resources as visual information and auditory information from the sensory aspect. The classifications included in the assumption were made depending on the nature of the resources in human communication.

The present study proposes to investigate the sub-group difference between ESB and NESB students, so English is a central theme to be concentrated on.
The following section will elaborate on the English language.

4.3.2.3 English language

English has been an official language or semi-official language in many countries because of the influence of Britain over the past few hundred years and, more recently, the influence of the United States (Macionis & Plummer 2010). The speech patterns of English were brought to Australia at the end of the eighteenth century as settlers came to Australia from the British Isles and it has been used until today (Crystal 2003).

In Australia, English is declared as the only official language of speaking throughout the country (Geldren 2006). The English language that originated in Australia has been influenced by other types of expressions due to the increasing number of immigrations, thus the language has a very mixed linguistic character (Crystal 2003).

Over the last two decades, a large number of international students have come to Australia to improve their learning. The majority of them come from non-English speaking backgrounds (NESB) and are enrolled in the higher education sectors (Oliver, Vanderford & Grote 2012). As a result, a corresponding concern has been raised regarding the difficulty NESB students might experience in academic learning. Recent literature demonstrated that English language competence was one main factor which could affect individuals' academic performance (Carstairs et al. 2006; Ramburuth & McCormick 2001; Volet 1999, 2001; Volet & Ward 2006).

Furthermore, comparative studies have been extensively documented in the literature over the past decades attempting to identify the sub-group diversity between various sample individuals who come from different language
backgrounds or cultural contexts. However, many of the studies were related to the context of the United States and the literature regarding Australian society has been limited (Baron et al. 2003; Carstairs et al. 2006; Fraser 1995; Levin et al. 1987; Neisser et al. 1996).

A comparative analysis related to Australian contexts was conducted to investigate the diversity of test performance between three sample groups (Carstairs et al. 2006). The adult participants were randomly recruited from the Sydney metropolitan area and categorised into three groups depending on their language backgrounds, including non-English speaking background participants whose first language spoken was other than English (NESB-OE), the non-English speaking background participants whose mother tongue was English (NESB-E) and English speaking background participants whose first language spoken was English (ESB) (Carstairs et al. 2006).

The materials used to test the participants’ cognitive abilities were from the Macquarie University Neuropsychological Normative Study (MUNNS) with a number of sub-tests. They included the Wechsler Memory Scale – Revised (WMS-R), the Rey Auditory Verbal Learning Test (RAVLT), the Wechsler Adult Intelligence Scale - Revised (WAIS-R), the Stockings of Cambridge Test from the Cambridge Neuropsychological Test Automated Battery, a non-verbal test of executive functioning, an Excluded Letter Fluency Test, a verbal test of information processing, the Speed and Capacity of Language Processing Test (SCOLP), a contextual version of the Australian National Adult Reading Test (C-AUSNART) and the Depression, Anxiety and Stress Scales test (DASS) (Carstairs et al. 2006).

The findings of Carstairs et al.’s (2006) study firstly demonstrated that the influence of participants’ first language spoken on test performance was significant. They further indicated that the people who were from NESB tended
to show disadvantages on verbal sub-tests due to a lack of English language proficiency, while visual materials could effectively reduce the difficulties that resulted from English language processing (Carstairs et al. 2006). Similar findings were proved by Owen et al. (1996), demonstrating that visual testing was resilient to the negative effects produced by language proficiency.

Carstairs et al. (2006) also found that there were two factors that could influence participants' test performance. One was the language or proficiency in English which affected the performance of verbal sub-tests. The other was the socio-cultural factors which possibly influenced the performance of nonverbal sub-tests. The findings were supported by Levin et al.'s (1987) study which also revealed that the socio-cultural factors could affect participants' performance in cognitive ability tests.

Another research study using Australian data was conducted by Ramburuth and McCormick (2001) in order to explore the diversity between Australian local and Asian international students regarding their preferred ways to process learning materials. The students were asked to complete two questionnaire surveys in Ramburuth and McCormick's (2001) study, which were the Study Process Questionnaire (SPQ) and the Perceptual Learning Styles Questionnaire (PLSQ) used to measure the students' motivation and strategies for learning and their learning style preference. The students were asked to circle the options on a five point like-type scale form in the motivation and strategy questionnaires. The options were from 'always or almost always true of me' to 'never or only rarely true of me'. There were various modes of learning included in the Perceptual Learning Style Questionnaire which contained 30 statements on a five point like-type scale, rated from 'strongly agree' to 'strongly disagree' (Ramburuth & McCormick 2001).

According to Ramburuth and McCormick (2001), Asian international students
were more deeply motivated than the Australian local students to learn, which was supported by Biggs (1990). As Biggs (1990) found, Australian students just met set requirements in learning. They tended to keep the balance between failure and hard work. By contrast, international students were highly motivated in learning. Similar findings also were found in Kember and Gow’s study (1990) and Kember et al.’s (1989) study. In this regard, Volet (1999) proved that when language comprehension was not an issue, many international Asian undergraduate students achieved better performances in academic learning than local students.

Regarding the preference for processing learning materials, according to Ramburuth and McCormick (2001) the only discriminator between Australian and international students was audio-related mode(s) in the overall approach. Australian students had a stronger preference for auditory mode(s) which might have been influenced by their collectivism and individualism. Asian students preferred to learn through visual mode(s) over auditory mode(s), due to their limited aural skills (Ballard & Clanchy 1991; Mezger 1992; Ramburuth & McCormick 2001; Zheng 1990).

As the studies presented above show, individuals’ language proficiency, particularly their aural comprehension skills, can substantially influence their performance. The significant difference in performance between ESB and NESB individuals was produced by verbal materials, while the difference in performance between them could be effectively eliminated by using visual contexts. Audio was the only mode that was discriminated in learning preference between Australian local and Asian international students. Specifically, local students preferred to process learning contexts through audio mode(s) and international Asian students preferred to learn using visual materials rather than auditory ones.
In this sense, it is necessary to recognise the processes of reading and listening comprehension for ESB and NESB individuals. The following sections will present some relevant literature and theoretical models in the field.

### 4.4 Reading comprehension and the reading process

Reading comprehension has been extensively documented in the literature. This section will focus on the processes of first and second language reading comprehension, in order to present the nature of reading comprehension and clarify the difference in comprehending a person’s first language and second language.

#### 4.4.1 The definitions and psychological models of reading comprehension

In the literature, reading comprehension has been defined in many ways over the years. In general, it refers to the holistic processes of interpreting information from the text and getting meaning and knowledge possessed by the readers together to produce meaning as the current knowledge (Anderson & Pearson 1984). The processes of reading comprehension have been typically presented with various models which contribute to demonstrating the actual processes of reading and suggest how reading should be taught (Manzo & Manzo 1990).

According to Harris and Sipay (1985), there are three primary models used to describe the process of reading comprehension. They are bottom-up, top-down and interactive models.

**Bottom-up models**

Bottom-up models of reading tend to be text-driven processes. Readers begin
their perception and recognition initially from details and specifics, such as
letters, then form words from letters and then form sentences from words. The
process of dealing with units is accurate and rapid, and meaning building is
moved from the smaller to the larger units. This approach assumes that
reading is a step-by-step process where one stage has to be completed before
the other one starts (Urquhart & Weir 1998). It also assumes that if each
reading sub-skill can be mastered by readers, then overall reading
competency will be attained eventually (Gough & Cosky 1977).

However, bottom-up models have been challenged by most psycholinguists
and cognitive psychologists for several reasons (Goodman 1988; Konza 2006).
These models were criticised for lapsing reading into mind-numbing routines,
as in the bottom-up reading processes words can be decoded automatically
but may not be understood. Also, decoding individual letters may result in
cognitive overload imposed on the readers’ working memory. A good reader is
able to decode about 250-350 words per minute, but the limited capacity of
his/her working memory cannot hold that amount of words at once, so the
reader may often forget the beginning of a sentence before reaching the end.
Thus, the top-down models tend to be advocated (Goodman 1988; Konza
2006).

Top-down models

Top-down reading is a meaning-driven process. In the processes, readers take
their prior knowledge as the basis to decode the text. Top-down reading
models emphasise readers and assume that readers come to the text with
formed predictions based on their background knowledge. Along with the units
of text, readers test their predictions to confirm the meaning of reading content
(Goodman 1988). In comparison with bottom-up reading, top-down reading
allows readers to be actively constructing meaning (Manzo & Manzo 1990).
As the empirical findings which could support top-down models are weak, the models have been increasingly challenged since the end of 1980s. Since then, interactive models have been suggested instead of top-down models (Stanovich 1980).

Interactive models

Interactive models employ contributions from both bottom-up and top-down models. Thus, interactive reading is a process that is driven by both text and meaning. Specifically, successful interactive reading results in information being gleaned from the text being read and advanced expectations being formed based on the readers’ background knowledge (Rumelhart 1977). In this sense, interactive reading is an active and strategic process to construct meaning through questioning, predicting, confirming and self-correcting the text according to their prior knowledge (Manzo & Manzo 1990).

To sum up, a process of bottom-up reading starts from decoding the details and specifics to forming a global concept of the reading content. On the other hand, a top-down reading process starts from a global concept which is predicted by the reader based on his/her previous knowledge and moves down to the details and specifics of the reading materials. In interactive models, the process of reading integrates top-down models with bottom-up models. The meaning is constructed from the integration of the information gleaned from the information being presented in the reading content and the evaluation of the content based on readers’ prior knowledge.

The majority of theories relevant to second language reading comprehension have been developed upon the theories of first language reading (Akbulut 2008). As a result, the nature of the second language reading process has
been explained by some models borrowed from the first language reading comprehension models, including bottom-up, top-down and interactive. Both first language and second language reading processes place the emphasis on both text-driven factors, such as the readers’ language decoding skills or reading proficiency, and reader-driven factors, such as interest in the topic of the text, readers’ prior knowledge and their learning styles (Akbulut 2008, Gascoigne 2005).

Readers’ language decoding skill or reading proficiency is a critical factor that can significantly affect readers’ reading comprehension (Akbulut 2008). Pressley (2000) classified the skills of reading comprehension into word-level skills and higher level skills.

4.4.2 Word-level skills

Word-level language skills play an integral role for readers in the process of reading comprehension (Snow, Burns & Griffin 1998). The language skills at the word-level are decoding, fluency and vocabulary knowledge (Snow, Burns & Griffin 1998).

Decoding refers to word recognition which is the process of breaking the code of written text (Juel 1988). At this stage, in order to achieve word recognition, readers need to translate meaningless units of words (individual or multiple letters) into recognisable objects, form an appropriate mental representation in their lexicon and retrieve the semantic content. In the process of decoding, readers need to have clarification of each word in their minds and build proper relations, such as word order, among them (Gough, Hoover & Peterson 1996; Hoover & Gough 1990).

Reading fluency is another key component that can affect reading
comprehension (National Reading Panel 2000). Fluent readers are able to control their reading processes by simultaneously recognising and comprehending words with accuracy, speed and expression. By contrast, less fluent readers do not have the ability to read smoothly, they read slowly and struggle in their reading processes. Thus, fluent readers usually perform more successfully than less fluent readers in reading comprehension (National Reading Panel 2000).

Furthermore, fluency skills can potentially influence readers’ ability to comprehend reading materials (Perfetti 1992). Both decoding and comprehension require cognitive resources. Specifically, for a reader who lacks fluency, much of their cognitive resources are dedicated to decoding the text and fewer cognitive resources are left to monitor comprehension. A fluent reader uses fewer cognitive resources to decode text which results in more cognitive resources to construct meaning (Perfetti 1992).

According to Grabe (2009), secondary or undergraduate students who learn English as a second language (L2) may read at 80-120 words per minute due to their limited fluency in second language reading. It reaches one-half to one-third of the capable maximum read rate for readers who speak English as their first language (L1).

In fact, reading comprehension is constrained by the limited capacity of working memory (Baddeley 1986; Gathercole & Baddeley 1993; Goldman, Varma & Cote 1996; Kintsch 1998). Through reviewing a number of studies, Berquist (1997) indicated that the capacity of working memory in comprehending L1 is limited. However, the capacity would be further reduced in comprehending L2 as more cognitive resources are demanded to deal with the information presented in L2 for adult learners. Similar findings also were proved by Diao and Sweller (2007), which was presented in Chapter 3, Section
3.2.11. It revealed that NESB students preferred to process instructional information from text-only formats rather than text-audio formats, which was not only because of their disadvantaged aural abilities but also because of their reduced working memory capacity in L2 comprehension.

Furthermore, Chun and Plass (1997) proposed that multimedia resources may negatively distract readers from the reading processes. Firstly, the concurrently presented multimedia information may produce deleterious effects as readers have to split their attention between various types of information. Secondly, readers distracted by non-relevant information that they are interested in, but does not add to their understanding. Finally, the ‘executive resources’ of L2 learners may be not enough to tackle multimedia information (Chun & Plass 1997).

However, L2 readers could perform reasonably well in reading comprehension when they were given enough time to complete the tasks, since they could read the materials with comprehension even though they read slowly. Also, Akbulut (2007) found that the lack of language fluency could be overcome by L2 readers in reading comprehension if they had the necessary background knowledge relevant to the given topic.

Vocabulary knowledge is also an essential word-level factor and is one of the best predictors of reading comprehension. It is able to enhance reading fluency and boosts reading comprehension (Cain, Oakhill & Lemmon 2004; National Reading Panel 2000; Snow, Burns & Griffin 1998). The previous investigations concluded that readers with weak vocabulary knowledge experienced more difficulties when having to comprehend new vocabulary (Cain, Oakhill & Lemmon 2004). According to Lesaux and Geva (2006), due to the limited vocabulary knowledge in L2 reading, L2 readers exhibited significantly poorer performance in decoding single words compared to L1
readers. Palladino (2007) argued that this recent literature had extensively evaluated readers’ performance on superficial vocabulary memorisation which could not indicate the relationship between readers’ vocabulary knowledge and their comprehension performance in reading.

Besides all this, other factors are also considered to be critical in affecting reading comprehension. According to Pressley (2000), reading comprehension can also be activated by prior knowledge, monitoring comprehension, asking questions and inferring, which are the comprehension skills above word level.

4.4.3 Higher-level language skills

Prior knowledge is one of the most important factors that can affect reading comprehension and which could impact other comprehension skills related to reading (Akbulut 2007; Anderson & Pearson 1984). In fact, readers’ prior knowledge can effectively determine a reader’s ability to monitor comprehension. Wagoner (1983) indicated that in the process of reading, the ability to monitor comprehension was decreased for readers who had less prior knowledge of the content being read. Also, prior knowledge could activate readers to generate questions toward the given topic or genre of the text being read (Wagoner 1983), which could further help readers to infer conclusions from the text and build the essential understandings (Keene & Zimmermann 2007; Keene 2006; Wagoner 1983).

Monitoring comprehension is an essential skill to improve reading comprehension (Palladino 2007). Good readers usually have the habit of monitoring their comprehension while reading, such as tracking their reading speed and understanding of the reading materials, while poor readers are less likely to monitor how fast they read and how well they understand in the
Questioning is another necessary skill in the active process of reading comprehension which refers to self-generated requests for the content on the given topic (National Reading Panel 2000). In the active reading process, readers seek information based on their prior knowledge. Thus, generating questions is beneficial for reading comprehension (Taboada & Guthrie 2006). Meanwhile, asking questions can also foster comprehension monitoring (Palladino 2007).

Several prior studies showed that there was a significant relationship between students’ questions and their reading comprehension, maintaining that the readers who asked questions understood the text deeper than the readers who did not ask any questions in the reading process (Collins, Brown & Newman 1990; Davey & McBride 1986; King 1994; Taboada & Guthrie 2006). In this regard, a face-to-face education is necessary in order to provide appropriate answers for readers’ questions. Also, face-to-face education is able to encourage readers to be active in reading and generating questions on both reading content and implementations, which are valuable feedback for instructional design and improvements (Galindo 2002, cited in Gómez, López & Marin 2011).

Inferring is a process of creating meaning from text by readers so it too is an essential comprehension skill to improve readers’ understanding of the text being read (Keene & Zimmermann 2007). There are a series of mental activities involved in the process of inferring, including: drawing conclusions; making predictions; formulating hypotheses; making generalisations; and visualisation (Keene & Zimmermann 2007).

In the active reading process, proficient readers are able to connect their own
experiences, background knowledge and other facts to infer conclusions, make predictions of the outcomes, develop hypotheses from the inputs, form generalisations from the details and use pictorial information to create personal interpretations (Keene 2006; Keene & Zimmermann 2007).

Besides prior knowledge, topic interest and learning styles are also critical in reading comprehension. They are reader-driven factors (Alexander, Kulikowich & Jetton 1994).

Topic interest is believed to be an essential reader-driven factor that influences reading comprehension (Alexander, Kulikowich & Jetton 1994; Brantmerier 2003; Carrell & Wise 1998). A significant relationship between topic interest and readers’ performance in L1 reading comprehension was found, while such findings have not been revealed by L2 reading comprehension research (Alexander, Kulikowich & Jetton 1994; Brantmerier 2003; Carrell & Wise 1998).

Learning styles are another reader-driven factor affecting reading comprehension (refer to Section 3.2.12.2 for the review of the definitions and prior studies relevant to learning styles). According to Plass et al (1998), readers’ performance in L2 reading comprehension could be effectively improved if they have the opportunity to process information using their preferred styles.

Previously presented reading comprehension theory models and research studies have been solidly developed and conducted in conventional print-based text environments. The recent advanced information technologies have allowed reading comprehension in the online hypermedia world (Leu et al. 2008). Hypermedia has been categorised as multimedia in nature (Dillon & Jobst 2005). Multimedia learning materials accommodate various types of
resources which allow learners to process the content based on their preferred learning styles (Liu & Reed 1994; Plass et al. 1998). Ramburuth and McCormick's (2001) study showed that Australian ESB students preferred to process information via auditory modes and NESB students were considered as visual learners who tended to process learning content through visual resources rather than aural ones (Chen 1998; Ramburuth & McCormick 2001; Reid 1987).

The comprehension skills and the models of bottom-up, top-down and interactive are necessary and relevant for readers in hypermedia reading, although it has been elicited that more cognitive demands are required to process hypermedia (Akbulut 2008, Ariew & Erçetin 2004; McEneaney 2003). The following section will focus on L1 and L2 reading comprehension in hypermedia environments. As hypermedia is the extension of hypertext, the literature relevant to hypermedia reading and hypertext reading will be drawn together to be discussed.

4.4.4 Comprehension performance in hypermedia reading

Well-prepared hypermedia annotations can contain lexical, syntactic contexts, extra information or important points on the topic. They also can include a target language used to translate the original term. Sometimes annotations can be presented with different media files for instructional purposes (Roby 1999). The relevant literature indicated that the facilitative role of hypermedia contexts in reading comprehension was better than non-hyperlinked materials, as hypermedia provides more explanations on the given topic via various glossaries or annotations which were beneficial to reading comprehension (Chen & Rada 1996; Liao 1999; Roby 1999). It further proved that hypermedia/hypertext contexts were more beneficial for learners who had a low reading proficiency (Knight 1994).
In the relevant literature, the main focus of L1 hypertext reading comprehension has been on investigating the relationship between readers’ comprehension performance and different reading strategies which demonstrated that effective reading strategies could significantly enhance readers’ comprehension performance (Altun 2000; Calisir, Eryazici & Lehto 2008; Dee-Lucas 1996; Duke, Schmar-Dobler & Zhang 2006). In these studies, readers were assigned to read linearly or hierarchically structured hypertexts and instructed with some cognitive comprehension strategies. Then the readers’ performance on reading, planning, previewing, making predictions, identifying main ideas or evaluating the textual content was monitored (Altun 2000; Calisir, Eryazici & Lehto 2008; Dee-Lucas 1996; Duke, Schmar-Dobler & Zhang 2006).

Munro and Verezub (2011) conducted a study aimed at evaluating the influence of different cognitive comprehension strategies on reading hypertexts by elementary students (Grade 3 and Grade 6). The students were asked to comprehend linearly structured hypertexts followed by comprehension tasks. At the post-instructional phase, students’ hypertext comprehension performance was measured under the same conditions as the pre-instructional phase. The findings revealed that the comprehension performance of Grade 3 students and Grade 6 students was enhanced by different strategies (Munro & Verezub 2011).

In addition, some studies of L1 reading comprehension explored the influence of learners’ prior knowledge or topic interest on readers’ comprehension performance (Blatchley & Lau 2010; Salmeron, Kintsch & Canas 2006a, 2006b). The findings showed that the readers who had sufficient prior knowledge on the subject performed significantly better than the readers who lacked prior knowledge (Carrell 1988; Sakar & Erçetin 2005). Sakar and
Erçetin’s (2005) study further proved that the performance of reading comprehension for the readers who had insufficient prior knowledge and low reading proficiency could be facilitated by hypertexts which were annotated by information at both the word (i.e. definitions of words) and topic levels (i.e. extra information about the topic) (Sakar & Erçetin 2005).

Some studies in L1 hypertext reading found that there was a significant relationship between topic interest and readers’ comprehension performance (Alexander, Kulikowich & Jetton 1994). However, this relationship was not found in L2 reading comprehension (Brantmeier 2003; Carrell & Wise 1998).

Hypermedia as a potential useful format was suggested for use in L2 reading comprehension as it could compensate for the difficulties that occurred in L2 reading as hypermedia made the reading materials more comprehensible for L2 readers by using different types of media to form annotations (Davis 1989; Roby 1999). Chun and Payne’s (2004) study and Erçetin’s (2003) study both indicated that L2 learners preferred to process information via annotations in hypermedia reading, in particular annotations which contained definitions and first language translations.

In the literature, several studies evaluated the effectiveness of annotations which were presented with various media formats on facilitating L2 reading comprehension (Akbulut 2008; Ariew & Erçetin 2004; Chun 2006; Chun & Payne 2004; Yeh & Wang 2003). Yeh and Wang’s (2003) study demonstrated that the most effective type of annotation presenting glossary and vocabulary information was text plus picture, which had a more facilitative effect than text-only and text plus picture and sound annotations on vocabulary acquisition for L2 readers located in Taiwan.

Ariew and Erçetin (2004) conducted a study to explore the effectiveness of
video and image annotations on enhancing L2 reading comprehension for intermediate and advanced readers who learn English as a second language. They found that the readers' comprehension performance was not significantly facilitated by any type of annotations for either group, and there was no significant difference between video and image annotations indicated. It may have been influenced by the readers' context-biasedness. Readers' language proficiency may influence their preference to process L2 reading content (Carrell 1988).

However, Ariew and Erçetin’s (2004) results contradict with the findings obtained by Akbulut (2008). Akbulut’s (2008) study aimed at identifying L2 readers’ learning styles in hypermedia reading. Fifty-four participants who were studying at a department of TEFL (Teaching English as a Foreign Language) were asked to read instructional materials presented with hypermedia with various types of annotations, including text, graphics, audio and video. The findings demonstrated that the most useful annotations for facilitating text recall were text and video, and text was more facilitative (Akbulut 2008). Thus, the L2 readers who took part in Akbulut’s (2008) study preferred to learn via text or video annotations.

Overall, as the prior studies showed, ESB and NESB readers tended to have a great difference in reading comprehension, including comprehension skills, working memory capacity, preferred styles etc. In fact, a considerable number of studies have investigated the English language proficiency of NESB individuals and the problems or difficulties they experienced in L2 comprehension (Burroughs 2008; Burroughs, Marie & McCroskey 2003; Swagler & Ellis 2003; Woodrow 2006). However, in comparison with the achievements in L1 reading comprehension literature which has been done over the last two decades, L2 reading comprehension literature showed larger gaps, in particular the limited explorations of readers who have lower level
reading skills (Prior 2012).
On the other hand, many studies recently have explored L1 or L2 readers’ comprehension performance (Goh 2013). However, their investigations relied on one group solely, either L1 or L2 readers, rather than both L1 and L2 readers together. Thus, comparative studies in this area are rare.

In order to effectively measure individuals’ comprehension performance, it is necessary to know the different levels of comprehension. The following section will elaborate them.

4.5 Three levels of reading comprehension

Clymer (1968) proposed that there were three levels involved in reading comprehension: the literal level, the inferential level and the critical level. Literal comprehension is the shallowest of the levels and critical comprehension is the deepest.

4.5.1 Literal comprehension

Literal comprehension refers to readers’ mental representations that simply recall the facts or information presented in a text. At this level, the information used to respond to literal questions is largely and explicitly from the text itself. Thus, comprehension on recalling is easily evaluated. Smith (1969) argues that minimum thinking skills are required for literal comprehension in order to understand the text in depth.

4.5.2 Inferential comprehension

Inferential comprehension is the next level of comprehension which describes readers’ ability to take information and knowledge presented in different
sections within a text. Inferential comprehension is a more sophisticated level of comprehension than literal comprehension because meaning that is not explicitly presented in the text can be extracted (Clymer 1968). According to Clymer (1968), in order to achieve inferential comprehension, readers are required to orchestrate and manipulate the information from the text as well as the information from their background knowledge to interpret, synthesise or extend the information which is explicitly expressed in the reading content.

4.5.3 Critical comprehension

Critical comprehension is the highest level of comprehension, and refers to readers’ ability to make critical judgements about the information presented in the text based on their prior knowledge. Answers to critical questions require a high level of interaction between the materials that have been read and the readers. In-depth analysis and critical thinking are necessary to make judgements and evaluations with reference to a reader’s own background, interest and disposition.

Section 4.5 has analysed and discussed three different levels of comprehension. Answering literal, inferential and critical questions was a task that was employed in the present study to measure students’ comprehension performance.

Audio is a common element which has been frequently employed in multimedia instruction (Clark & Mayer 2008; Mayer 2009). Thus, listening comprehension is another necessary skill in learning. The following content will concentrate on listening processing and the relevant literature about ESB and NESB individuals in listening comprehension.
4.6 Listening comprehension and the listening process

The research into listening comprehension has been ongoing for three decades (Goh 2013). In the past, listening was labelled as a passive skill in comparison with active skills such as speaking and writing. However, recent literature argues that listening is an active process rather than a passive one and is an integral part of communicative competence (Rivers 1981). Peterson (2001) further defined listening comprehension as a multilevel and interactive cognitive process to understand incoming auditory content.

4.6.1 Listening stages and processing models

According to Coakley and Wolvin (1986), listening is a process of ‘receiving, attending to, and assigning meaning to aural stimuli’ in any language (p.18). DeVito (2000) summarised five important sub-processes for listening comprehension, including: receiving; understanding; remembering; evaluating; and responding. Beebe, Beebe and Ivy (2001) proposed another five-step listening process in a slightly different way, referring to selecting, attending, understanding, remembering and responding. Adler and Towne (2005) summarise the listening process as hearing, attending, understanding, responding and remembering.

To sum up, the steps considered by all in listening at a minimum are:

- Receiving;
- Attending; and
- Understanding (Frommer 2006; Neff 2006).

In sequence, the specifics of the receiving stage refer to getting or hearing
auditory messages from the external environment (Neff 2006). Receiving occurs because of the interaction between listeners and environmental or external factors but listeners need to attend to the stimuli to ensure the listening process continues. Thus, attending is the next stage of listening. However, attending does not occur all the time and it is what determines whether the auditory input is processed in working memory (Frommer 2006; Neff 2006; Witkin 1993). At the stage of receiving, the sources of stimuli may be numerous, reaching the senses of a listener and competing for his/her attention. Thus, the topics of listening are those the listener is interested in, in order to successfully help him/her to omit the ineffective messages and achieve an effective listening process. In other words, without attention, a listening process cannot take place (Neff 2006). At the understanding stage, the meaning of the auditory message is understood and interpreted by the listeners, which implies that listeners are able to recognise the content and also ascertain the emotional meaning attached by the speaker, such as through the tone of voice and body language (DeVito 2012; Neff 2006).

There have been three models used to describe the nature of listening processes. They are the bottom-up, top-down and interactive models (Flowerdew & Miller 2010).

Bottom-up models

The bottom-up models were the first listening models, developed between the 1940s and 1950s (Flowerdew & Miller 2010). The bottom-up models of listening assume that the processes of constructing meaning get started from the smallest linguistic units of the acoustic message, such as phonemes or words. Then the units are combined into words to make up phrases, clauses and sentences. Finally the global concepts toward the learning contexts are formed by blending individual sentences together (Flowerdew & Miller 2010).
Top-down models

The top-down models contrast with the bottom-up models as the meaning is constructed based on listeners’ prior knowledge rather than the individual sound and word segments of the listening materials (Flowerdew & Miller 2010). The emphasis of the top-down model is on ‘listeners’ ability to bring prior information to bear on the task of understanding the “heard” language’ (Morley 2001, p.74). The models view listening as an active and complex process. Listeners are involved in actively selecting aural input, constructing understanding and building relations between the incoming sound and their prior knowledge (Byrnes 1984).

Interactive models

These models were developed by Rumelhart and his associates (Rumelhart & McClelland 1982). The interactive models of listening are a combination on the bottom-up and top-down processes working simultaneously, referring to the bottom-up processes of decoding the audio segments, such as words, structures and sounds, and the top-down processes of making inferences based on the listeners’ background knowledge of the listening content (Gascoigne 2005; Rumelhart & McClelland 1982).

The bottom-up models of listening are preferred by beginner listeners to decode exact phrases and words (Gascoigne 2005). Bottom-up processing requires a great deal of conscious attention from listeners, but limited chunks of information can be comprehended. In comparison with bottom-up processing, top-down and interactive models of listening are more suitable for proficient listeners, placing the emphasis on comprehending bigger chunks and selecting important input from the information being heard (Flowerdew &
Miller 2010; Gascoigne 2005). Both top-down and interactive models of listening hold fewer chunks of information from the auditory message in working memory, so there is a large capacity of cognitive resources available to be devoted to comprehending the content (Gascoigne 2005).

The nature of the listening process in L1 and L2 is considered to be similar, but the L2 listening comprehension is more complex (Wilczynska 1993, cited in Frommer 2006). In fact, individuals usually listen to their first language faster than the average rate of speech-language presented and wait for additional incoming data (Coakley & Wolvin 1986; Johnson 1993; Witkin 1993). The challenge for L2 listeners is mainly produced by their insufficient linguistic competence (Apitz 2008). In practice, L2 listening comprehension is more difficult than L2 reading comprehension as the speech rate of the presentation, unknown vocabulary and other factors such as the speaker's accent may be out of the listener's control (Ching-Shyang & Read 2007; Graham 2002, 2006; Smidt & Hegelheimer 2004; Yeh & Wang 2003).

Also, the difficulty of L2 listening comprehension may be the result of the listeners' inability to recognise the patterns used to express language (Apitz 2008). According to Witkin (1993), listeners do not decode the incoming message directly but are accustomed to identifying the pattern of language first and translating the message into another pattern which is familiar to them. For instance, in French, *maigre comme un clou* (in English is 'thin as a rail', *comme* is 'as' or 'like') follows the pattern 'adjective + *comme* + indefinite article + noun'. If the listeners are familiar with the pattern, they will automatically expect a noun after 'adjective + *comme*' in their listening process (Apitz 2008).

Some studies have evaluated the effectiveness of various types of assessment instructions on improving L2 listening comprehension (Coniam
In Coniam's (2001) study, there were two groups of participants who learned English as a second language invited and assigned to complete the same listening materials presented in different modes. One group was instructed by audio mode listening materials, the other one was instructed by video mode. The results of Coniam's (2001) study indicated that there was no statistically significant difference between the two groups of participants' performance in listening comprehension, although some participants indicated that they liked to interact with the given materials using the video format. The findings might be because the participants who were presented with video had to look up and down from their question paper to the computer screen, which led to a struggle in their visual channel and a negative influence on their performance (Coniam 2001).

To sum up, listening comprehension in L1 and L2 is similar, but the second language listening processing is more complex due to the L2 listeners' abilities. In fact, L2 listeners cannot effectively handle the auditory input due to the unfamiliar vocabulary, the rate of oral speaking and the different patterns of language expression which all produced challenges and difficulties faced by the learners who learn in a second language.

Furthermore, multimedia or hypermedia resources have been associated with various media formats to present information (Dillon & Jobst 2005; Vaughan 2008). Thus, both reading and listening processes and abilities need to be taken into consideration when evaluating the factors influencing students' comprehension performance.

4.7 Concluding remarks

In this chapter, the relevant literature on English speaking background (ESB) and non-English speaking background (NESB) students and reading and
listening comprehension was reviewed and evaluated. Firstly, this chapter discussed and analysed the definitions of students from ESB and NESB. ESB students are defined in various ways. Associating with Australian contexts, in this study ESB students are specified as individuals who were born in Australia or other English speaking countries and learned or acquired English as their first language. NESB students are defined as those who were born in non-English speaking countries, do not speak English at home and have been residents in English-speaking countries for less than 10 years.

Secondly, this chapter broadly classified the main differences between ESB and NESB individuals as being culture and language. As the previous research studies revealed, cultural contexts and language proficiency can significantly influence performance in comprehending given materials between ESB and NESB participants. Also, ESB and NESB individuals tended to process information via different modes. Australian local students showed a strong preference to receiving information through auditory stimuli, while Asian international students were likely to prefer learning content with visual information over aural information. In addition, the cognitive abilities of ESB and NESB students were significantly different. It further showed that NESB participants had disadvantages when interacting with verbal sub-tests as compared to ESB participants, and that the difference in their cognitive abilities could be effectively diminished by visual test materials.

Thirdly, this chapter gave insight into reading comprehension in L1 and L2 respectively. It reviewed the recent literature relevant to L1 and L2 learners’ comprehension performance in reading, including bottom-up, top-down and interactive models of reading and several text-driven factors - word-level, reader-driven and higher-level (above words). The previous studies indicated that ESB and NESB readers had some significant differences in reading processing, such as their preference style, reading skills, working memory
capacity and comprehension performance.

Furthermore, this chapter clarified the three levels of reading comprehension. They were literal, inferential and critical comprehension. Literal comprehension was the lowest level of comprehension of the three, while critical comprehension was the highest one. Thus, answers to the comprehension questions at these three levels require readers to have different abilities to interact with the reading materials. The present study employed literal, inferential and critical questions to assess students’ performance in comprehending the given materials.

Finally, this chapter discussed and evaluated relevant theories and studies on listening comprehension in L1 and L2. In fact, listening processing in L1 and L2 is similar and was mainly outlined using one of three models, namely bottom-up, top-down and interactive models of listening. However, the listening comprehension in L2 was more complex due to listeners’ listening or language abilities. The unknown vocabulary, speech rate of the speaker and the different language expression patterns from L1 produced challenges and difficulties in listening that have to be faced by L2 learners.

The relevant literature and prior studies that investigated the sub-group differences between ESB and NESB individuals proved that their differences significantly resulted from their different cognitive abilities, language proficiency and individual factors. The present study aims to explore the diversity of performance between ESB and NESB students in comprehending various formats of learning materials. The overview of the present study will be unfolded in the next chapter, including the research method, experimental instruments, the overall research design and the participants.
Chapter 5

Overview of the present study and the research methodology

The gaps in the recent literature have been identified in the previous chapters (Chapter 2 to Chapter 4). In order to fill in these gaps and achieve the expected findings, a research plan has been developed based upon the research questions, or hypotheses. This chapter aims to show a detailed presentation and discussion of the research methodology used in the present study. The following sections will clarify the aims, hypotheses, expected findings and key terminologies. Then each component employed in the research method will be described, including the research approaches, design strategies, the sample, instruments and the experimental procedure as well as the collected data. Finally, the ethics issues that were taken into account when commencing the experiment will be discussed.

This chapter is divided into several sections as follows:

| Section 5.1 | Aims of the present study |
| Section 5.2 | Hypotheses of the present study |
| Section 5.3 | The key terminologies used in the present study |
| Section 5.4 | The research method |
| Section 5.5 | The research design |
| Section 5.6 | Participants |
| Section 5.7 | The research data |
| Section 5.8 | The research instruments |
| Section 5.9 | Procedures |
| Section 5.10 | Ethical considerations |

5.1 Aims of the present study

The present study aims to evaluate the influence of various formats of learning contexts presented through a hypermedia system, referring to hypermedia materials with image links, hypermedia materials with audio links, hypermedia materials with audio-visual links, and free text materials. The aims are to understand how the different media formats influence learning outcomes, and to identify the most effective and efficient learning contexts.
materials with video links, hypermedia materials with animation links and hypertext materials with text links on learners' comprehension performance in an authentic multimedia learning environment.

The study further aims to recognise the diversity of performance between ESB and NESB sample groups in comprehending the various formats of learning contexts and to explore further the differences of comprehension performance within each group in order to provide practical evidence that reveals the most effective structures for instruction design, contributing to facilitation of comprehension performance for teaching and learning, and to fulfil the different needs of students who come from different language backgrounds.

According to Cooper and Schindler (2008), a research plan is a blueprint attempting to fulfil the hypotheses. It is generally strategised as shown in Figure 5.1.

**Figure 5.1 A visual conceptual model of research plan**

![Figure 5.1](source: Cooper & Schindler 2008)
As seen in Figure 5.1, a research study is planned upon the research hypotheses. The hypotheses can direct the research method. Then the choice of method, either quantitative or qualitative, can further impact on the research design and the nature of the research data which then determines the experimental instruments used in order to ensure that the process of data collection is effective. Thus, it is important to firstly clarify the hypotheses of the present study.

5.2 Hypotheses of the present study

This section will concentrate on the two hypotheses of this study. In order to clearly present the contexts related to the ESB and NESB sample groups respectively, hypothesis 2 will be further divided into two sub-hypotheses.

Table 5.1 Outline of the hypotheses

<table>
<thead>
<tr>
<th>Hypothesis 1: It is hypothesised that there is a diversity of performance between ESB and NESB students in the active learning process. Thus, ESB and NESB students will perform differently within the experiment-provided multimedia learning contexts, namely: hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statistical Hypotheses</strong></td>
</tr>
<tr>
<td><strong>H₀</strong>: It is predicted that there will be a significant difference in comprehending hypermedia materials with image links between the ESB and NESB sample groups. (independent samples t-test)</td>
</tr>
<tr>
<td><strong>H₀</strong>: It is predicted that there will be no difference in comprehending hypermedia materials with audio links between the ESB and NESB sample</td>
</tr>
<tr>
<td>Groups</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>H0: It is predicted that there will be a significant difference in comprehending hypermedia materials with video links between the ESB and NESB sample groups. (independent samples t-test)</td>
</tr>
<tr>
<td>H0: It is predicted that there will be a significant difference in comprehending hypermedia materials with animation links between the ESB and NESB sample groups. (independent samples t-test)</td>
</tr>
<tr>
<td>H0: It is predicted that there will be a significant difference in comprehending hypertext materials with text links between the ESB and NESB sample groups. (independent samples t-test)</td>
</tr>
</tbody>
</table>

**Hypothesis 2.1:** It is further hypothesised that ESB students’ performance will be maximised by hypermedia with audio links.

**Statistical Hypotheses**

<p>| H0: It is predicted that there will be no difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with image links for the EBS sample group. (paired samples t-test) | H1: It is predicted that there will be a significant difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with image links for the EBS sample group, and the performance in comprehending hypermedia with audio links will be significantly better. |
| H0: It is predicted that there will be no difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with video links for the EBS sample group. (paired samples t-test) | H1: It is predicted that there will be a significant difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with video links for the EBS sample group, and that the performance in comprehending hypermedia with video links will be significantly better. |</p>
<table>
<thead>
<tr>
<th>t-test)</th>
<th>hypermedia with audio links will be significantly better.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: It is predicted that there will be no difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with animation links for the EBS sample group. (paired samples t-test)</td>
<td>$H_1$: It is predicted that there will be a significant difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with animation links for the EBS sample group, and that the performance in comprehending hypermedia with audio links will be significantly better.</td>
</tr>
<tr>
<td>$H_0$: It is predicted that there will be no difference in comprehending hypermedia materials with audio links and hypertext materials with text links for the EBS sample group. (paired samples t-test)</td>
<td>$H_1$: It is predicted that there will be a significant difference in comprehending hypermedia materials with audio links and hypertext materials with text links for the EBS sample group, and the performance in comprehending hypermedia with audio links will be significantly better.</td>
</tr>
</tbody>
</table>

**Hypothesis 2.2:** It is also hypothesised that the NESB students will show a maximum performance with interactivity with hypertext containing text links.

**Statistical Hypotheses**

<table>
<thead>
<tr>
<th>$H_0$: It is predicted that there will be no difference in comprehending hypertext materials with text links and comprehending hypermedia materials with image links for the NESB sample group. (paired samples t-test)</th>
<th>$H_1$: It is predicted that there will be a significant difference in comprehending hypertext materials with text links and comprehending hypermedia materials with image links for the NESB sample group, and the performance in comprehending hypertext with text links will be significantly better.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: It is predicted that there will be no difference in comprehending hypertext materials with text links and comprehending hypermedia materials with audio links for the NESB sample group. (paired samples t-test)</td>
<td>$H_1$: It is predicted that there will be a significant difference in comprehending hypertext materials with text links and comprehending hypermedia materials with audio links for the NESB sample group, and the performance in comprehending hypertext with text links will be significantly better.</td>
</tr>
</tbody>
</table>
samples t-test) | performance in comprehending hypertext with text links will be significantly better.
---|---
**H₀**: It is predicted that there will be no difference in comprehending hypertext materials with text links and comprehending hypermedia materials with video links for the NESB sample group. (paired samples t-test) | **H₁**: It is predicted that there will be a significant difference in comprehending hypertext materials with text links and comprehending hypermedia materials with video links for the NESB sample group, and the performance in comprehending hypertext with text links will be significantly better.

**H₀**: It is predicted that there will be no difference in comprehending hypertext materials with text links and comprehending hypermedia materials with animation links for the NESB sample group. (paired samples t-test) | **H₁**: It is predicted that there will be a significant difference in comprehending hypertext materials with text links and comprehending hypermedia materials with animation links for the NESB sample group, and the performance in comprehending hypertext with text links will be significantly better.

1. It is hypothesised that there is a diversity of performance between ESB and NESB students in the active learning process. Thus, ESB and NESB students will perform differently within some of the experiment-provided multimedia learning contexts, namely: hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links.

According to Ramburuth and McCormick (2001), the significant discriminate between Australian ESB and Asian international NESB students was produced by audio modes only, as Australian students showed a stronger preference to learning with auditory stimuli. By contrast, the international students were likely to avoid that due to their disadvantaged aural skills. Thus, they preferred visual
resources over auditory ones. Also, the diversity of cognitive abilities test performance between ESB and NESB participants was effectively eliminated by using visual resources (Carstairs et al. 2006). In this respect, the comprehension performance of ESB and NESB students in the active learning process may differ under some of the experiment-provided conditions.

2. It is also hypothesised that the performance of ESB and NESB students in the active learning process will differ such that ESB students’ performance will be maximised by hypermedia materials with audio links while NESB students will show maximum performance when comprehending hypertext materials containing text links.

The modality effect has been proved by a considerable number of studies in multimedia learning (Baddeley 1986, 1999; Clark & Mayer 2008; Mayer 2009; Moreno & Mayer 2002; Sweller, Ayres & Kalyuga 2011), which maintain that learners’ performance may be effectively facilitated by multimedia learning contexts presented with concurrent visual and auditory stimuli. In this regard, ESB students’ comprehension performance will be maximised by hypermedia materials with audio links. On the other hand, NESB students relied on read-only instructions rather than concurrent read and spoken instructions due to the reduced size of their working memory capacity when also comprehending a second language (Diao & Sweller 2007). Also, as Chun and Plass (1997) stated, learners may not have enough ‘executive resources’ for tackling the multimedia information presented in the second language. NESB students will therefore show maximum performance when comprehending hypertext materials with text links.

5.3 The key terminologies used in the present study

There are several key terminologies included in the current study that need to
be reviewed, namely: students from English speaking backgrounds (ESB); students from non-English speaking backgrounds (NESB); multimedia; hypertexts; hypermedia; reading comprehension; and listening comprehension. They have been defined variously in the recent literature. The selected definitions for the present study of the above items were linked to the relevance of the descriptions to the aims of the present study.

ESB students: The definitions from the Oxford English Dictionary Online (2008), Tay (1982) and McKay (2002) were taken into account. Considering the contexts in the relevant literature, the definition of ESB students in the present study refers to someone who was born in an English speaking country; someone who has spoken English since their earliest childhood; and someone who has reached a high level of language competence in the English language.

NESB students: As Chapter 4 discussed, there are various interpretations of NESB students. The present study relies on Mulligan and Kirkpatrick’s (2000) definition rather others, which states that NESB students are individuals who were born in non-English speaking countries, speak a language other than English at home, and have been living in Australia for less than 10 years.

Multimedia: Reviewing the relevant literature in Chapter 2, the definitions of multimedia have evolved over time. Based on the relevance of descriptions associated with several definitions (Greenlaw & Hepp 1999, Mayer 2009, Neo & Neo 2001, Schwarts & Beichner 1999), in the present study, the term ‘multimedia’ is defined as follows:

- A combination containing more than one media element (generally includes image, audio, video, animation and text);
- An electronic tool used to present information;
- A computer-based program;
- An instructional / educational tool used to achieve academic goals or improve the performance of learning; and
- A system-integrated multisensory interaction that may influence users’ cognitive processes.

Hypertexts: Referring to the discussion presented in Chapter 2, hypertext is defined as ‘information systems in which the contents are organised in an interrelated network with nodes that are documents and links that are the relations between these documents’ (Salmeron et al. 2005, p.171).

Hypermedia: In actual fact this is an extension of the term ‘hypertext’. Hypermedia is a type of multimedia may further link text, image, video or audio information through nodes (Dillon & Jobst 2005). Thus, it is a sub-classification of multimedia (Walker 2010).

Reading comprehension: This was reviewed and evaluated in Chapter 4 and is defined as the holistic process of interpreting information from text and the gaining of knowledge by readers in order to produce meaning as the current knowledge (Anderson & Pearson 1984).

Listening comprehension: This was discussed in Chapter 4 as well. According to Peterson (2001), listening comprehension refers to a multilevel and interactive cognitive process to recognise and interpret auditory inputs. Listening is generally viewed as a three-step process, including receiving, attending and understanding (Frommer 2006; Neff 2006).

In order to assist the process of investigating the diversity of performance between English speaking background (ESB) and non-English speaking
background (NESB) students in comprehending various formats of learning materials, an effective research plan was developed and executed. The following section will present the relevant information about the research method of this study.

5.4 The research method

The frequently used research methods are quantitative research methods and qualitative research methods (Cooper & Schindler 2008). Quantitative research methodology is based on the precise measurement of something, which typically is expressed in terms of numbers, percentages or scores (Cooper & Schindler 2008). Qualitative research methodology differs from the quantitative one, as it includes an 'array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world' (Van Maanen 1979, p.520, cited in Cooper & Schindler 2008). Qualitative research methods use non-numerical information from interviews or surveys, in terms of words in narrative or in verbal forms (Cooper & Schindler 2008).

A quantitative research methodology was adopted in the present study, aiming at measuring ESB and NESB students’ performance in comprehending the experimental learning materials which were presented in the five different formats. In the present study, the data was collected from the students’ answers to the comprehension tasks. Approximately one hour was given to students to complete each session, including reading a text and answering nine comprehension questions related to the text to check their comprehension. More details about the experiment-provided instructional materials and the comprehension tasks will be elaborated on in Section 5.8.3 and Section 5.8.4.
The present study aims to explore the influence of two independent variables, the formats of the learning materials and the students' language backgrounds, on the dependent variable, students' performance in comprehending the materials. The tool for data analyse was SPSS version 19, which was used to analyse the mean comprehension scores of the two groups of students from the comprehension tasks in each reading session. The statistical results were simply measured by mean, standard deviation, skewness and kurtosis, then presented and reported through the general linear model, analysed by independent samples t-tests and paired samples t-tests, and visually demonstrated by box plots.

5.5 The research design

The research design is a plan to structure the study aiming at testing the hypotheses. The used research designs in this quantitative research study are experimental design and correlational design.

5.5.1 Experimental design

Experimental design is used to examine cause-and-effect relationships. For instance, if A is prepared, B will come up followed by A (Blankenship 2010). This approach was used in the present study to test whether different formats of learning materials have different levels of effectiveness in enhancing comprehension performance in students from different language backgrounds.

The experimental design is accurate and unequivocal to help the testing of the hypotheses (Blankenship 2010). There are three types of experimental design, being between-subjects design, within-subjects design and mixed design.
Between-subjects design

Between-subjects design is sometimes called independent or separate groups design (Davis & Bremmer 2006). In the between-subjects design, two or more separate groups of participants each receive one or more different levels of treatment and each subject is observed under one of the several treatments’ conditions (Gravetter & Forzano 2008). For example, if a group of participants are given computer-based reading materials to read and another group are asked to read traditional print-based materials, this is a between-subjects design.

Within-subjects design

Within-subjects design is also called repeated group design (Davis & Bremmer 2006). In the condition of the within-subjects design, one group is assigned to undertake more than one treatment condition (Gravetter & Forzano 2008). For instance, if a group of individuals are asked to complete computer-based reading contexts as well as print-based contexts, this is a within-subjects design.

Mixed design

Mixed design has been frequently been employed in many research studies (Mitchell & Jolley 2009). Mixed design is a combination of drawing the other two experimental design approaches, namely between-subjects design and within-subjects design, together. It consists of at least one factor from each (Mitchell & Jolley 2009).

The present study is proposed to indicate the cause-and-effect relationship between the independent variables and the dependent variable. The diversity
of comprehension performance between ESB and NESB students was compared on their mean comprehension scores for each format which is a between-subjects design. Also, the diversity of comprehension performance within ESB or NESB students was compared on their mean comprehension scores across all formats within each sample group which is a within-subjects design. Thus, a mixed design approach was adopted in the present study which gains the advantages of both between-subjects design and within-subjects design (Mitchell & Jolley 2009).

5.5.2 Correlational design

Correlational design is a typical design approach applied to explore the relationship between two or more variables by using statistical or mathematical methods (Mitchell & Jolley 2009). In the present study, it has been used to examine the relationship between presentation formats (independent variable), participants’ language backgrounds (independent variable) and participants’ comprehension performance (dependent variable).

This study employed experimental design and correlational design approaches to structure the research when attempting to evaluate whether there is a difference in performance between ESB and NESB students in comprehending various formats of instructional materials (namely: hypermedia materials with image links, hypermedia materials with audio links, hypermedia materials with video links, hypermedia materials with animation links and hypertext materials with text links). It further explores whether, and how, the different formats of instructional materials influence the students’ comprehension performance for the ESB and NESB groups respectively.

5.6 Participants
The fifty-four students who took part in the present study (27 ESB students and 27 NESB students) were enrolled in various undergraduate programs and studying a core communication unit at Swinburne University of Technology, Lilydale Campus. Initially, there were 180 students who voluntarily participated in the present study, including 100 ESB and 80 NESB students. However, a large proportion of them were disqualified from the final sample, as the students withdrew from the study at any stage or missed any one of the five sessions.

The students who took part in this research were from groups enrolled in a unit called Professional Communication Practice with the code LPR100. The students study professional communication related subjects, such as Media Studies, Public Relations, Social Media, Global Social Communication, etc. This subject aims to equip learners with oral and written communication skills through investigating both the theoretical and practical dimensions of professional communications and introduces the fundamental part communication will play for students in their professional communication life. This provides them with, or improves, their techniques to deal with different communication environments. The purpose of the instructional materials of the present study is to reinforce the students' knowledge acquisition related to this subject.

Professional Communication Practice at Swinburne University of Technology attracts a large number of students from both ESB and NESB backgrounds. One pathway to this undergraduate unit is by direct entry. Academic entry to the unit at undergraduate level requires that all students have gained the Year 12 Victoria Certificate of Education (VCE) or achieved an equivalent qualification to fulfil the required prerequisites for undergraduate courses. The Foundation Year Program provides an alternative pathway to gain eligibility into this undergraduate unit. International students who speak English as a
Second Language (ESL) are required to achieve a level of performance in the IELTS (International English Language Test System) with a band score of 6.0 at least and no less than 6.0 in each sub-band to enrol in undergraduate programs. All the requirements mentioned above aim at ensuring that the students’ English language proficiency is at the same level in academic learning.

The ESB students who took part in the present study were mainly Australian locals who were born in Australia. A minority of ESB students came from other English speaking countries, so English is their mother tongue or first language spoken. The students from NESB were international students who mainly originated from Asian countries, including China, Vietnam, India, the Philippines or other non-English speaking countries, with a minority of European students. Their first language spoken was other than English, so English is their second or even third language spoken.

5.7 The research data

This section describes the collected data in the experiment. There were two independent variables and one dependent variable which occurred in the research process, which were:

- Presentation formats;
- Language backgrounds; and
- Comprehension performance.

5.7.1 Presentation formats (independent variable)

In the present study, ‘presentation formats’ as an independent variable refers to the specific formats used to present the instructional materials. The
materials were presented in five different formats: (1) hypermedia materials with image links, (2) hypermedia materials with audio links, (3) hypermedia materials with video links, (4) hypermedia materials with animation links and (5) hypertext materials with text links.

5.7.2 Language backgrounds (independent variable)

‘Language background’ is an independent variable in the present study which primarily concentrates on the first language spoken by the participants who took part in the study. They were naturally divided into two groups depending on their first language spoken, one was those with an English speaking background (the ESB group), and the other was those with a non-English speaking background (the NESB group).

5.7.3 Comprehension performance (dependent variable)

‘Comprehension performance’ was the dependent variable in the current research which refers to participants’ performance in comprehending the various formats of the instructional materials. The performance was measured by the comprehension scores they earned by completing comprehension tasks in each reading session.

In order to effectively ensure the implementation of this research, it was necessary to employ an array of instruments. They will be elaborated on in Section 5.8.

5.8 The research instruments

The major instruments used in the present study were:
• Computers and Internet access;
• A hypermedia system;
• Instructional materials; and
• Comprehension tasks.

5.8.1 Computers and Internet access

A website was designed specifically for the current research project (available at http://project.faysoft.com.au/ca/). The experimental learning provisions were all free to be accessed online and the contexts were shown and viewed through computer screens. As a result, computers and the Internet were taken as necessary components to ensure the effective implementation of the experiment, as demonstrated in Figure 5.2.
As seen in Figure 5.2, the experiment-provided learning contexts were divided into five independent reading sessions which presented in the different formats as follows: Session 1 - hypermedia materials with image links; Session 2 - hypermedia materials with audio links; Session 3 - hypermedia materials with video links; Session 4 - hypermedia materials with animation links; and Session 5 - hypertext materials with text links. The participants were asked to read the texts provided in each session and answer the related nine questions in the computer lab on a weekly basis.

5.8.2 A hypermedia system

The experimental multimedia learning materials were presented through a hypermedia system. Since hypermedia is a sub-classification of multimedia associated with the Internet as well as being an extension of hypertext, both multimedia and hypertext related contexts for structuring were taken into
consideration when designing the experimental materials for the present study.

5.8.2.1 Multimedia context design

From the multimedia perspective, as in the relevant literature discussed in Chapter 2, there are four main types of resources, which were elaborated on in Section 2.5, including linear, non-linear, hypermedia and website multimedia (Walker 2010). The great promise of hypermedia learning contexts is perhaps the ability to associate with multiple media elements (Dillon & Jobst 2005). The recent studies relevant to hypermedia have frequently taken Paivio’s dual-coding assumption (refer to Section 3.2.3), Baddeley’s dual-channel assumption (elaborated on in Section 3.2.1), the limited capacity of working memory (refer to Section 3.2.2 and Section 3.2.5.2), Cognitive Load Theory (CLT) (refer to Section 3.2.5) and Mayer’s cognitive theory of multimedia learning (refer to Section 3.2.10) as theoretical frameworks, in particular Sweller’s CLT and Mayer’s cognitive theory of multimedia learning, in order to effectively instruct learners (Akbulut 2008).

In the present study, several effects of cognitive load were considered when constructing the content, including the redundancy effect, the element interactivity effect and the expertise reversal effect. Besides these, there are several common principles of multimedia learning that were taken into consideration when forming content, namely the temporal contiguity principle and the coherence principle.

5.8.2.2 Hypertext context design

Compared with traditional print-based text, hypermedia reading is a more complex process for readers as it requires more cognitive resources to get involved in cognitive activities resulting from the spatial layout (Dee-Lucas
1996, cited in Fastrez 2002; McEneaney 2003). Thus, choosing the appropriate principles to instruct the hypermedia context design was crucial.

In the present study, the hypermedia system was instructed by some relevant hypertext design principles, as hypermedia is an extension of hypertext (Dillon & Jobst 2005). The relevant literature suggests that a correct representation of hypertext design is important in order to ensure readers navigate the content effectively (Koneman & Jonassen 1994). Reading in the hypertext world is not a smooth process as readers move forward and backward frequently through multiple pages in the process. Thus, well-organised hypertext is beneficial for readers to access the content (Koneman & Jonassen 1994).

Fastrez (2002) outlined rationality principles versus functionality principles used to structure hypertexts which provide a general view for instructing hypertext design. According to Fastrez (2002), rationality is a basic principle which can be used to organise various types of instructional hypertexts. The rationality principle suggests that hypertexts should be organised logically and be partially independent from the context and the readers who activate them (Fastrez 2002). Rationality structure has been widely applied in the educational field, frequently used to design instructional materials for learning-by-doing and tasks of problem-solving (Fastrez 2002).

Reading in practice sometimes goes beyond rationality (Fastrez 2002). In this case, the functionality principle is more applicable. According to Fastrez (2002), a functionality approach suggests that hypertexts should be designed as functional documents based on searching functions and supporting navigational activities. For example, if a student’s learning outcomes could be critically affected by the processes of information browsing and searching, functionality principles should be appropriately used in designing hypertexts. However, the same concept may be different when activated in different
contexts by different people, which is the disadvantage of this approach (Fastrez 2002).

According to Fastrez (2002), the design approach for structuring hypertext should be determined by the nature of the contexts provided. In the present study, the learning materials were used to reinforce students' knowledge acquisition in the domain of professional communication so the rationality approach was the core design principle used to structure the hypertexts.

Specifically, the frameworks used to form the hypermedia system in the present study were proposed by Jonassen (1986), which included an array of step-by-step design principles. These were:

1. **Identify all key concepts.** The basis of hypertext is to recognise concepts. Thus, the related key concepts or knowledge in a particular domain should be identified. Also the glossaries and indexes should be consulted if necessary. Additionally, the key concepts should be carefully edited in order to reduce redundancies presented.

   In the present study, all the key concepts included in the learning content belonged to the unit of Professional Communication Practice. Each reading session concentrated on one specific topic in this field, so there were five topics involved across all sessions, including communication models, culture context, social media technologies and Public Relations. The learning content aimed to reinforce student's knowledge on this subject so all the concepts and key words were in accordance with the lecture topics of Professional Communication Practice on a weekly basis.

2. **Map the structure of the content.** At this stage, designers need to define the inherent relationship between the key concepts. Mapping tools are able
to represent multiple types to determine interrelationships between
concepts, and based on this, the links are established (Preece 1976; Field
1982; Dansereau & Holley 1982; Jonassen 1984, all cited in Jonassen
1986). The network mapping tool proposed by Dansereau and Holley
(1982) was used in designing the hypertexts for the present study. As
Dansereau and Holley (1982) suggested, the text structures can be defined
from either the chain perspective or the hierarchy perspective. The chain
perspective suggests that the information or concept in one node leads to, or
results in, the information or concept in another node, and the chain
perspective has been widely applied in structuring linear hypertext contexts
(Dansereau & Holley 1982). In the present study, linearly structured
hypertexts were used. Thus, the chain perspective was employed when
designing the hypertexts. The hypertexts were also carefully reviewed by a
communication subject convenor, in terms of validation of the
interrelationships among nodes, and the information and knowledge
included.

3. **Verify the structure.** Technical support is necessary when designing
hypertexts to ensure the validation of the link mapping mechanism. In the
present study, the information technology support was provided by a
specialist who tracked the whole experimental procedure to make sure that
the website ran well.

4. **Determine the type of hypertext structure.** At this stage, the designers
also need to decide what type of hypertext structure should be employed
during the design process, including the type of frame and the type of links.
The decision should be reflected in the map developed in stage 2 - map the
structure of the content. The structures of hypertexts used to present the
experimental learning contexts were linear.
As discussed in Chapter 2, three types of structure can be applied in structuring hypertexts, which are linear structure, hierarchical structure or referential structure. Furthermore, linearly structured and hierarchically structured hypertexts have been suggested for use for educational and instructional purposes (Lawdow 2006; Oliver & Herrington 1995).

In the present study, linearly-structured hypertexts were selected to present the learning contexts. In comparison with hierarchical structure, linearly structured hyper-documents can effectively eliminate the cognitive demands imposed on readers’ working memory in the reading process (Astleitner & Leutner 1996). Also, choosing a linearly structured network would effectively diminish the extraneous load which is caused by the way information to be learned is presented (Sweller 2010; Sweller & Chandler 1994; Sweller, van Merrienboer & Paas 1998).

In the reading process, students followed the pre-defined reading sequence which was set up by the designer. As the hypertexts were structured linearly, all the links available in the content were in a single-level hierarchy, and there were no further links provided within the linked content. Thus, students had to move back to the main content when they finished the information included in links (Lawdow 2006; Oliver & Herrington 1995), as shown in Figure 5.3.
Figure 5.3 Screenshot of the linearly structured hypertexts of this study

Figure 5.3 shows an example from one reading session, which represents the stylised depiction of the linearly structured network used to form the experimental learning materials. When a reader clicked on a link, a new window containing the related information, such as an image, video or audio clip popped up.

5. **Prepare the concept blocks.** Designers need to write text into each node and ensure the accuracy of the content. The content was written based on knowledge and information from reputable sources, including textbooks and journal articles from various online databases in the domain of professional communication. The content was also carefully reviewed by the subject convenor of Professional Communication Practice to ensure its validity and reliability.

6. **Provide links and cues to other concepts.** At this stage, designers need to decide how to organise nodes and links included in hypertexts. In this study, students were allowed to move forwards and backwards using icons or menu bars while reading. The platform used to display the hypertexts
was their Internet browser such as Internet Explorer or Firefox. There was a menu bar on the left-hand side of each interface layout as shown in Figure 5.2. All words listed on the menu bar enabled students to jump from one node to another without returning to the homepage.

7. **Debug the system.** Lastly, designers need to test the systems, to run them and detect any possible errors in order to make sure the systems are user-friendly and running well without technological faults. The experiment website was tested by the author before the experiment commenced. Also, the system was maintained and updated periodically in order to keep it working well.

Interface design

According to Jonassen (1986), a good hypertext version shows the entire content in a map as an introductory display on the starting web page, aimed at directly navigating readers into an adjacent hypertext display. It not only gives readers a global overview, but also provides a guide to tour the system for possible link types within the substructure for navigational purposes. In the present study, a menu bar was given on the starting page which included all the links underlined, as shown in Figure 5.2.

As Hemard (1997) suggested, the screen design of hypertexts should be two-dimensional, which is a basic design principle and guideline in accordance with ergonomics. This was taken into account when designing the experimental contexts.

Besides this, in terms of the details of hypertext interface design, according to Hemard (1997), either sans-serif or slab-serif fonts should be used appropriately in the design of hypertext contexts and the spacing between
every two lines in the content should be 1.5. Also, colour is a component which should be taken into account when designing hypertexts (Hemard 1997). People’s capacity of working memory is limited for processing colours (approximately between five and nine colours). Thus, the webpage should be presented in a limited colour palette and simple colour scheme, and not using incompatible colours such as red and green or yellow and blue in order to eliminate cognitive load imposed on reader’s working memory. In addition, all texts within the hypertext should be organised in recognisable paragraphs and left-justified, which works well for student's reading in most cases (Hemard 1997).

Furthermore, according to Hemard’s (1997) study, Arial is the expected font, which is in the category of sans-serif fonts.

5.8.3 Instructional materials design

In the present study, the instructional materials were in a particular unit – Professional Communication Practice (LPR 100) and were used to supplement student’s knowledge on this unit. All concepts and relevant information were selected from reputable textbooks and online resources in this area, including communication concepts and contexts, intrapersonal and interpersonal communication, intercultural communication, social media and media management, which were in accordance with the lecture topics of Professional Communication Practice. The instructional materials were reviewed by a communication subject convener before being presented to the students.

Furthermore, when designing the instructional materials, a readability test for content was done before presenting them to students. The statistical results were computed by means of readability formulas used to approximately measure of the level of difficulty of a particular text to be read and understood
by readers. These tests have been extensively used for educational purposes to judge the readability level of many documents (Ivey & Fisher 2006).

The readability test mechanism used to assess the learning materials of the present study was the Flesch-Kincaid readability test, which is the ‘Flesch-Kincaid Grade Level Test’ (Ivey & Fisher 2006). The test rates text on school grade level. For instance, a score on the Flesch-Kincaid Grade Level of 9.0 means that the text can be understood by a ninth grader (Ivey & Fisher 2006). All the instructional materials for each session had the same level of readability - between 11.4 and 12.0, which matches the student’s education level of English language from Grade 11 to 12, as shown in Table 5.2. According to Snow, Burns and Griffin (1998), compatible content that matches a reader’s grade level is content that is able to be fluently read aloud and comprehended. In this regard, the language used in the instructional materials was appropriate for the students who took part in the study so that they could fully understand the instructional content.

Table 5.2 The scores of the readability tests for the instructional materials included in all five sessions

<table>
<thead>
<tr>
<th>Reading session</th>
<th>Score in readability test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.7</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>11.4</td>
</tr>
</tbody>
</table>

5.8.4 Comprehension tasks

In the present study, the comprehension tasks for each session were closely related to the learning materials which were assigned to the students to
comprehend. The comprehension tasks consisted of three types of questions, namely, literal, inferential and critical questions, and there were three questions underlying each type. Therefore, there were nine questions in total for each session.

The literal questions examined the surface meaning of the learning content and the answers were stated explicitly within the text. Thus, the students were able to quickly find answers as long as they could comprehend what the learning content literally meant. For example, ‘What are external media?’ (Session 5). The answers to the inferential ones could not be easily located within the instructional contexts. While interacting with the inferential questions, the students were required to connect their prior knowledge with the information they obtained from the content, to make predictions or develop ideas in order to give answers. For instance, ‘How could social bookmarking sites help people to extend their social network?’ (Session 4). The critical questions required the students to comprehend between the lines and make associations with their prior knowledge and experience, as well as to analyse and evaluate the information about what was being learned from the materials, for instance, ‘How can one build positive self-awareness via self-talk, in order to speak in public effectively?’ (Session 2) (Clymer 1968; Davis & Lass 1996; Wang & Verezub 2010).

5.9 Procedures

The experiment was designed to be delivered over five one hour sessions on a weekly basis in semester two, 2010. The students were asked to provide their basic demographic information, such as their language background and their student ID, in order to match the results obtained from the five sessions (see Appendix IX).
5.9.1 Overview of the experiment

The experimental learning materials were presented in five formats through hypermedia/hypertext contexts, namely, hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links, which were delivered on a weekly basis during five of the student’s usual tutorials and were in accordance with the lecture topics of Professional Communication Practice. In each tutorial, students were asked to complete the given learning materials and the related comprehension tasks in one hour. The instructional materials included in each session had the same number of links (5 links) containing key words, were approximately the same length (1,000-1,500 words) and had nine comprehension questions included as tasks. The whole structure of the program applied in the experiment is shown in Table 5. In this study, the related comprehension tasks were not only shown on the computer screens, but also were printed on A4 paper with enough space for students to give their answers.

**Table 5.3 Design of experiment-provided instructional materials**

<table>
<thead>
<tr>
<th>Reading Session</th>
<th>Text length in words</th>
<th>Type of links</th>
<th>Number of links</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000-1,500</td>
<td>Image</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>1,000-1,500</td>
<td>Audio</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>1,000-1,500</td>
<td>Video</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>1,000-1,500</td>
<td>Animation</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>1,000-1,500</td>
<td>Text</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>

Before the experiment commenced, the students were given explicit instructions and explanations of the current research project. The consent
statement is a part of the ethical considerations which will be discussed in this chapter in Section 5.10.1.

5.9.2 The experiment procedures

- **Session 1**

At the beginning, the students who took part into this study were told that their participation was voluntary and their decision to participate or not would not influence their final academic assessment for the subject they were enrolled in (LPR100 Professional Communication Practice). Then the students were given a brief introduction to the research project and the work to be done. All the students who took part in the study were instructed on how to interact with the experimental information online. For instance, when the students clicked on one link, the related information would show on the screen in a new pop-up window. When they clicked off the window, they were returned to the main content.

The learning content included in the first reading session was relevant to communication concepts and contexts. This material was presented as hypermedia materials with image links. Participants were given hard copies of the comprehension tasks before commencing reading so that they could easily review the information that was covered in the session and organise their own way of learning. Students were encouraged to openly ask questions about any confusion or frustration during all sessions. They also were encouraged to associate with their prior knowledge and past experiences when responding. Finally, the students were informed what content would be presented in the next session after the answer sheets were collected.
• **Session 2**

The results attained by the students from session 1 were firstly reviewed. Then the content contained in session 2 was introduced. Again, a short and clear instruction was given regarding how to process the instructional materials. The learning content of session 2 discussed intrapersonal and interpersonal communication which was presented as hypermedia materials with audio links. Students were asked to complete the learning content and the related comprehension tasks. At the end, the students were informed what they would learn in the next tutorial.

• **Session 3**

The learning activities of this session also started with the review of the previous results. Then a short introduction related to the hypermedia manipulation was given again. In fact, as the students had already performed the experiment as their usual tutorials twice, they were experienced in interacting with the hypermedia content provided. The topics of session 3 were relevant to globalisation and intercultural communication between people from different regions and backgrounds. The learning materials assigned for students were presented as hypermedia materials with video links. Students had one hour to complete the materials and the related comprehension tasks. When the questionnaires were collected, the author briefly introduced the content provided for the next session.

• **Session 4**

The results obtained from the last session were reviewed at the beginning. The students were continually encouraged to contribute to the experiment. Also
they were told that any questions about difficulties or confusion they encountered in the learning process were welcomed. The instructional materials included in session 4 were presented as hypermedia materials with animation links about mobile and social media. Similar to the previous sessions, students had one hour to complete the reading and comprehension tasks. At the end, a short introduction was given about the content included in session 5.

- **Session 5**

This session was the last one in the present study, and it was about managing the media inside and outside the organisation. The learning materials were presented as hypertext materials with text. Students also had one hour to finish the reading materials and comprehension questions. This session ended with a brief review of all five sessions.

- **Marking system**

The students’ performance in comprehending the five formats of learning materials was measured by their comprehension scores from the comprehension question answers. According to the marking system used in the study, students were given different levels of marks based on their answers. The full mark for each question was 1.0. Therefore a full mark for all the comprehension tasks in a single reading session was 9 marks. Students were given 1.0 as a full mark for completed and correct answers; 0.75 for completed answers which had minor errors; 0.5 for completed answers which were half correct; 0.25 for answers which had not caught the key point; and zero marks for uncompleted and incorrect answers. All answer sheets collected from students were marked by the author’s first supervisor.
5.10 Ethical considerations

There were several ethical issues considered in the present study:

- Obtaining consent from the university and participants; and
- Ensuring the confidentiality of the participants and the collected data.

5.10.1 Consent Information Statement and Consent Form

The ethics approval for this study was firstly obtained from the Human Research Ethics Committee of Swinburne University of Technology, which contained the information necessary to gain permission to conduct this study. Before the main study commenced, each participant was presented with a hard copy of the Consent Information Statement that invited them into the research project. The statement was presented in plain English and indicated the related information about undertaking this study, including what they were required to do and what benefits they would possibly gain. Besides this, they had opportunities to ask questions about the study. After that, the consent forms were sent and signed by the participants to declare their interest and participation (see Appendix II). All students were also informed that their participation in this research was voluntary and their decision about whether to join would not influence their academic assessment in the unit of Professional Communication Practice (LPR 100).

5.10.2 Anonymity

Regarding the information requested in the present study, participants needed to be identified individually in some way. Thus, they were asked to provide their student ID number, aimed at matching their results across the five sessions. In order to ensure their information was confidential, the ID number list was
separately stored in a locked filing cabinet. Besides this, the list was destroyed immediately once the data matching process was completed. All processed data was anonymous and data was not traceable to a particular individual. It was stored electronically with password protection. Only the researchers (the author and her coordinating supervisors) had access to the data.

5.11 Concluding remarks

This chapter has provided a brief overview of the present study and the research methodology used to achieve the objectives and goals. In this chapter, it firstly clarified that the present study aims to investigate the influence of various types of multimedia formats (presented as hypermedia/hypertexts associated with different types of media links, namely: image, audio, video, animation and text) on learners’ comprehension performance. Further, it aims to recognise the diversity of performance in comprehending each format of learning materials between ESB and NESB sample groups and the diversity of performance in comprehending all five formats of learning materials within the ESB and NESB sample groups respectively.

Secondly, it clarified the hypotheses of the present study. There were two hypotheses presented. The first one was that there is diversity of performance between ESB and NESB students in the active learning process. Thus, ESB and NESB students perform differently within some of the experiment-provided learning contexts, namely: hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links. The other hypothesis was that ESB students’ performance will be maximised by hypermedia with audio links while NESB students will show maximum performance when interacting with hypertext containing text links.
Thirdly, several key terminologies used in the present study were reviewed. They were: students from English speaking backgrounds (ESB); students from non-English speaking backgrounds (NESB); multimedia; hypertexts; hypermedia; reading comprehension; and listening comprehension.

Furthermore, a quantitative research methodology was employed in the present study. The data was collected from student’s answers to the comprehension tasks included in the five reading sessions. For research design, the present study employed both experimental design and correlational design approaches to investigate whether there is a difference in performance between ESB and NESB students in comprehending various formats of learning materials, and to explore whether, and how, the formats affect ESB and NESB students’ comprehension performance respectively.

Also, it presented the demographic information about the ESB and NESB sample groups. They were all students enrolled in the unit of Professional Communication Practice at Swinburne University, Lilydale Campus. The size for the final sample was twenty-seven for each group, so fifty-four students in total.

In addition, this chapter presented the instruments used in the present study, which were: computers and the Internet; a hypermedia system; instructional materials; and comprehension tasks. A specific website was set up for this study which was informed by various design principles (available at http://project.faysoft.com.au/ca/).

This chapter also reviewed the main procedures of the experiment in the present study. The experimental materials were delivered through five one hour tutorials on a weekly basis. The students were asked to finish the reading materials and the nine comprehension tasks in each session. The answers to
the comprehension tasks formed the research data that was collected from the students for analysis purposes.

Finally, the chapter discussed the ethical issues which were considered with respect to the protection and confidentiality of participants and the collected research data. All data was separately stored and could be accessed by the author only with password protection. The empirical data of this study will be presented in the following chapter.
Chapter 6

Presentation and analysis of empirical data

This chapter will present the statistical analysis of the empirical data according to the hypotheses of this study. In this chapter, the results of the data analysis are elaborated in several sections in order to examine the diversity of performance in comprehending the various formats of learning materials, including hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links in an authentic learning environment between the two sample groups, the students from English speaking backgrounds (ESB) and the students from non-English speaking backgrounds (NESB), linked to the first hypothesis of this study. This study will further investigate the effects of the different types of multimedia learning materials and language backgrounds on the participants’ comprehension performance connected to the second hypothesis of this study in order to identify which format(s) are the easiest and/or the most challenging one(s) for each group of participants.

The results of the present study are elaborated in these sections as follows:

<table>
<thead>
<tr>
<th>Section 6.1</th>
<th>Descriptive statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 6.2</td>
<td>Some differences in comprehension performance between the two sample groups for each multimedia format</td>
</tr>
<tr>
<td>Section 6.3</td>
<td>The differences in comprehending different types of multimedia formats within the ESB group</td>
</tr>
<tr>
<td>Section 6.4</td>
<td>The differences in comprehending different types of multimedia formats within the NESB group</td>
</tr>
</tbody>
</table>
6.1 Descriptive statistics

This section presents the descriptive statistics of the results which were analysed using SPSS version 19 (Statistical Package for the Social Sciences), running on the Swinburne University of Technology’s mainframe system. The descriptive statistics will show the patterns and general trends of the dataset by simply measuring and reducing them to mean, standard deviation, skewness and kurtosis. The interactions between the multimedia formats and the two sample groups will be presented in a general linear model (GLM).

6.1.1 Response rate

In this study, 180 university students were initially invited into the experiment, made up of 100 ESB and 80 NESB individuals. However, from among the initial group, a large proportion of students were disqualified from the final sample by the following conditions:

If a student withdrew from the study at any stage; or
If a student missed any one of the five sessions.

Therefore, once the data was prepared for analysis, the final sample group was 54 in total (27 participants in each group). With returned and useable questionnaires from 54 participants out of 180, the response rate was 30%.

6.1.2 Results for the ESB and NESB sample groups

As mentioned above, the final sample included 27 ESB participants. The means (or average scores), standard deviations, skewness and kurtosis of the comprehension scores in comprehending the learning materials presented in the five different multimedia formats (i.e. hypermedia with image links,
hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links) for the ESB sample group are shown in Table 6.1.

**Table 6.1 Means, standard deviations, skewness and kurtosis of comprehension scores of each session for ESB participants**

<table>
<thead>
<tr>
<th>Format of learning materials</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Sk</th>
<th>Ku</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM with image links</td>
<td>27</td>
<td>5.42</td>
<td>0.97</td>
<td>-0.16</td>
<td>0.28</td>
</tr>
<tr>
<td>HM with audio links</td>
<td>27</td>
<td>6.06</td>
<td>0.91</td>
<td>-0.43</td>
<td>-0.27</td>
</tr>
<tr>
<td>HM with video links</td>
<td>27</td>
<td>5.12</td>
<td>0.83</td>
<td>0.54</td>
<td>-0.04</td>
</tr>
<tr>
<td>HM with animation links</td>
<td>27</td>
<td>4.48</td>
<td>0.77</td>
<td>0.44</td>
<td>-0.28</td>
</tr>
<tr>
<td>HT with text links</td>
<td>27</td>
<td>5.36</td>
<td>0.74</td>
<td>-0.17</td>
<td>-0.78</td>
</tr>
</tbody>
</table>

Notes: HM=hypermedia, HT=hypertext, SD=standard deviations, Sk=skewness and Ku=kurtosis

As Table 6.1 illustrates, the mean comprehension score for ESB participants (n=27) in comprehending the materials presented in hypermedia with image links is 5.42 and the SD is 0.97. There is a wide range in the scores they earned, from the lowest one (3.25) to the highest one (7.25). Typically 50% of the participants’ scores were between 5.00 and 6.00 points.

Skewness and kurtosis can be used as indicators to determine whether the data approximates normal distributions (Tabachnick & Fidell 2013; Vogt 1999). Both ideal values of skewness and kurtosis statistics produced by normal distributions are equal to zero. However, skewness and kurtosis values will rarely tend toward zero in normal distributions when they are calculated from real data, which can produce either positive or negative numbers (Tabachnick...
According to Tabachnick and Fidell (2013), the distribution of data can be assessed by two standard errors of skewness and kurtosis. The calculated values of skewness and kurtosis are assumed to be significantly non-normal when they are greater (regardless of sign) than two standard errors of skewness (SES) and kurtosis (SEK). The SES and SEK can be estimated using the formulas (Tabachnick & Fidell 2013):

\[
\text{SES} = \frac{\sqrt{6}}{\sqrt{N}}
\]

\[
\text{SEK} = \frac{\sqrt{24}}{\sqrt{N}}
\]

where \(N\) is the sample size.

Thus, skewness will be significant when a calculated value of skewness is greater than \(2 \times \frac{\sqrt{6}}{\sqrt{N}}\). Kurtosis will be significant when a calculated value of kurtosis is greater than \(2 \times \frac{\sqrt{24}}{\sqrt{N}}\).

The data in the present study approximates normal distributions based on skewness and kurtosis. The SES of the data collected from each group of participants who comprehended the multimedia learning materials is 0.47. Therefore, two standard errors of skewness is 0.94. The SEK of the each sample group is 0.94. Thus, two standard errors of kurtosis is 1.89.

Therefore,

if skewness is greater than \(-0.94\) or less than \(+0.94\), the distribution is normal; and

if kurtosis is greater than \(-1.89\) or less than \(+1.89\), the distribution is normal.
Compared to the two standard errors of skewness and kurtosis respectively, both of the skewness and kurtosis for the ESB participants who comprehended hypermedia with image links lie within the acceptable ranges. Thus, the results indicate the comprehension scores of the ESB group for comprehending hypermedia with image links are normally distributed, as shown in Figure 6.1.

**Figure 6.1 Data distribution in comprehending hypermedia materials with image links for ESB participants**

Table 6.1 shows that the mean comprehension score for ESB participants (n=27) in comprehending hypermedia learning materials with audio links is 6.06 on average and the standard deviation is 0.91. The scores vary from 4.25 to 7.75 displaying a wide scale. Typically, there were 50% of participants’ scores between 5.50 and 6.75 points. The scores for ESB participants are normally distributed as shown in Figure 6.2.
In general, in the ESB sample group of 27 participants, the mean comprehension score for comprehending hypermedia with video links is 5.12 and the standard deviation is 0.83. The lowest score they have earned when comprehending is 3.75 and the highest one is 7.00. The scores from approximately 50% of the participants are between 4.50 and 5.50 points, indicating a narrow range. The distribution of their comprehension scores does not differ from a normally distributed set, as shown in Figure 6.3.
Table 6.1 indicates that the average score of ESB participants (n=27) in comprehending the learning materials presented in hypermedia with animation links is 4.48 and the SD is 0.77. The minimum score they gained is 3.25 and the maximum one is 6.25. Overall, 50% of the ESB participants’ scores for these ESB participants are from 3.75 to 5.00 points. The distribution does not differ from a normal set, which is shown in Figure 6.4.
For the ESB sample group of 27 participants, the mean score for comprehending hypertext materials with text links is 5.36. The standard deviation is 0.74. The lowest score earned in this sample group is 4.00 and the highest one is 6.75. The results of 50% of participants are between 4.75 and 6.00 points. These results are normally distributed, as shown in Figure 6.5.
There were 27 NESB participants in the second sample group. The means (or average scores), standard deviations, skewness and kurtosis of comprehension scores for comprehending the learning materials presented in the five different multimedia formats (i.e. hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links) for the NESB sample group are shown in Table 6.2.
Table 6.2: Means, standard deviations, skewness and kurtosis of comprehension scores of each session for NESB participants

<table>
<thead>
<tr>
<th>Format of multimedia learning materials</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Sₖ</th>
<th>Kᵤ</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM with image links</td>
<td>27</td>
<td>5.04</td>
<td>0.77</td>
<td>-0.89</td>
<td>-0.25</td>
</tr>
<tr>
<td>HM with audio links</td>
<td>27</td>
<td>4.81</td>
<td>0.75</td>
<td>-0.27</td>
<td>-0.86</td>
</tr>
<tr>
<td>HM with video links</td>
<td>27</td>
<td>4.85</td>
<td>0.50</td>
<td>0.04</td>
<td>-0.78</td>
</tr>
<tr>
<td>HM with animation links</td>
<td>27</td>
<td>4.62</td>
<td>0.58</td>
<td>-0.22</td>
<td>-0.37</td>
</tr>
<tr>
<td>HT with text links</td>
<td>27</td>
<td>5.48</td>
<td>0.55</td>
<td>-0.84</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Notes: HM=hypermedia, HT=hypertext, SD=standard deviations, Sₖ=skewness and Kᵤ=kurtosis

The results, as seen in Table 6.2, indicate that the mean comprehension score for the NESB sample group (n=27) for comprehending the hypermedia materials with image links is 5.04 and the standard deviation is 0.77. The scores display a very narrow scale, from 3.50 to 6.00. It was found that 50% of the participants’ scores fall between 4.75 and 5.50 points which is a very narrow interval. The results for the NESB participants in comprehending the materials do not differ from a normally distributed set as shown in Figure 6.6.
The results in Table 6.2 indicate that the mean comprehension score for the NESB participants (n=27) in comprehending hypermedia materials with audio links is 4.81 and the SD of these results is 0.75. The lowest score they earned while comprehending is 3.25 and the highest one is 6.00. Overall, 50% of the participants' scores are between 4.25 and 5.50 points. The comprehension scores for comprehending hypermedia with audio links for NESB participants are distributed normally, which is shown in Figure 6.7.
In the NESB sample group (n=27), the mean score for comprehending hypermedia materials with video links is 4.85 and the standard deviation is 0.50. The lowest score among participants is 4.00 and the highest one is 5.75. The scores of 50% of NESB participants are between 4.5 and 5.25. The distribution of the scores for comprehending the materials does not differ from a normally distributed set, as shown in Figure 6.8.
The results in Table 6.2 indicate that the mean score for NESB participants (n=27) in comprehending hypermedia materials with animation links is 4.62 and the SD is 0.58. The minimum score gained in comprehension is 3.50 and the maximum one is 5.75. Typically, according to the results, 50% of scores for NESB participants varied from 4.25 to 5.00. The results for NESB participants in comprehending hypermedia materials with animation links do not differ from a normally distributed set as shown in Figure 6.9.
The results, as seen in Table 6.2, show that the mean score for NESB individuals (n=27) for comprehending the learning materials presented as hypertext materials with text links is 5.48 and the SD is 0.55. Overall, 50% of the scores in comprehending the hypertext vary from 5.00 to 5.75 showing a very narrow interval. The minimum score for the NESB participants in this session is 4.25, and the maximum one is 6.25. The results indicate the scores for comprehending hypertext materials with text links are normally distributed which is shown in Figure 6.10.
6.1.3 General trends in the results of participants comprehending experimental multimedia learning materials

In order to assess the influence of the different multimedia formats and participants' language backgrounds on comprehending the learning materials, the gathered results were analysed and will be presented from three different perspectives. Firstly, the influence of each multimedia format on all participants' comprehension performance will be presented. Secondly, the influence of language backgrounds on all participants' comprehension performance will be shown. Finally, the influences of a combination of multimedia formats and language backgrounds on the participants' comprehension performance will be presented.
6.1.3.1 The influence of the different types of multimedia formats on participants’ comprehension performance

The experiment-provided multimedia learning materials were presented in five different formats in the hypermedia contexts, namely: hypermedia with image links; hypermedia with audio links; hypermedia with video links; hypermedia with animation links; and hypertext with text links.

**Figure 6.11 The influence of the different types of multimedia formats on participants’ comprehension performance**

A one-way analysis of variance was conducted to determine the influence of the various multimedia formats on participants’ comprehension performance. It showed that $F(2.965, 157.122)=18.157$, $p<0.001$, which indicates that different multimedia formats do have any influence on participants’ performance in
comprehending learning materials.

6.1.3.2 The influence of different language backgrounds on participants’ comprehension performance

This study explores the influence of the different language backgrounds of participants on comprehending learning materials. There were two sample groups of participants. The first group consisted of students from English speaking backgrounds (ESB) and the second one of students from non-English speaking backgrounds (NESB). This trend is shown in Figure 6.12.

**Figure 6.12 The influence of language backgrounds on participants’ comprehension performance**

![Graph showing the influence of language backgrounds on participants' comprehension performance. The x-axis represents the sample groups (ESB and NESB), and the y-axis represents the means comprehension scores in reading multimedia learning materials. The graph shows a downward trend from ESB to NESB.]
A one-way analysis of variance was conducted to find out the influence of the participants’ language backgrounds on their results. It was found that $F(1, 268)=10.033$, $p<0.05$, which indicated that the different language backgrounds (ESB and NESB) do have any influence on participants’ comprehension performance.

6.1.3.3 The influence of a combination of multimedia formats and language backgrounds on participants’ comprehension performance

This section explores the influence of a combination of different multimedia formats and different language backgrounds on participants’ comprehension performance. Therefore, a 5 (formats of multimedia learning materials) by 2 (groups of sample) mixed design analysis of variance was conducted based on the data, with multimedia formats as the within-subjects variables and the sample groups as the between-subjects variables. Figure 6.13 indicates the trends of the two groups of participants’ performance in comprehending the five different formats of multimedia learning materials.
Figure 6.13 shows the mean scores of comprehension of multimedia learning materials for the ESB and NESB sample groups. The results reveal a significant difference in the mean comprehension scores, $F(3.336, 173.450) = 22.268$, $p < 0.001$. The results, as seen in Figure 6.13, also indicate that the facilitative role of the various multimedia formats for ESB and NESB sample groups was different, $F(3.336, 173.450) = 13.000$, $p < 0.001$.

The results in Figure 6.13 reveal that for ESB participants, hypermedia materials with audio links produced a substantial increase in facilitating their comprehension performance. For NESB participants, on the other hand, the most facilitative effect was produced by hypertext materials with text links. They also reveal that the facilitative role of hypermedia materials with
animation links was small for both groups.

The following sections will present the ESB and NESB participants’ performance in comprehending multimedia learning materials. Independent samples t-tests were used to compare the means and standard deviations of the comprehension scores with each multimedia format between the two sample groups. These results are presented in Section 6.2. Furthermore, paired samples t-tests were used to compare means and standard deviations of the comprehension scores with the different multimedia formats within each sample group. These results are presented in Section 6.3

6.2 Some differences in comprehension performance between the two sample groups for each multimedia format

Hypothesis 1 predicted that ESB and NESB participants would perform differently with some of the experiment-provided multimedia learning materials, namely: hypermedia with image links; hypermedia with audio links; hypermedia with video links; hypermedia with animation links; and hypertext with text links. The results of hypothesis 1 were analysed through independent samples t-tests to compare the mean comprehension scores of each multimedia format between the ESB and NESB participants.

The results of hypothesis 1 are presented as five sub-hypotheses in order to clearly reveal the results of each comparison between the two sample groups. Independent samples t-tests were performed in order to test each sub-hypothesis.
6.2.1. ESB vs. NESB in comprehending hypermedia materials with image links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.2.1a</th>
<th>Alternate Hypothesis 6.2.1b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be a significant difference in comprehending hypermedia materials with image links between the ESB and NESB sample groups.</td>
<td>There will be no difference in comprehending hypermedia materials with image links between the ESB and NESB sample groups.</td>
</tr>
</tbody>
</table>

On average, the mean comprehension score for ESB participants in comprehending hypermedia materials with image links is higher (Mean=5.42, SD=0.97) than for NESB participants (Mean=5.04, SD=0.77). Figure 6.14 shows the mean scores for the ESB and NESB participants in comprehending hypermedia materials with image links.

**Figure 6.14 Boxplots of mean scores in comprehending hypermedia materials with image links for ESB and NESB participants**

- Boxplot of HM-image ESB vs.NESB
Figure 6.14 indicates that the ESB participants’ mean comprehension score in comprehending the hypermedia materials with image links is higher than the NESB participants. However, an independent samples t-test reveals that the difference between the ESB and NESB participants in comprehending hypermedia with image links is not significant, with t=1.60, p>0.05. There is insufficient evidence provided by the present study to prove that there is a difference between ESB and NESB participants’ mean scores in comprehending hypermedia materials with image links. The results determine a rejection for the null sub-hypothesis 6.2.1a. As predicted, there is no difference in comprehending hypermedia materials with image links between ESB and NESB participants.

6.2.2 ESB vs. NESB in comprehending hypermedia materials with audio links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.2.2a</th>
<th>Alternate Hypothesis 6.2.2b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference in comprehending hypermedia materials with audio links between the ESB and NESB sample groups.</td>
<td>There will be a significant difference in comprehending hypermedia materials with audio links between the ESB and NESB sample groups.</td>
</tr>
</tbody>
</table>

The results indicate that the ESB participants’ (n=27) mean comprehension score (Mean=6.06, SD=0.91) in comprehending hypermedia materials with audio links is higher than the NESB participants (n=27, Mean=4.81, SD=0.75). The mean scores for the ESB and NESB participants in comprehending hypermedia materials with audio links are shown in Figure 6.15.
Figure 6.15 Boxplots of mean scores in comprehending hypermedia materials with audio links for ESB and NESB participants

Figure 6.15 indicates that the ESB participants’ mean score for comprehending hypermedia materials with audio links is higher than the NESB participants’. An independent samples t-test further shows that the difference of mean comprehension scores between the ESB and NESB participants is significant, with $t=5.50$, $p<0.05$. As a result, the analysis does not support the null sub-hypothesis 6.2.2a. As expected, there is a significant difference in comprehending hypermedia materials with audio links between ESB and NESB participants.
6.2.3 ESB vs. NESB in comprehending hypermedia materials with video links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.2.3a</th>
<th>Alternate Hypothesis 6.2.3b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be a significant difference in comprehending hypermedia materials with video links between the ESB and NESB sample groups.</td>
<td>There will be no difference in comprehending hypermedia materials with video links between the ESB and NESB sample groups.</td>
</tr>
</tbody>
</table>

The results indicate that on average, ESB participants (n=27) had a slightly higher mean score in comprehending hypermedia materials with video links than NESB participants (n=27, Mean=4.85, SD=0.50). Figure 6.16 shows ESB and NESB participants’ mean scores for comprehending hypermedia materials with video links.

**Figure 6.16 Boxplots of mean scores for comprehending hypermedia materials with video links for ESB and NESB participants**

![Boxplot of HM-video ESB vs. NESB](image-url)
Figure 6.16 indicates that the ESB participants’ mean score in comprehending hypermedia materials with video links is higher than the NESB participants’. However, the difference between the mean comprehension scores of ESB and NESB participants is not statistically significant. An independent samples t-test indicates that $t=1.44$, $p>0.05$. Thus, there is insufficient evidence to suggest that there is a difference in comprehending hypermedia materials with video links between the ESB and NESB groups. The analysis does not support the null sub-hypothesis 6.2.3a. As expected, there is no difference in comprehending hypermedia materials with video links between ESB and NESB participants.

6.2.4 ESB vs. NESB in comprehending hypermedia materials with animation links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.2.4a</th>
<th>Alternate Hypothesis 6.2.4b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be a significant difference in comprehending hypermedia materials with animation links between the ESB and NESB sample groups.</td>
<td>There will be no difference in comprehending hypermedia materials with animation links between the ESB and NESB sample groups.</td>
</tr>
</tbody>
</table>

The mean score for by the ESB participants (n=27) in comprehending hypermedia materials with animation links (Mean=4.48, SD=0.77) is slightly lower than the one for the NESB participants (n=27, Mean=4.62, SD=0.58). Figure 6.17 demonstrates the mean scores in comprehending hypermedia materials with animation links for ESB and NESB participants.
Figure 6.17 indicates that the ESB participants’ mean score for comprehending hypermedia materials with animation links is lower than the mean comprehension score of the NESB participants. However, an independent samples t-test indicates that the difference between the two sample groups is not significant, $t=-0.75$ and $p>0.05$. There is insufficient evidence to suggest that there is a difference in comprehending materials between the ESB and NESB groups. Thus, the null sub-hypothesis 6.2.4a is rejected. As predicted, there is no difference in comprehending hypermedia materials with animation links between the ESB and NESB participants.
6.2.5 ESB vs. NESB in comprehending hypertext materials with text links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.2.5a</th>
<th>Alternate Hypothesis 6.2.5b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be a significant difference in comprehending</td>
<td>There will be no difference in comprehending hypertext materials</td>
</tr>
<tr>
<td>hypertext materials with text links between the ESB and</td>
<td>with text links between the ESB and NESB sample groups.</td>
</tr>
<tr>
<td>NESB sample groups.</td>
<td></td>
</tr>
</tbody>
</table>

According to the results, the mean score for comprehending hypertext with text links for ESB participants (n=27) is lower (Mean=5.36, SD=0.74) in comparison to the mean comprehension score for NESB participants (n=27, Mean=5.48, SD=0.55). Figure 6.18 shows the mean scores for ESB and NESB participants in comprehending hypertext with text links.

**Figure 6.18 Boxplots of mean scores in comprehending hypertext materials with text links for ESB and NESB participants**
The results, as seen in Figure 6.18, indicate that the ESB participants’ mean score for comprehending hypertext materials with text links is lower than the NESB participants’. However, an independent samples t-test shows that the difference of the mean comprehension scores between the ESB and NESB groups is not significant, \( t = -0.68, p > 0.05 \). There is insufficient evidence to suggest that there is a difference in comprehending hypertext with text links between ESB and NESB participants. The above analysis implies that the null sub-hypothesis 6.2.5a is rejected. As predicted, there is no difference in comprehending hypertext with text links between the ESB and NESB sample groups.

The statistical analysis provides enough evidence to test the hypotheses. All the null sub-hypotheses included in hypothesis 1 have been rejected. Therefore, hypothesis 1 is supported by the results. As predicted, the ESB and NESB students performed differently when using some of the experiment-provided multimedia learning contexts, namely: hypermedia with image links; hypermedia with audio links; hypermedia with video links; hypermedia with animation links; and hypertext with text links.

Hypothesis 2 hypothesised that the performance of the ESB and NESB participants in the active learning process would differ, such that ESB participants’ performance would be maximised by hypermedia materials containing audio links and NESB participants would show maximum performance with hypertext materials containing text links.

In order to clearly present the results, hypothesis 2 was further divided into two sub-hypotheses based on the different sample groups. The first one hypothesised that the ESB participants’ performance will be maximised by hypermedia materials containing audio links. The second one hypothesised that the NESB participants’ comprehension performance will be maximised by
hypertext with text links. The results related to each sample group (ESB and NESB) will be presented in Section 6.3 and Section 6.4 respectively.

6.3 The differences in comprehending different types of multimedia formats within the ESB group

The results of the ESB sample group for hypothesis 2 will be presented as sub-hypotheses in order to clearly present the differences in comprehending hypermedia with audio links and the other formats. Paired samples t-tests were performed in order to test each sub-hypothesis.

6.3.1 Hypermedia with audio links vs. hypermedia with image links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.3.1a</th>
<th>Alternate Hypothesis 6.3.1b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with image links for the EBS sample group.</td>
<td>There will be a significant difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with image links for the EBS sample group, and the performance in comprehending hypermedia with audio links will be significantly better.</td>
</tr>
</tbody>
</table>

The results indicated that for the ESB participants’ (n=27), the mean score for comprehending hypermedia materials with image links is lower (Mean=5.42, SD=0.97) than the mean for comprehending hypermedia materials with audio links (Mean=6.06, SD=0.91). The mean scores for ESB participants in comprehending these two formats are shown in Figure 6.19.
A paired samples t-test further shows that the difference in comprehending hypermedia materials with audio links and comprehending hypermedia materials with image links (Mean_d=0.65, SD_d=0.69) is significant, t=4.90, p<0.05. Therefore, the null sub-hypothesis 6.3.1a is rejected. As predicted, there is a significant difference in comprehending hypermedia materials with audio links and comprehending hypermedia materials with image links for EBS participants, and they performed significantly better in comprehending the hypermedia with audio links.
6.3.2 Hypermedia with audio links vs. hypermedia with video links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.3.2a</th>
<th>Alternate Hypothesis 6.3.2b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with video links for the EBS sample group.</td>
<td>There will be a significant difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with video links for the EBS sample group, and the performance in comprehending hypermedia with audio links will be significantly better.</td>
</tr>
</tbody>
</table>

On average, the mean comprehension score for ESB participants (n=27) in comprehending hypermedia materials with audio links (Mean=6.06, SD=0.91) is higher than the mean for comprehending hypermedia materials with video links (Mean=5.12, SD=0.83). Figure 6.20 shows the mean scores given to the ESB participants in comprehending the hypermedia materials with audio links and the hypermedia materials with video links.
Figure 6.20 Boxplots of mean scores in comprehending hypermedia materials with audio links and comprehending hypermedia materials with video links for ESB participants

A paired samples t-test further reveals that for ESB participants, the difference in comprehending these two formats (Mean$_d$=0.94, SD$_d$=0.92) is significant, $t=5.36$, $p<0.05$. The null sub-hypothesis 6.3.2a is thus rejected. As expected, there is a significant difference in comprehending hypermedia materials with audio links and comprehending hypermedia materials with video links for the EBS group, and they performed significantly better in comprehending hypermedia with audio links.
6.3.3 Hypermedia with audio links vs. hypermedia with animation links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.3.3a</th>
<th>Alternate Hypothesis 6.3.3b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with animation links for the EBS sample group.</td>
<td>There will be a significant difference between comprehending hypermedia materials with audio links and comprehending hypermedia materials with animation links for the EBS sample group, and the performance in comprehending hypermedia with audio links will be significantly better.</td>
</tr>
</tbody>
</table>

According to the results, the mean score in comprehending hypermedia materials with audio links (Mean=6.06, SD=0.91) for ESB participants (n=27) is substantially higher in comparison to that for comprehending hypermedia materials with animation links (Mean=4.48, SD=0.77). Figure 6.21 shows the mean comprehension scores for the ESB participants in comprehending hypermedia with audio links and comprehending hypermedia with animation links.
The results, as seen in Figure 6.21, indicate that the ESB participants’ mean score in comprehending hypermedia materials with audio links is higher than the mean of comprehending hypermedia materials with animation links. A paired samples t-test further indicates the difference (Mean_d=1.58, SD_d=0.98) in comprehending hypermedia with audio links and comprehending hypermedia with animation links for EBS participants is significant, t=8.37, p<0.05. Therefore, the null sub-hypothesis 6.3.3a is rejected. As expected, there is a significant difference between comprehending hypermedia with audio links and comprehending hypermedia with animation links for EBS participants, and they had a significantly higher mean score in comprehending hypermedia materials with audio links.
6.3.4 Hypermedia with audio links vs. hypertext with text links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.3.4a</th>
<th>Alternate Hypothesis 6.3.4b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypermedia materials with audio links and comprehending hypertext materials with text links for EBS participants.</td>
<td>There will be a significant difference between comprehending hypermedia materials with audio links and comprehending hypertext materials with text links for EBS participants, and the performance in comprehending hypermedia with audio links will be significantly better.</td>
</tr>
</tbody>
</table>

The mean score of the ESB participants (n=27) in comprehending hypermedia materials with audio links (Mean=6.06, SD=0.91) is higher in comparison to the mean in comprehending hypertext with text links (Mean=5.36, SD=0.74). Figure 6.22 shows the mean comprehension scores of the ESB participants in comprehending hypermedia materials with audio links and comprehending hypertext with text links.
As seen in Figure 6.22, ESB participants had a higher mean score in comprehending hypermedia materials with audio links than in comprehending hypertext with text links. A paired samples t-test further shows that there is a significant difference (Mean\(_d\)=0.70, SD\(_d\)=0.99) between comprehending these two formats for ESB participants, t=8.37, p<0.05. The null sub-hypothesis 6.3.4a is rejected. Therefore, there is a significant difference in comprehending hypermedia materials with audio links and comprehending hypertext with text links for EBS students, and their performance in comprehending hypermedia with audio links is significantly better.

6.3.5 Comparisons between other formats within the ESB sample group

Within the ESB sample group, the following comparisons are presented:
Hypermedia with image links – Hypermedia with video links;
Hypermedia with image links – Hypermedia with animation links;
Hypermedia with image links – Hypertext with text links;
Hypermedia with video links – Hypermedia with animation links;
Hypermedia with video links – Hypertext with text links; and
Hypermedia with animation links – Hypertext with text links

Firstly, the results, as seen in Table 6.1, indicate that the mean score for ESB students (n=27) in comprehending hypermedia materials with image links (Mean=5.42, SD=0.97) is higher than that of comprehending hypermedia materials with video links (Mean=5.12, SD=0.83). The mean comprehension scores for these two formats for ESB participants are shown in Figure 6.23.

**Figure 6.23 Boxplots of the mean scores in comprehending hypermedia materials with image links and comprehending hypermedia materials with video links for ESB participants**
Figure 6.23 indicates that ESB participants had a higher mean comprehension score in comprehending hypermedia materials with image links than that of comprehending hypermedia materials with video links. A paired samples t-test further shows that the difference in comprehending these two formats (Mean_d=0.30, SD_d=0.84) for ESB participants is significant, t=1.83, p<0.05. As a result, there is a significant difference in comprehending hypermedia materials with image links and hypermedia materials with video links for ESB participants.

Secondly, the results indicate that the ESB participants (n=27) had a higher mean score in comprehending the hypermedia materials with image links (Mean=5.42, SD=0.97) than that of comprehending hypermedia materials with animation links (Mean=4.48, SD=0.77). Figure 6.24 demonstrates the mean comprehension scores for ESB participants in comprehending these two formats.
As Figure 6.24 indicates, ESB participants show a better performance in comprehending hypermedia materials with image links than comprehending hypermedia materials with animation links. A paired samples t-test shows that the difference (Mean\_d=0.94, SD\_d=1.20) for the ESB group in comprehending these two hypermedia formats is significant, t=4.06, p<0.05. Thus, there is a significant difference in comprehending hypermedia materials with image links and hypermedia materials with animation links for ESB participants.

Thirdly, on average, ESB participants (n=27) performed slightly better in comprehending hypermedia materials with image links (Mean=5.42, SD=0.97) than in comprehending hypertext materials with text links (Mean=5.36, SD=0.74). The mean scores for ESB participants in comprehending hypermedia with image links and hypertext with text links are shown in Figure 6.25.
Figure 6.25 Boxplots of the mean scores in comprehending hypermedia materials with image links and comprehending hypertext materials with text links for ESB participants

However, a paired samples t-test shows that the difference ($\text{Mean}_d=0.06$, $\text{SD}_d=0.91$) in comprehending these two formats for ESB participants is not significant, $t=0.32$, $p>0.05$. Therefore, there is no difference for ESB participants in comprehending hypermedia materials with image links and comprehending hypertext materials with text links.

In addition, the results, as seen in Table 6.1, indicate that the mean comprehension score for ESB participants ($n=27$) in comprehending hypermedia materials with video links ($\text{Mean}=5.12$, $\text{SD}=0.83$) is higher than the mean for comprehending hypermedia materials with animation links ($\text{Mean}=4.48$, $\text{SD}=0.77$). The mean scores in comprehending these two formats for ESB participants are demonstrated in Figure 6.26.
The difference in comprehending these two formats was further analysed by a paired samples t-test, which shows that the difference (Mean_d=0.64, SD_d=1.00) is significant, t=3.33, p<0.05. Therefore, there is a significant difference in comprehending hypermedia materials with video links and comprehending hypermedia materials with animation links for ESB participants.

Also, the results, as shown in Table 6.1, indicate that the mean score of ESB participants (n=27) in comprehending hypermedia materials with video links (Mean=5.12, SD=0.83) is lower than that for comprehending hypertext materials with text links (Mean=5.36, SD=0.74). The mean comprehension scores of these two formats for ESB participants are shown in Figure 6.27.
Figure 6.27 Boxplots of the mean scores in comprehending hypermedia materials with video links and comprehending hypertext materials with text links for ESB participants

Although ESB participants performed better in comprehending hypertext with text links than in comprehending hypermedia materials with video links, a paired samples t-test shows that the difference (Mean$_d$=-0.24, SD$_d$=0.77) in comprehending hypermedia materials with video links and comprehending hypertext materials with text links is not significant, t=-1.62, p>0.05. As a result, there is no difference in comprehending hypermedia with video links and comprehending hypertext with text links for EBS students.

Finally, according to the results, the mean score in comprehending hypermedia materials with animation links for ESB participants (n=27, Mean=4.48, SD=0.77) is considerably lower than comprehending hypertext materials with text links (Mean=5.36, SD=0.74). Figure 6.28 reveals ESB participants’ mean scores in comprehending hypermedia with animation links and comprehending hypertext with text links.
Figure 6.28 Boxplots of the mean scores in comprehending hypermedia materials with animation links and comprehending hypertext materials with text links for ESB participants

As Figure 6.28 shows, ESB participants had a higher mean score in comprehending hypertext materials with text links than in comprehending hypermedia materials with animation links. A paired samples t-test indicates that the difference ($\text{Mean}_d=0.88$, $\text{SD}_d=0.81$) in comprehending these two formats is significant, $t=5.67$, $p<0.05$. Thus, there is a significant difference in comprehending hypermedia materials with animation links and comprehending hypertext materials with text links for the EBS sample group.

6.4 The differences in comprehending different types of multimedia formats within the NESB group

In order to demonstrate the differences in comprehending hypertext materials with text links and the other four multimedia formats within the NESB sample group, four sub-hypotheses were tested by paired samples t-tests and are
presented in the following sections.

6.4.1 Hypertext with text links vs. hypermedia with image links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.4.1a</th>
<th>Alternate Hypothesis 6.4.1b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypertext materials with text links and comprehending hypermedia materials with image links for the NESB sample group.</td>
<td>There will be a significant difference between comprehending hypertext materials with text links and comprehending hypermedia materials with image links for the NESB sample group, and the performance in comprehending hypertext with text links will be significantly better.</td>
</tr>
</tbody>
</table>

The mean score of the NESB participants (n=27) in comprehending hypertext with text links (Mean=5.48, SD=0.55), in comparison with the mean score in comprehending hypermedia materials with image links (Mean=5.04, SD=0.77), is higher. Figure 6.29 demonstrates the mean scores of the NESB sample group in comprehending hypertext materials with text links and comprehending hypermedia materials with image links.
Figure 6.29 Boxplots of the mean scores in comprehending hypertext materials with text links and comprehending hypermedia materials with image links for NESB participants

The results, as seen in Figure 6.29, indicate that the NESB participants had a higher mean score in comprehending hypertext with text links in comparison to comprehending hypermedia materials with image links. Furthermore, a paired samples t-test indicates that the difference (Mean_d=0.44, SD_d=0.56) in comprehending these two formats for NESB participants is significant, t=4.15, p<0.05. The null sub-hypothesis 6.4.1a is rejected. There is a significant difference in comprehending hypertext materials with text links and comprehending hypermedia materials with audio links for the NESB individuals’ sample, and their performance in comprehending hypertext with text links is significantly better as predicted.
6.4.2 Hypertext with text links vs. hypermedia with audio links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.4.2a</th>
<th>Alternate Hypothesis 6.4.2b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypertext materials with text links and comprehending hypermedia materials with audio links for the NESB sample group.</td>
<td>There will be a significant difference between comprehending hypertext materials with text links and comprehending hypermedia materials with audio links for the NESB sample group, and the performance in comprehending hypertext with text links will be significantly better.</td>
</tr>
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</table>

Compared to the mean score of the NESB participants (n=27) in comprehending hypertext materials with text links (Mean=5.48, SD=0.55), the score for comprehending hypermedia materials with audio links (Mean=4.81, SD=0.75) is lower. The mean scores in comprehending hypertext materials with text links and comprehending hypermedia materials with audio links for NESB participants are shown in Figure 6.30.
The results in Figure 6.30 indicate that the NESB participants had a higher mean score in comprehending hypertext materials with text links than in comprehending hypermedia materials with audio links. The difference in the comprehending scores for these two formats was further analysed by a paired samples t-test. The results show that the difference (Mean$_d$=0.67, SD$_d$=0.74) is significant, t=4.70, p <0.05. As expected, there is a significant difference in comprehending hypermedia materials with audio links and comprehending hypertext materials with text links for the NESB sample group, and they performed significantly better in comprehending hypertext with text links.
6.4.3 Hypertext with text links vs. hypermedia with video links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.4.3a</th>
<th>Alternate Hypothesis 6.4.3b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypertext materials with text links and comprehending hypermedia materials with video links for the NESB sample group.</td>
<td>There will be a significant difference between comprehending hypertext materials with text links and comprehending hypermedia materials with video links for the NESB sample group, and the performance in comprehending hypertext with text links will be significantly better.</td>
</tr>
</tbody>
</table>

The results indicate that for the NESB participants (n=27), the mean score in comprehending hypertext materials with text links (Mean=5.48, SD=0.55) is higher in comparison to the score for comprehending hypermedia materials with video links (Mean=4.85, SD=0.50). Figure 6.31 demonstrates the mean scores for the NESB participants in comprehending the two formats.
Figure 6.31 Boxplots of the mean scores in comprehending hypertext materials with text links and comprehending hypermedia materials with video links for NESB participants

Figure 6.31 indicates that the NESB participants’ mean score in comprehending hypertext materials with text links is higher than comprehending hypermedia materials with video links. A paired samples t-test further shows that the difference in NESB participants’ scores in comprehending hypertext materials with text links and comprehending hypermedia materials with video links is significant ($\text{Mean}_d=0.63$, $\text{SD}_d=0.73$), $t=4.47$, $p<0.05$. The results above were in favour of the alternative sub-hypothesis 6.4.3b. Therefore, there is a significant difference in comprehending hypertext materials with text links and hypermedia materials with video links for the NESB sample group, and they had a significantly higher mean score in comprehending hypertext with text links.
6.4.4 Hypertext with text links vs. hypermedia with animation links

<table>
<thead>
<tr>
<th>Null Hypothesis 6.4.4a</th>
<th>Alternate Hypothesis 6.4.4b</th>
</tr>
</thead>
<tbody>
<tr>
<td>There will be no difference between comprehending hypertext materials with text links and comprehending hypermedia materials with animation links for NESB students.</td>
<td>There will be a significant difference between comprehending hypertext materials with text links and comprehending hypermedia materials with animation links for NESB students, and the performance in comprehending hypertext with text links will be significantly better.</td>
</tr>
</tbody>
</table>

As the results indicate, the mean score earned by the NESB sample group (n=27) in comprehending hypertext materials with text links is higher (Mean=5.48, SD=0.55) than comprehending hypermedia materials with animation links (Mean=4.62, SD=0.58). The mean scores of the NESB participants in comprehending these two formats are presented in Figure 6.32.
The results, as shown in Figure 6.32, indicate that the NESB participants performed differently in comprehending hypertext materials with text links and comprehending hypermedia materials with animation links. The participants had a higher mean comprehension score in reading hypertext with text links. A paired samples t-test further indicates that the difference (Mean_d=0.86, SD_d=0.58) of the NESB participants’ scores in comprehending these two formats is significant, t=7.75, p<0.05. As a result, the null sub-hypothesis 6.4.4a is rejected. As expected, there is a significant difference in comprehending hypertext materials with text links and comprehending hypermedia materials with animation links for the NESB sample group, and the students earned a significantly better mean score for comprehending hypertext with text links.
The other results related to the differences for the NESB sample group in comprehending hypermedia with image links, hypermedia with audio links, hypermedia with video links and hypermedia with animation links were analysed by paired samples t-tests and are presented below.

6.4.5 Comparisons between other formats within the NESB sample group

Within the NESB sample group, the following comparisons are presented:

- Hypermedia with image links – Hypermedia with audio links;
- Hypermedia with image links – Hypermedia with video links;
- Hypermedia with image links – Hypermedia with animation links;
- Hypermedia with audio links – Hypermedia with video links
- Hypermedia with audio links – Hypermedia with animation links; and
- Hypermedia with video links – Hypermedia with animation links.

The results show that the mean score of NESB participants (n=27) in comprehending hypermedia materials with image links is slightly higher (Mean=5.04, SD=0.77) than for comprehending hypermedia materials with audio links (Mean=4.81, SD=0.75). The mean scores of the NESB sample group in comprehending hypermedia with image links and comprehending hypermedia with audio links are shown in Figure 6.33.
According to the results shown in Figure 6.33, NESB participants had a higher score in comprehending hypermedia materials with image links than in comprehending hypermedia materials with audio links. A paired samples t-test shows that the difference (Mean_d=0.22, SD_d=0.59) in comprehending hypermedia materials with image links and comprehending hypermedia materials with audio links is significant, t=1.95, p<0.05. Thus, there is a significant difference in comprehending hypermedia materials with image links and comprehending hypermedia materials with audio links for NESB participants.

The results also indicate that on average, the NESB sample group had a higher mean score in comprehending hypermedia materials with image links (Mean=5.04, SD=0.77), in comparison with comprehending hypermedia materials with audio links.
materials with video links (Mean=4.85, SD=0.50). The results for NESB participants in comprehending the two formats are shown in Figure 6.34.

**Figure 6.34 Boxplots of the mean scores in comprehending hypermedia materials with image links and comprehending hypermedia materials with video links for NESB participants**

A paired samples t-test shows that the difference (Mean_d=0.19, SD_d=0.83) in comprehending the materials presented in these two formats is not significant, t=1.17 and p>0.05. Therefore, there is no difference in comprehending hypermedia materials with image links and comprehending hypermedia materials with video links for the NESB sample group.

Furthermore, the results, as shown in Table 6.2, indicate that on average, the mean score for NESB participants in comprehending hypermedia materials with image links (Mean=5.04, SD=0.77) is higher in comparison to comprehending hypermedia materials with animation links (Mean=4.62, SD=0.58). Figure 6.35 illustrates the mean scores of the NESB participants in
comprehending the materials presented in these two formats.

**Figure 6.35 Boxplots of the mean scores in comprehending hypermedia materials with image links and comprehending hypermedia materials with animation links for NESB participants**

A paired samples t-test further shows that the difference (Mean\_d=0.42, SD\_d=0.63) in comprehending the materials presented in the two formats is significant, t=3.43, p<0.05. Thus, there is a significant difference in comprehending hypermedia materials with image links and comprehending hypermedia materials with animation links for the NESB sample group.

Moreover, the results show that for the NESB sample group (n=27), the mean comprehension score in comprehending hypermedia materials with audio links (Mean=4.81, SD=0.75) is slightly higher for comprehending hypermedia materials with video links (Mean=4.85, SD=0.50). The mean scores of the NESB participants in comprehending the materials presented in these two formats are shown in Figure 6.36.
However, a paired samples t-test indicates that the difference ($\text{Mean}_d=-0.37$, $\text{SD}_d=0.77$) for the NESB participants in comprehending these two hypermedia formats is not significant, $t=-0.25$, $p>0.05$. Thus, there is no difference in comprehending hypermedia materials with audio links and comprehending hypermedia materials with video links for the NESB sample group.

In addition, the results, as demonstrated in Table 6.2, indicate that on average, the mean score for the NESB sample group in comprehending hypermedia materials with audio links ($\text{Mean}=4.81$, $\text{SD}=0.75$) is slightly higher than in comprehending hypermedia materials with animation links ($\text{Mean}=4.62$, $\text{SD}=0.58$). Figure 6.37 illustrates NESB participants’ mean scores in comprehending hypermedia materials with audio links and comprehending hypermedia materials with animation links.
Figure 6.37 Boxplots of the mean scores in comprehending hypermedia materials with audio links and comprehending hypermedia materials with animation links for NESB participants

A paired samples t-test indicates that the difference (Mean\(_d\)=0.19, SD\(_d\)=0.73) in comprehending the materials presented in hypermedia with audio links and comprehending hypermedia with animation links for NESB participants is not significant, t=1.38, p>0.05. As a result, there is no difference in comprehending hypermedia materials with audio links and comprehending hypermedia materials with animation links for the NESB sample group.

Finally, the results indicate that the mean comprehension score of the NESB participants (n=27) in comprehending hypermedia materials with video links is slightly higher (Mean=4.85, SD=0.50) than for comprehending hypermedia materials with animation links (Mean=4.62, SD=0.58). The mean scores of the NESB participants in comprehending the two formats are shown in Figure 6.38.
Figure 6.38 Boxplots of the mean scores in comprehending hypermedia materials with video links and comprehending hypermedia materials with animation links for NESB participants

As Figure 6.38 indicates, NESB participants show a slightly better performance in comprehending hypermedia materials with video links than in comprehending hypermedia materials with animation links. A paired samples t-test further shows that the difference (Mean\(_d\)=0.23, SD\(_d\)=0.70) for NESB participants in comprehending the materials presented in hypermedia with video links and in hypermedia with animation links is significant, t=1.72, p<0.05. Thus, there is a significant difference for NESB participants in comprehending hypermedia materials with video links and comprehending hypermedia materials with animation links.

In summary, the results of the data analysis have indicated that there is a difference in experiment-provided multimedia learning contexts, namely: hypermedia with image links; hypermedia with audio links; hypermedia with video links; hypermedia with animation links; and hypertext with text links. In
addition, as predicted, ESB participants’ performance is better when interacting with hypermedia with audio links and NESB participants show maximum performance when interacting with hypertext containing text links.

6.5 Concluding remarks

The results presented in this chapter were mainly used to respond to the two hypotheses posed in Chapter 5. Firstly, one hundred and eighty data logs were retrieved for analysis. Once the data had been reorganised and prepared, the final sample consisted of 54 individuals in total and 27 participants for each sample group respectively.

Secondly, the research data was analysed using SPSS. The results consisted of three parts.

Part 1 demonstrated the basic descriptive data, including the results for the ESB and NESB sample groups, which were summarised and reported as mean, standard deviation, skewness and kurtosis for the five different multimedia formats. The general trends of the data were analysed by one-way analysis of variance to determine the influence of the different multimedia formats on participants’ comprehension performance, and these indicated that the different multimedia formats did have some influence on participants’ performance in comprehending the learning materials. One-way analysis of variance was used to analyse the influence of the different language backgrounds on participants’ comprehension performance. It was found that the different language backgrounds (ESB and NESB) had some influence on participants’ comprehension performance. Also, one-way analysis of variance was conducted to analyse the influence of multimedia formats and language backgrounds on participants’ comprehension performance. The results showed that the facilitative role of the various multimedia formats for the ESB
and NESB sample groups was different.

Part 2 presented the results related to hypothesis 1, running independent samples t-tests to compare mean scores in comprehending each format between the ESB and NESB groups. There was a significant difference in comprehending the hypermedia materials with audio links between the two sample groups. Also, independent samples t-tests indicated that the differences between the two groups of participants in comprehending the other four formats, including hypermedia materials with image links, hypermedia materials with video links, hypermedia materials with animation links and hypertext materials with text links were not significant. Thus, hypothesis 1 was supported as predicted.

Part 3 presented the results relevant to hypothesis 2. Paired samples t-tests were used to compare the mean scores in comprehending the five formats of materials within each sample group to assess the maximum performance for ESB students and NESB students. The results indicated that the ESB participants' performance was maximised by hypermedia materials with audio links and the NESB participants' comprehension performance was maximised by hypertext containing text links. As expected, hypothesis 2 was proved as well.

The two hypotheses have been supported by the results of the present study, which indicated that participants' comprehension performance was influenced by various multimedia formats and their language backgrounds. For instance, ESB participants' comprehension performance was significantly facilitated by hypermedia with audio links. By contrast, NESB participants’ comprehension performance was maximised by hypertext materials with text links. The discussion of these results will be presented in Chapter 7.
Chapter 7

Discussion

This chapter will link the results of the present study with previous research and discuss the key findings of the study. The chapter is divided into three main sections to present the analysis of the findings related to the learning performance of participants from different language backgrounds under the experiment-provided conditions within each hypothesis.

This chapter is divided into three sections as follows:

<table>
<thead>
<tr>
<th>Section 7.1</th>
<th>The diversity of comprehension performance between the ESB and NESB sample groups</th>
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<tbody>
<tr>
<td>Section 7.2</td>
<td>The diversity of comprehension performance within the ESB sample group</td>
</tr>
<tr>
<td>Section 7.3</td>
<td>The diversity of comprehension performance within the NESB sample group</td>
</tr>
</tbody>
</table>

Section 7.1 will concentrate on the general findings of the present study and will draw connections between this study and previous studies on similar topics in order to demonstrate the pertinence of the findings about the diversity of performance between ESB and NESB individuals. The findings included in Section 7.2 will be specific, attempting to explore the factors that may influence the performance of the two groups of individuals in comprehending the experimental materials. Section 7.2 will be further divided into two sections to elaborate the connections between the findings and the prior research studies. Section 7.2.1 will concentrate on the ESB (English speaking background) sample group and the centre of attention of Section 7.2.2 will be the NESB group. These two sections will be linked to the previous studies that are
relevant to the influence of cognitive load and language backgrounds on the proficiency of multimedia learning.

7.1 The diversity of comprehension performance between the ESB and NESB sample groups

There were five experimental reading sessions in this study that presented learning materials in different multimedia formats, namely hypermedia with image links (Session 1), hypermedia with audio links (Session 2), hypermedia with video links (Session 3), hypermedia with animation links (Session 4) and hypertext with text links (Session 5). One of the aims of the present study was to investigate the diversity of comprehension performance of participants who come from different language backgrounds. The following section will discuss the key findings of this study connected to hypothesis 1 and will further demonstrate the pertinence of the current findings and the previous studies.

In the process of multimedia learning, cognitive load is a determining factor influencing the two groups of students’ comprehension performance (Brunken et al. 2002). However, for NESB students, language proficiency is another critical factor which may significantly affect their performance in comprehending learning contexts (Carstairs et al. 2006; Diao & Sweller 2007; Ramburuth & McCormick 2001). In the present study, in considering students’ learning performance in comprehending the five formats of learning materials, a general finding has been revealed, that:

- Not all formats of learning materials could facilitate learning performance in reading comprehension for either the ESB group or the NESB group equally.

A considerable amount of recent literature in the area of multimedia learning
has investigated the relationship between presentation formats and learning outcomes (Chandler & Sweller 1991; Clark & Mayer 2008; Mayer 2001; Mayer & Moreno 1998; Moreno & Mayer 1999; Sweller, van Merrienboer & Paas 1998; Tindall-Ford, Chandler & Sweller 1997). The present findings were also in line with Norman’s (1988) study, which stated that any individual media element included in multimedia sources has its own effects on ‘affordances’ or ‘constraints’ at cognitive levels which may influence learners’ achievements. In this regard, different media formats have different influences on learning.

Thus, linking to hypothesis 1, there is a diversity of comprehension performance between the ESB and NESB students within some of the experimental conditions. Several key findings associated with hypothesis 1 are as follows:

- Audio-related mode(s) was the best discriminator to produce a significant diversity of comprehension performance between the two groups of students, namely: ESB and NESB.
- Visual information effectively diminished the disparity in comprehension performance between ESB and NESB students; and
- ESB and NESB students had different individual styles to process instructional information.

7.1.1 The influence of audio-related mode(s) on participants’ comprehension performance

The findings of the present study indicate a diversity of learning performance between ESB and NESB students in only one reading session - hypermedia materials with audio links (Session 2). Thus, the current findings suggest that audio has a more significant role in facilitating the learning performance of ESB groups than NESB participants. These findings are someway consistent
with a previous study conducted by Ramburuth and McCormick (2001), who maintained that Australian local students showed a stronger preference for processing information through audio modes than international students due to their learning styles.

It is important to mention that the data in Ramburuth and McCormick’s (2001) study came from a questionnaire survey aimed at discovering students’ attitudes towards learning and preferred learning styles, and was not justified by quantitative data. However, the data in the present study was quantitatively obtained from the answers to comprehension questions by two sample groups to test their performance in comprehending the given instructional materials. Furthermore, the ESB sample individuals who showed a preference for auditory learning were all Australian local students.

In addition, the international students from non-English speaking backgrounds who took part in Ramburuth and McCormick’s (2001) study, as well as the present study, were Asians. Thus, cultural factors might have influenced the students’ academic results (Volet & Ward 2006).

The current findings are also supported by Carstairs and his colleagues (2006) in their study that claimed that individuals from non-English speaking backgrounds whose first language was other than English tended to show some disadvantage in verbal sub-tests due to their lack of English language proficiency. However, in comparison with Carstairs et al.’s (2006) study, a difference between the current findings and that study might be attributed to the different instructional materials. The participants were presented with test materials from MUNNS in Carstairs et al.’s (2006) study that was used to reflect on the differences in cognitive abilities between three sub-groups for each sub-test. By contrast, the learning materials used in the present study were in the domain of professional communication and were related to the
students’ mainstream subject.

Furthermore, the difference between the present study and Carstairs et al.’s (2006) study might be related to the educational levels of the participants as suggested in a previous study by Cornelious and Caspi (1987). They indicated that educational backgrounds could significantly affect participants’ performance as students with high educational levels could be actively engaged in cognitive processes and could achieve a better understanding. The participants involved in Carstairs et al.’s (2006) study were adults who were randomly recruited from the Sydney metropolitan area while in the present study the participants were undergraduate students. All of them had gained the Year 12 Victoria Certificate of Education (VCE) or achieved an equivalent qualification to fulfil the academic entry requirements for an undergraduate program.

7.1.2 The influence of visual information on participants’ comprehension performance

Regarding the five different types of multimedia formats in the present study, the hypermedia materials with audio links were presented in dual-mode in terms of on-screen text and auditory links. The findings of the current study also indicated that the other four formats of learning materials provided in the experiment, hypermedia with image links (Session 1), hypermedia with video links (Session 3), hypermedia with animation links (Session 4) and hypertext with text links (Session 5) did not lead to significant differences of comprehension performance between ESB and NESB participants. The findings of the present study have been supported by Carstairs et al.’s (2006) study. They showed that providing visual materials could effectively diminish the distinction of test performance between ESB and NESB participants (Carstairs et al. 2006).
This shows that visual resources could effectively eliminate the diversity between ESB and NESB students due to the students' different learning styles. This discussion will be presented in Section 7.1.3.

7.1.3 The influence of individual factors on participants’ comprehension performance

As previously discussed, Australian ESB students showed a strong preference to process learning content through audio mode(s), and thus their comprehension performance was significantly enhanced by hypermedia materials with audio links. In this regard, it may be assumed that the NESB students who took part in the present study, preferred to learn with visual sources rather than auditory ones.

Similar findings were found by Chen (1998), indicating that in comparison with native English speakers, the learners who speak English as a second language preferred to process visual information rather than aural, as they experienced more listening difficulties when comprehending the second language. However, the participants in Chen’s study were all Chinese. The students in the present study were international NESB students from over the world. These findings were also consistent with previous results found by Reid (1987), indicating that Korean, Chinese and Japanese students were all visual learners. They preferred to read and obtain information from visual stimulation over aural.

Furthermore, the results of the present study indicated that the difference was not statistically significant. NESB participants earned a slightly better mean score in comprehending hypertext with text links (Session 5) than the ESB participants. It might be because the NESB sample group involved in the current study preferred to access the learning materials in the hypertext with
text links format (Session 5) than the other formats. The findings have been someway supported by the findings revealed by Plass et al. (1998), indicating that L2 students had a better performance in reading comprehension when they had the opportunity to receive information via their preferred mode(s).

In summary, the current findings suggest that a significant difference in performance between ESB and NESB students is obtained when comprehending hypermedia materials with audio links (Session 2) on the given topic. However, it was found that there was no difference in performance between the ESB and NESB students in comprehending visual-related resources, including hypermedia with image links (Session 1), hypermedia with video links (Session 3), hypermedia with animation links (Session 4) and hypertext with text links (Session 5). More studies demonstrating ESB and NESB students’ performance in comprehending various types of learning materials will be presented in the following sections, linked to hypothesis 2.

The present study also aimed to investigate the differences in performance within each sample group, ESB and NESB, in comprehending the various formats of learning materials on the given topic. Cognitive load plays a significant role in the process of multimedia learning in authentic learning environments (Brunken et al. 2002). Language background is another factor that may affect learning outcomes (Carstairs et al. 2006; Diao & Sweller 2007; Ramburuth & McCormick 2001), which leads to a more complex understanding of multimedia learning. The following sections will discuss the performance of the ESB sample group and the NESB sample group in comprehending the various formats of learning materials.
7.2 The diversity of comprehension performance within the ESB sample group

As predicted, hypothesis 2 confirmed that the ESB participants' comprehension performance was maximised by the hypermedia materials with audio links. As the previous studies proved, in the process of multimedia learning, ESB participants' comprehension performance could be effectively influenced by a number of factors.

Several key findings of the present study linked to the comprehension performance of the ESB sample group are as follows:

- Dual-modality multimedia presentation formats may effectively facilitate ESB participants' comprehension performance;
- Limited capacity working memory may affect ESB participants' processing of information in a multimedia environment;
- Audio information may easily be comprehended by ESB participants; and
- Individual factors may influence ESB participants' comprehension performance.

7.2.1 The influence of the dual-modality presentation format on ESB participants' comprehension performance

The current findings suggest that the ESB students' comprehension performance could be effectively facilitated by hypermedia materials with audio links (Session 2) on a given topic. The learning materials were presented in both visual (on-screen text) and auditory (audio links) modalities. These findings are discussed with a reference to the modality effect of multimedia learning that implies that multimedia information is better comprehended when presented in two different modalities, visual and audio (Mayer 2001; Mayer &
The cognitive load theory also indicated that people have two information processing channels to handle visual information and auditory information separately. Learners' performance is affected by the sources of information that are presented. Multiple sources of information that are presented in dual-modality had a more facilitative effect on learning rather than information that is presented in one modality only, either visual or aural (Chandler & Sweller 1991; Sweller, van Merrienboer & Paas 1998; Tindall-Ford, Chandler & Sweller 1997). In addition, the current findings may be supported by the dual channel assumption (Baddeley 1986), claiming that the integration of information from multiple sources can be efficient if it is concurrently presented to two sensory channels, as this may exceed the processing capacity of a single channel.

The findings relevant to the facilitative role of dual-modality information have been highlighted in previous studies. As Hebb (1949) showed, the human brain is more physically active when concurrently experiencing both visual and auditory stimuli. Penney (1989) reported that words presented in two modalities could enhance learners' memory recall in comparison with words that were just presented in visual modality. Stimuli were effectively simultaneously processed by two sensory channels, both ears and eyes, rather than just one channel (Treisman & Davies 1973). Similar findings have been outlined by Lewandowski and Kobus (1993), who maintained that for learners, significantly better performance in recalling words resulted from using dual-modality materials. The stimuli that were concurrently presented to both their auditory and visual channels more effectively engaged them in learning than the stimuli presented to their visual channel only.
The findings of the present study on the other hand might also be explained by the effect of split-attention as revealed in several prior studies (Ayres & Sweller 2005; Chandler & Sweller 1991; Clark & Mayer 2008; Sweller 2005; Tarmizi & Sweller 1988). They found that if the effect of split-attention occurred, the students’ learning would be impaired as split-attention has a negative effect on learning compared to conditions without split attention. As a result, if the effect of split-attention is eliminated, the learning may be improved (Mousavi, Low & Sweller 1995). In the present study, there were multiple visual sources presented in Session 1, Session 3, Session 4 and Session 5 - image, video, animation and on-screen text. Thus, the students had to split their attention in order to comprehend these different sources of information through the visual sensory channel.

More specifically, the findings of the present study suggest that the facilitative effect of hypermedia materials with audio links (Session 2) was better than hypermedia materials with image links (Session 1) in an authentic multimedia learning environment, which is consistent with the findings of a prior study by Mayer (2005b), which found that the learners who were presented with narrative and graphical materials (a dual-modality condition) performed better than those who were presented with text and graphics (visual mode only).

The current findings also suggest that for ESB students, hypermedia with audio links (Session 2) had a more positive effect on facilitating comprehension performance than hypermedia materials with animation links (Session 4), which is in accordance with a study conducted by Mayer and Moreno (1998). It maintained that a dual-modality presentation could more effectively improve learning than a one-modality (either auditory or visual) presentation as the split-attention effect may occur when processing animation in accompanying text. However, the dual-modality materials delivered to the learners were mostly presented with animation or graphic with narration.

The present study employed on-screen text associated with audio as the dual-modality presentation.

On the other hand, the students’ eyes could not fully engage in processing the various types of visual resources (Clark & Mayer 2008). When they attend to on-screen words, they cannot effectively interact with other visual illustrations, such as image or video, due to the limited capacity in their visual sensory channel (Clark & Mayer 2008).

7.2.2 The influence of the limited capacity of working memory on ESB participants’ comprehension performance

The findings of the present study for ESB participants could be attributed to the limited capacity of working memory. As Miller (1956) stated, sensory stimuli presented in a multimedia environment may be infinite, but the capacity of either visual or auditory working memory used to process and store the information is limited.

In fact, visual information is initially processed in visual working memory and auditory information is firstly handled in auditory working memory (Mayer 2001; Moreno & Mayer 1999). In the present study, the on-screen text would have initially been dealt with by the students’ visual working memory. Simultaneous to this, the images annotated in Session 1, videos annotated in Session 3 and animations annotated in Session 4 would have been processed by their visual channel as well which possibly produced a heavy cognitive load imposed on the students’ visual working memory. As the available capacity of visual working memory is limited to about five to seven chunks at any one time, the
various resources of visual information could not be effectively processed in the learning process (Baddeley 1986, 1992; Clark & Mayer 2008; Miller 1956).

7.2.3 The influence of audio mode(s) on ESB participants’ comprehension performance

The findings of the present study suggest that hypermedia with audio links (Session 2) had a significant facilitative effect on enhancing comprehension performance for the ESB students, as opposed to hypertext with text links (Session 5). This finding is in accordance with a study conducted by Leahy, Chandler and Sweller (2003), indicating that information presented in the audio-visual format is more beneficial to learning than information presented in the text format only.

Furthermore, the advantage of audio has been revealed by Mayer (2001), who showed that 'students learn better when words in a multimedia message are presented as spoken text rather than printed text' (p.134). In comparison with text annotations, content presented in audio links might be easier to comprehend (Tindall-Ford, Chandler & Sweller 1997). The findings have also been supported by Mayer and Moreno (2002) who demonstrated that words presented in dual-modality could enhance learning more than words presented in just one modality. Aural information supplemented with printed text could enhance learners’ comprehension (Clark & Mayer 2008). However, in Tindall-Ford et al.’s (1997) study, the aural information and textual information were duplicated, as it was the same content presented with different media formats. The information contained in the audio links in the present study did not exactly duplicate the on-screen text.
7.2.4 The influence of individual factors on ESB participants’ comprehension performance

According to the findings relevant to the present study, the ESB participants showed a significantly better performance in comprehending hypermedia materials with audio links (Session 2) than the other four formats which is consistent with the findings from a study by Ramburuth and McCormick (2001). That study indicated that Australian local students tended to have very specific media preferences for the audio mode to process information (Ramburuth & McCormick 2001). Therefore, the ESB participants who took part in the present study might also have a strong preferred style of relying on auditory stimuli in learning.

Thus, hypothesis 2 for ESB students has been supported by previous studies and relevant theories. However, comparisons between the other experiment-provided formats (namely, hypermedia materials with image links, hypermedia materials with video links, hypermedia materials with animation links and hypertext materials with text links) in establishing the facilitative effect on comprehension on the given topic were also carried out and will be discussed in the following sections.

7.2.5 The diversity of performance in comprehending other formats of learning materials for ESB participants

The current discussion will be relevant to the comparisons between the other four formats of learning materials, namely: hypermedia with image links (Session 1), hypermedia with video links (Session 3), hypermedia with animation links (Session 4) and hypertext with text links (Session 5). According to the findings of the present study, ESB participants’ comprehension performance is influenced by both learning material factors and individual
factors. The factor of the learning materials is the presentation format.

Firstly, the findings of the present study suggest that hypermedia with image links (Session 1) had a more substantial effect on facilitating ESB students’ comprehension performance on the given topic than hypermedia with video links (Session 3). The findings also suggest that in comparison with hypermedia with animation links (Session 4), hypermedia with image links (Session 1) had a more facilitative role in improving comprehension performance for ESB individuals. These findings might be attributed to the media formats provided (Butcher 2006). According to Butcher (2006), the degree of comprehending is promoted by text and simple illustration more than by text and detailed illustration. Simple illustrations, such as simple line drawings, were able to more effectively enhance students’ understanding compared to more complex ones (Butcher 2006; Clark & Mayer 2008). In the present study, in comparison with the video and animation annotated information, images were considerably simpler which helped the students to understand the texts.

The findings related to hypermedia with image links (Session 1) and hypermedia with animation links (Session 4) are in line with other studies conducted by Ayres et al. (2005) and Ploetzner and Lowe (2004), which proved that animation could place more cognitive load demand on the learners’ working memory compared to static graphics. Such findings were consistent with Vogel-Walcut’s (2010) study, which indicated that static picture illustrations had more effect on facilitating learning materials acquisition, application and short-term retention than animations.

Secondly, the findings of the present study suggest that hypermedia with image links (Session 1) could not effectively facilitate comprehending performance more than hypertext with text links (Session 5) for ESB
participants, which contradicts with the multimedia principle of multimedia learning stated by Mayer (2001). This principle was proved by several previous studies (Mayer 1989, cited in 2003; Mayer & Gallini 1990, cited in Mayer 2003), which indicated that the students’ comprehension was better when the information was presented with corresponding images rather than text only. These results could be explained by the presentation and delivery of the materials using the Web, as indicated by McEneaney (2003). Hypermedia reading requires a higher level of cognitive load than traditional textbook reading which may influence the participants’ comprehension performance (Brunken & Leutner 2001; Mayer 2001; McEneaney 2003).

Also, the current findings could be attributed to the students’ learning styles. Previous studies have proved that individual factors, such as the learners’ age, gender and learning style, could affect learners’ learning outcomes (Mayer 2001; Plass et al. 1998; Volet 2001; Volet & Ward 2006). However, the influence of these factors on students’ performance in comprehending the learning materials was not taken into account in the present study.

The findings of the current study suggest that in the processes of comprehending, hypermedia with video links (Session 3) had better effects on enhancing ESB students’ comprehension performance than hypermedia with animation links (Session 4). It could be because of the annotated media files, as suggested by Lewis and Barron (2009). The study revealed that animation offered little guidance in comparison to video when it lacked narrated instructions. Thus, the learners had to produce self-explanations to assist comprehension, which may lead to cognitive overload. Very similar findings were also confirmed in a study conducted by Wittwer and Renkl (2008), showing that animation led to inaccurate and incomplete information produced which damaged learning or comprehending due to the insufficiently narrated instruction provided (Renkl 2002; Wittwer & Renkl 2008).
Moreover, current findings suggest that the facilitative roles of hypermedia with video links (Session 3) and hypertext with text links (Session 5) on comprehending were equal, which is in contrast to the split-attention principle of multimedia learning (Chandler & Sweller 1991; Mayer 2001; Mayer & Moreno 1998; Moreno & Mayer 1999; Sweller, van Merrienboer & Paas 1998; Tindall-Ford, Chandler & Sweller 1997). The difference between the previous findings and the current ones might be attributed to the medium used to present and deliver the learning materials. McEneaney (2003) proposed that more cognitive demands are required in hypermedia reading which might influence the students' performance in comprehending the given content. On the other hand, there is relatively little research investigating the variances or differences between text and video on cognitive achievement and attitudes toward learning. Videos may help learners to perceive and feel information, but research to give an indication of its effectiveness on significantly improving learning is insufficient (Swisher 2007).

Finally, for ESB students, current findings suggest hypertext with text links (Session 5) had a more facilitative effect on comprehending the given materials than hypermedia with animation links (Session 4), which could be supported by the split-attention effect (Sweller 1999). The students had to split their visual attention between the animation and the on-screen text which negatively influenced their comprehension performance. In the learning process, the split-attention effect often results in higher cognitive load and lower performance compared to no or less split-attention (Chandler & Sweller 1991; Mayer 2001; Mayer & Moreno 1998; Moreno & Mayer 1999; Sweller, van Merrienboer & Paas 1998; Tindall-Ford, Chandler & Sweller 1997). Also, similar findings were provided by Ayres et al. (2005) and Ploetzner and Lowe (2004), showing that, for learners, animations posed more cognitive demands on working memory to ensure understanding due to a lack of apparent instruction.
In contrast, for the NESB sample group, the hypertext with text links format (Session 5) had a more facilitative role in comprehension on the professional communication topics than the other formats, including hypermedia with image links (Session 1), hypermedia with audio links (Session 2), hypermedia with video links (Session 3) and hypermedia with animation links (Session 4). The discussion relevant to the comprehension performance for the NESB sample group will be elaborated in Section 7.3.

7.3 The diversity of comprehension performance within the NESB sample group

As predicted, hypothesis 2 in relation to the NESB students has also been confirmed. Reviewing their learning performance for the five different reading sessions, the findings of the present study suggest that not all types of formats could equally facilitate NESB participants’ performance in comprehending the given materials in authentic learning environments. Similar findings have been found by many previous studies that were relevant to second language comprehension (Akbulut 2008; Chun & Plass 1996; Jones 2004; Mayer 2001; Yeh & Wang 2003).

In the present study, several key findings have been established through the investigation of NESB participants’ performance in comprehending the various formats of learning materials, including:

- Limited capacity working memory affected information processing for the NESB participants in multimedia learning;
- The text only mode can be easily comprehended by NESB participants;
- English language proficiency or difficulties experienced in listening comprehension influenced the NESB participants’ comprehension performance; and
Individual factors may influence NESB participants' comprehension performance.

7.3.1 The influence of the limited capacity of working memory on NESB participants' comprehension performance

The findings of the present study suggest that the comprehension performance of NESB students was effectively facilitated by hypertext with text links (Session 5), which is consistent with prior works by Baddeley (1986, 1992), Berquist (1997), Diao and Sweller (2007) and Chun and Plass (1997).

According to Baddeley (1986, 1992), learners’ capacity of working memory is limited for processing information. Furthermore, similar findings can be found in Chun and Plass (1997), stating that the executive resources used to tackle multimedia information may not be enough when also comprehending a second language. For the second language learners, their available capacity of working memory is more reduced when dealing with information presented in the second language, in comparison with using their first language (Berquist 1997; Diao & Sweller 2007). In the present study, hypertext materials with text links were more easily tackled by the NESB participants due to their reduced availability of cognitive resources when using the other multimedia formats, including hypermedia with image links, hypermedia with audio links, hypermedia with video links and hypermedia with animation links.

7.3.2 The influence of textual information on NESB participants’ comprehension performance

The findings of the present study suggest that the facilitative role of hypertext with text links was more effective than hypermedia with image links (Session 1). Similar findings were indicated by Akbulut (2008) maintaining that the most
useful format used to facilitate NESB students’ comprehension performance was hypertext annotated with textual information in a hypermedia learning environment.

The findings suggested by the present study however, are in opposition to the multimedia principle and the relevant literature claiming that ‘text plus image’ is more effective in improving second language acquisition than ‘text-only’ (Chun & Plass 1996; Jones 2004; Mayer 2001; Yeh & Wang 2003). The difference might be attributed to the medium used to present the experiment-provided learning materials. Reading in a hypermedia system might increase the cognitive load imposed on the students’ working memory, in comparison with reading printed textbooks, because it resulted in a more interactive experience and required resources for navigation control in cyberspace (McEneaney 2003).

In addition, the findings of the present study might be because of the task characteristics. Paas and van Merrienboer (1994) stated that in the learning process, the task characteristics can influence learners’ cognitive load and comprehension performance. Learners’ cognitive load increases when the learning materials get more difficult. In the present study, the learning materials assigned to the NESB participants were in accordance with their educational level in a particular domain, that of professional communication. By contrast, the instructional materials used in the previous studies attempted to facilitate learners’ second language vocabulary acquisition. The different learning content and tasks might influence the students’ cognitive load and further influence their performance in comprehending the given materials.

7.3.3 The influence of textual information on NESB participants’ comprehension performance
The current findings suggest that hypertext with text links (Session 5) could improve NESB students’ comprehension performance more than hypermedia with video links (Session 3). The findings are in line with prior research that concluded that second language learners had a better performance in comprehending textual annotations than in comprehending video annotations in a hypermedia environment (Akbulut 2008). According to Akbulut (2008), learning outcomes in second language acquisition within multimedia environments could be significantly influenced by learners’ preferred learning style due to the various media elements offered. Furthermore, a previous study demonstrated that second language learners could perform better in reading comprehension when they had the opportunity to process the information in their preferred mode(s) (Plass et al. 1998). It is therefore assumed that in the hypermedia environment, NESB students might prefer to process information through text annotation rather than video.

Also, similar statements could be discussed with a reference to the split-attention effect (Ayres & Sweller 2005; Chandler & Sweller 1991; Clark & Mayer 2008; Sweller 1999, 2005; Tarmizi & Sweller 1988). In this regard, the NESB participants might have to split their attention between the main textual reading content and the annotated video resources at the same time in their learning process in order to comprehend the materials, which could lead to cognitive overload in their visual sensory channel and visual working memory.

The split-attention effect may also be used to support the conclusion associated with hypermedia with animation links and hypertext with text links for facilitating NESB students’ comprehension performance in the present study (Ayres & Sweller 2005; Chandler & Sweller 1991; Clark & Mayer 2008; Sweller 1999, 2005; Tarmizi & Sweller 1988). The NESB participants had lower performance under the condition which required them to split their attention between the different types of visual resources (animations and on-screen text).
to ensure content understanding in comparison with the condition which did not need them to split their attention.

Furthermore, text had a more facilitative effective on reinforcing learning than animations, which may be because of the limited amount of available working memory for learners with second language comprehending. Thus, two different visual resources may be restricted in their processing by NESB participants (Berquist 1997; Chun & Plass 1997; Diao & Sweller 2007). Additionally, NESB students might have preferred to look up information presented in the textual format to animations as animations are more difficult to control for pace and order when presenting. On the contrary, text allowed the participants to have control over comprehension at their own pace which could lead to better comprehension performance (Clark & Mayer 2008).

7.3.4 The influence of English language proficiency on NESB participants’ comprehension performance

The findings of the present study suggest that hypertext with text links (Session 5) had a significant effect on facilitating comprehension performance for NESB participants rather than hypermedia with audio links (Session 2). These findings can be discussed with a reference to Graham (2002, 2006), who claimed that listening comprehension is considered more difficult compared with reading comprehension for learners who speak English as a second language.

The current results are further consistent with the findings by Diao and Sweller (2007). They claimed that text mode instruction could significantly enhance second language learners’ performance in passage comprehension and lexical knowledge as opposed to written/spoken mode instruction (Diao & Sweller 2007). The learners’ reduced capacity of working memory in
processing the second language might be a factor (Berquist 1997; Diao & Sweller 2007). Besides, Diao and Sweller (2007) further confirmed that the second language learners tended to rely on text-only more heavily to comprehend the instructional materials. When tasks were more difficult, spoken instructions impaired their information acquisition (Diao & Sweller 2007).

The findings of the present study are also in accordance with the findings of a study revealing that students who learn English as a foreign language are more comfortable to receive visual information over aural, as they experience difficulties in second language listening comprehension (Yeh & Wang 2003). However, the students who participated in Yeh and Wang’s (2003) study were all from Taiwan. In contrast, the NESB students who took part in the present study were from all over the world.

7.3.5 The diversity of performance in comprehending other formats of learning materials for NESB participants

In this section, the discussion will concentrate on the NESB participants’ performance in comprehending the other formats of learning materials, i.e. hypermedia with image links (Session 1), hypermedia with audio links (Session 2), hypermedia with video links (Session 3) and hypermedia with animation links (Session 4). The NESB participants’ learning performance might have been influenced by their preferred learning style, the formats of the learning materials and their English language (L2) proficiency.

Firstly, the current findings suggest that the hypermedia materials with image links (Session 1) were likely to have a better facilitative effect on improving comprehension performance for NESB students than hypermedia materials with audio links (Session 2), which is in line with the previous study conducted
by Plass et al. (1998). They indicated that students who learn English as a foreign language preferred to look up graphic annotations to comprehend learning content rather than audio annotations (Plass et al. 1998). Also, learning style was a reader-driven factor in reading comprehension for the students who learn English as a second language. In comparison with audio, they preferred to process information using image (Plass et al. 1998).

Secondly, in the present study, the findings demonstrate that hypermedia materials with image links (Session 1) and hypermedia materials with video links (Session 3) had no difference in the level of facilitation of NESB participants’ comprehension performance. This is in contrast to a previous study that claimed that picture annotations were more effectively used to facilitate second language acquisition in a follow-up vocabulary test than video annotations (Chun & Plass 1996). Also, the current findings are not in line with another prior study conducted by Akbulut (2008). It revealed that video annotations had a significantly better facilitative effect on L2 reading comprehension than image annotations (Akbulut 2008).

The difference between the findings of the prior studies and the present study might be attributed to the different instructional materials. The materials employed by Chun and Plass (1996) were used to facilitate vocabulary acquisition in second language learning. The materials presented in Akbulut’s (2008) study were in the domain of Teaching English as a Foreign Language (TEFL). However, the learning materials of the present study were all in the discipline of professional communication, which was neither TEFL nor L2 vocabulary acquisition. In this regard, the effectiveness of annotated video in facilitating students’ comprehension performance might be affected by the field of professional communication.
On the other hand in the present study, the findings related to hypermedia with image links (Session 1) and hypermedia with video links (Session 3) are partially maintained in that there was no significant difference between video annotations and graphics annotations used to facilitate second language reading comprehension for the learners who spoke English as a foreign language at intermediate and advanced levels (Ariew & Ercetin 2004) due to their English language proficiency (Ariew & Ercetin 2004). The difficulties in the second language learning influenced the learners’ context-biasedness in learning (Carrell 1988). The findings of the present study might also be explained by differences in learning styles. Plass et.al (1998) proposed that second language learners had better performance in comprehending materials that were presented in their preferred mode(s). Thus, hypermedia with video links (Session 3) might not be the preferred way for the NESB participants in the present study.

Thirdly, the current results suggest that for NESB students, hypermedia with video links (Session 3) is not as useful in promoting learning as compared with hypermedia with audio links (Session 2), which is in contrast to Akbulut’s (2008) findings. The difference might be in the different reading topics and the participants’ learning styles (Brunken et al. 2003; Carrell 1988; Plass et.al 1998) as mentioned above.

The current findings are in line with a study by Coniam (2001) that indicated that there was no significant difference between video and audio modes on facilitating NESB learners’ performance in listening comprehension tests. In comparison with the audio mode, video produced more difficulties for learners as the visual content contained in video clips and on-screen tasks made the learners have to look up and down (Coniam 2001).
Furthermore, the findings of the present study suggest that hypermedia with image links (Session 1) had a more significant effect in enhancing comprehension performance for NESB students rather than hypermedia with animation links (Session 4). These findings are supported by Lin, Chen and Dwyer (2006), who maintained that static picture illustrations were more effective for second language learners in improving their English language understanding and retention than computer-generated animations (Lin, Chen & Dwyer 2006).

In addition, the current findings suggest that the role of hypermedia materials with audio links (Session 2) and hypermedia materials with animation links (Session 4) in facilitating NESB students’ comprehension performance were equal. But in fact, the very same findings have been limited in recent literature to second language learning. The findings of the present study might be attributed to the proficiency of the NESB students’ English language which could have led to the poor use of reading strategies chosen while comprehending materials in the second language, relying on textual information only to aid their comprehension (Carrell 1988). Also, they might not have ‘enough executive resources’ to handle other resources except on-screen text (Chun & Plass 1997). Thus, the difference between NESB students’ performance in comprehending hypermedia with audio links and comprehending hypermedia with animation links was not found.

Finally, the findings of the present study suggest that for NESB students, hypermedia with video links (Session 3) can facilitate their performance in comprehending the given materials more than hypermedia with animation links (Session 4). The similar findings can be discussed with references to Wittwer and Renkl’s (2008) study and Lewis and Barron’s (2009) study. They both demonstrated that animations lack narrated guidance, as compared with video instructions, can lead to inaccurate and incomplete information being produced,
so that learning and comprehension is impaired. As well, according to Lewis and Barron (2009), learners had to create self-explanations while comprehending animation without narrated instructions, which resulted in higher cognitive load imposed on their working memory and lower performance in learning.

To sum up, for NESB participants, the facilitative roles of various formats of learning materials in the present study were different. The findings suggest that the hypertext materials with text links format (Session 5) was the most useful format to significantly improve the students' performance in comprehending the given materials in the professional communication discipline, rather than hypermedia with image links (Session 1), hypermedia with audio links (Session 2), hypermedia with video links (Session 3) or hypermedia with animation links (Session 4).

7.4 Concluding remarks

This chapter has provided a discussion of the key findings of the present study. It is of great importance to fulfil the needs of learners across all different language backgrounds in order to facilitate their reading comprehension of learning materials in an authentic multimedia learning environment successfully. However, the design principles of multimedia learning in a hypermedia environment to meet the needs of students across different language backgrounds have not been established yet.

Also, in the recent literature, many research studies or relevant theories related to multimedia learning have been based on printed illustrations or textbooks. In addition, the experimental materials used to measure learners’ performance in multimedia learning were short and simple, and the learners were presented with animation-accompanying-narration-type instructions.
Furthermore, comparative analysis indicating differences between ESB and NESB students in multimedia learning has been limited. Moreover, some studies employed a qualitative approach to show the preferred learning styles to process information. From a different aspect, in first language hypermedia reading, the focus of the existing literature was heavily on reading comprehension strategies. Additionally, the influence of language proficiency on comprehending instructional materials has not been taken into account frequently in multimedia learning, in particular for second language learners. A previous study investigated the effectiveness of various types of annotations on facilitating second language hypermedia reading comprehension. The study focused on learning styles solely (Akbulut 2008). However, learning is a complex process which can be influenced by numerous factors and might not be significantly influenced by any one factor alone (Kolb 1984, cited in Scott 2010; Maki 2010)

In order to fill in these gaps, firstly, the present study attempted to measure the performance between ESB and NESB students in comprehending various formats of materials. Their performance was determined by the accuracy of their answers to comprehension questions.

Secondly, the present study employed a hypermedia system as the medium to present the learning contexts, which were hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links. In comparison with the prior studies in the field of multimedia learning, the participants who took part in the present study had a longer experiment (i.e. five one-hour training sessions on a weekly basis) and had academic learning materials reinforcing their subject knowledge in the domain of professional communication at undergraduate level.
Thirdly, the findings of the present study consisted of two different components: the main factors which could influence ESB students’ performance in comprehending various formats of learning materials; and the main factors which could affect NESB students’ comprehension performance in interacting with different formats of learning materials. The current results parallel some of the previous findings, but contradict others. Thus, this chapter has compared and contrasted the present study with previous ones.

In addition, the current findings proved that not all given formats of learning materials could facilitate the two groups’ comprehension performance. To be more specific, in the present study, the ESB students’ comprehension performance was facilitated by hypermedia materials with audio links. Conclusions of previous studies have confirmed that multimedia information presented in dual-modality (visual plus auditory stimuli) is able to improve learners’ performance in comprehending multimedia learning materials, but those were mostly presented with animation accompanied by narration.

The present study on the other hand indicated that NESB students’ performance in comprehending the given learning materials was effectively facilitated the most by hypertext materials with text links. English language proficiency was taken into consideration when examining the factors that might influence the comprehension performance of the participants who come from non-English speaking backgrounds. Based on the current findings, the following chapter will recommend a design approach aiming at effective delivery of instructional materials to fulfil the different needs of ESB and NESB students and to facilitate their comprehension performance.
Chapter 8
Design and delivery of instructional materials

In this chapter, the design approach will be provided which was used to effectively deliver the learning materials which were used to instruct the students from different language backgrounds. The design approach was developed from the empirical findings of the present study and consists of two components: the design of the instructional materials and the delivery of the instructional materials, which will be elaborated in Section 8.1 and Section 8.2.

Specifically, this chapter will be divided into two main sections:

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8.1 The overview of instructional materials design

In the present study, the instructional materials were prepared to investigate the effectiveness of the various formats of learning materials on facilitating ESB and NESB participants’ comprehension performance. In other words, they were used to evaluate the most effective one(s) to facilitate the performance of each group of participants in comprehending the experimental learning materials. From reviewing the relevant literature, several issues were taken into consideration while designing which were regarded as the guidelines to effectively design learning materials for educational and instructional purposes. The guidelines were as follows:

- The goals and objectives of the instructional materials;
- The formats of the instructional materials design;
• The interface design of the instructional materials;
• The content design of the instructional materials;
• The design of the comprehension tasks; and
• The participants' prior knowledge.

8.1.1 The goals and objectives of the instructional materials

The pedagogical goals and objectives of the instructional materials are essential elements while designing (Gagne et al. 2005). The goals and objectives must be clarified in order to ensure specific and measurable outcomes (Gagne et al. 2005).

In the present study, firstly the goals and objectives of the instructional materials were to investigate the effectiveness of various formats of learning materials on enhancing ESB and NESB participants’ comprehension performance. Thus, there were five different formats of learning materials used to measure participants' performance in comprehending the given instructional content in the professional communication context.

Secondly, in the present study, the goals and objectives of the instructional materials were to reach a wide body of participants and engage them in a convenient and interactive learning environment. Thus, the instructional materials were integrated with the Internet and computer technologies in order to ensure that a large number of participants were able to have the interactive experiences and access the content from any location.

In considering the volume of multimedia content (including text, image, audio, video and animation) and web browsing now available, hypermedia should be made available to participants. Thus, the learning materials employed in the present study were presented through a well-designed hypermedia system.
and presented in five different formats, which were hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links. The detailed information about the various formats of the experimental learning materials was presented in Chapter 5, Section 5.7.1.

Thirdly, the goals and objectives of the instructional materials in the present study were used to supplement the participants’ comprehension performance and their knowledge acquisition in the domain of professional communication. According to Kalyuga et al. (2003) and McNamara et al. (1996), the topics and concepts involved in the instructional materials should be chosen from the mainstream context in order to help them to achieve better comprehension. In this regard, the topics of the set learning materials in the present study were selected from the professional communication subjects and were in accordance with the lecture topics.

Finally, the goals and objectives of the instructional materials in the present study were to measure the sub group differences between ESB and NESB participants, aiming at finding the most effective materials to facilitate the different groups of participants’ comprehension performance in an authentic learning environment. The results will contribute to fulfilling participants’ different needs and will lead to increased comprehension performance. Thus, the five media elements employed in the instructional materials, including text, image, audio, video and animation shared common formats and widely applied to teaching and learning. Also, the effects of these media elements on learning have been frequently investigated in prior research studies in multimedia environments. The media elements played different roles in improving learners’ comprehension performance which was mentioned previously in the present study in Chapter 2, Chapter 3 and Chapter 4.
As the above information has presented, the goals and objectives of the instructional materials should necessarily be considered by instructional designers in order to effectively determine the general design approach and the main factors to be employed. The present study has confirmed that ESB and NESB participants’ comprehension performance was significantly facilitated by different formats of learning materials. As a result, the formats of instructions should be carefully chosen by designers. The following section will present some suggestions about the formats used to present instructional materials and how these can fulfil the different needs of ESB and NESB students.

8.1.2 The formats of instructional materials design

According to Crichton and Kopp (2006, p.4), the instructional materials of multimedia learning are ‘those that integrate media objects such as text, graphics, video, animation, and sound to represent and convey information which have the potential to connect key learning objectives in a prescribed curriculum to real world contexts, integrate diverse curriculum areas, support student decision-making, and foster authentic collaboration’. Thus, choosing the right format for materials design is another important issue for designers of instructional materials.

It has been confirmed that the ESB participants showed maximum performance in comprehending hypermedia materials with audio links which differed from the NESB participants who preferred to comprehend the given learning materials through hypertext with text links. In this sense, the influence of the various formats of learning materials was different for enhancing the comprehension performance of students who come from different language backgrounds. In the following sections, the suggestions relevant to instruction formats design will be presented. Furthermore, as the instructional learning
contexts were delivered through a hypermedia system in the present study, the design principles of hypermedia will be a particular focus. Thus, the following sections will be divided into two parts to suggest the format design of multimedia resources and hypermedia/hypertext resources.

8.1.2.1 Multimedia formats design

As Norman (1988) stated, each media format has ‘affordances’ and ‘constraints’, which may affect learners’ achievements. In other words, different media representations have different roles in facilitating learning. Therefore, multimedia is a cognitive tool which may have a significant influence on learning. However, many multimedia or e-learning programs have not taken human cognitive processes into account in their design (Clark & Mayer 2008; Mayer 2011; von Brevern 2004). Thus, some prior studies and the relevant cognitive theories should be taken into account when designing multimedia learning instructions for educational purposes (Clark & Mayer 2008). In the present study, the influence of the learning materials’ format, the participants’ cognitive load and their language proficiency were all considered when measuring the participants’ performance in comprehending the given learning materials.

Regarding the instructional materials, when designing the instructional formats in a hypermedia world, some relevant theories of multimedia learning have been frequently taken as frameworks (Akbulut 2008). In the present study, Baddeley’s dual-channel assumption (discussed in Section 3.2.1), the limited capacity of working memory (refer to Section 3.2.2 and Section 3.2.5.2), Cognitive Load Theory (CLT) (refer to Section 3.2.5) and Mayer’s cognitive theory of multimedia learning (presented in Section 3.2.10) were all considered as a basis for the design of the materials.
Multimedia materials may be separately processed by the visual channel (eyes) and the auditory channel (ears) at the same time. In this regard, dual-mode multimedia information can effectively engage learners’ different sensory channels to process multiple sources of information and further improve their performance in comprehending the materials (Akbulut 2008; Mayer 2009).

Thus, appropriate multimedia formats should be used in order to facilitate participants’ comprehension performance (Clark & Mayer 2008). The findings of the prior studies and the present study indicate that dual-modality formats of multimedia learning materials which are concurrently presented with visual and auditory stimuli can effectively improve learners’ learning performance in authentic multimedia environments. In this process, the multimedia resources are simultaneously presented to both of the learners’ sensory channels, eyes and ears (Mayer 2009). Therefore, in the present study, the most effective format used to facilitate ESB participants’ information acquisition and their performance in comprehending the content in the field of professional communication was presented as on-screen text incorporated with audio. Associated with hypermedia contexts, the format of most use to enhance performance in comprehending the materials on the given topic was hypermedia with audio links.

However, while the dual-modality multimedia learning materials may be more effective for improving comprehension performance for ESB learners (Clark & Mayer 2008), both the previous research and the present study indicated that the participants from different language backgrounds preferred to process learning information through a different mode. Thus, participants from different language backgrounds, namely the ESB and NESB participants, should be instructed differently by using different formats of learning materials to facilitate their comprehension performance (Carstairs et al. 2006; Ramburuth & McCormick 2001).
In the present study, the NESB learners experienced more difficulty in comprehending learning content via audio-related mode(s) compared to the ESB individuals (Carstairs et al. 2006; Ramburuth & McCormick 2001). Thus, to educate second language learners, instructions different to those for ESB participants need to be applied which aim at interpreting the content and getting learners accustomed to the learning experiences (Clark & Mayer 2008). It was confirmed that multimedia instructional learning materials were not beneficial for NESB learners. They were usually unable to get control over the learning contexts presented with multiple resources since the size of their available working memory to comprehend materials in the second language was reduced (Chun & Plass 1997).

In order to distribute learning contexts widely and make them easily accessed by learners, instructional materials should be integrated with the Internet (Holmes & Gardner 2006). In the present study, hypermedia contexts were used as the medium to present the instructional materials. Thus, the relevant influence of learning in a hypermedia world should be taken into consideration as well when designing instructional materials in order to enhance teaching and learning (Dillon & Jobst 2005).

In the present study, the experimental materials were presented in hypermedia formats with different media links, including images, audio, video, animations and text (Dillon & Jobst 2005). As hypermedia is associated with on-screen text with various media links, it is multimedia in nature (Dillon & Jobst 2005). Thus, the design of the instructional materials should take into account both the relevant multimedia design principles and hypertext design principles (Akbulut 2008).

In comparison with traditional print-based reading text, hypermedia contexts bring a more interactive experience to learners which may place more
cognitive demands on them when they are processing information (Dillon & Jobst 2005; McEneaney 2003). In second language reading comprehension, it was suggested that hypermedia was potentially useful as it made learning materials become more comprehensible when supplemented with various glossaries (Davis 1989; Martinez-Lage 1997; Roby 1999).

In fact, hypermedia is an extension of hypertext, so it can be structured based on existing theories and principles of hypertext (Jonassen 1989; Walker 2010). The following section will focus on the design principles of hypertext structures.

8.1.2.2 The hypertext structures design

Hypertexts can be presented with three ways, namely: linear structure, hierarchical structure and referential structure. Linear structure and hierarchical structures are recommended when structuring hyper-documents for educational and instructional purposes (Lawdow 2006; Oliver & Herrington 1995). The present study employed linearly structured hypertexts only. The reasons for selecting the linear structure are as follows:

- Linearly structured hypertexts provide a pre-determined reading sequence so that learners are not required to navigate through hypertext reading (Oliver & Herrington 1995). In this sense, learners do not experience disorientation in the processes of reading and comprehending the instructional hypertexts; and

- Linearly structured hypertexts exclude navigational activities. Thus, they produce lower extraneous cognitive load on participants’ working memory than hierarchically structured hypertexts (van Merrienboer & Sweller 2005; Sweller, van Merrienboer & Paas 1998)
Furthermore, multimedia resources employed in the present study sometimes placed a high cognitive load on learners which could influence the learners’ comprehension performance (Chun & Plass 1997). In this sense, the linearly structured hypertext was kept simple and explicit for the learners (Koneman & Jonassen 1994).

The number of hyperlinks contained in each set of material remained the same for each reading session. There were five links in each set. The first reading session was presented with hypermedia material with image links, so the learners obtained information through hypertext reading contexts and detailed explanations presented by pictorial information. The instructional material for session 2 was presented by hypermedia with audio links. Thus, learners could acquire information from the on-screen text and aural clips. Session 3 was presented using hypermedia material with video links, session 4 employed hypermedia material with animation links and session 5 was presented using hypertext material with five text links. According to Brunken, Plass and Leutner (2003), the conditions given should be similar when measuring the learners’ comprehension performance and the facilitative role of various presentation formats in multimedia learning.

To sum up, the instructional design for multimedia learning programs should be incorporated into mainstream subjects, aiming at reinforcing knowledge acquisition on a particular domain. Also, the instructional design for multimedia learning programs should be carefully planned in order to meet the different needs of learners who come from various language backgrounds. Hypermedia material with audio links is the most effective format to instruct ESB participants in comprehending learning content in the discipline of professional communication, while NESB students’ performance in comprehending the learning information in the field of communication was more effectively facilitated by hypertext material with text links. So ESB students should be
presented with audio-related materials in order to improve their comprehension performance and by contrast, NESB students should be presented with visual resources over auditory ones to aid in second language comprehension (Ramburuth & McCormick 2001; Reid 1987; Volet & Ward 2006). In this regard, auditory mode(s) materials should be avoided when instructing NESB learners in order to enhance their performance in comprehending second language learning materials.

The relevant literature showed that the interface design of hypermedia contexts could affect the learners' information processes as well (Bose & Sammons 2009; Hemard 1997). Some suggestions relevant to hypermedia interface design will be presented in the following section.

8.1.3 The interface design of the instructional materials

Principles of interface design for hypermedia contexts were suggested by Hermard (1997). This study stated that core information should be presented simply and clearly in order to minimise learners' disorientation during the reading process. In addition, Jonassen (1986) proposed that a good hypertext version should have a map displayed on the starting web page which briefly introduces the main content included and attempts to directly and effectively navigate readers to interact with the hypertext contexts.

Furthermore, according to Hermard (1997), graphic overviews should be used and placed on the right hand side of the screen. Any inappropriate setting of the interface may reduce learners' performance in comprehending the hypertext reading contexts on a given topic, in particular for individuals who have low levels of prior knowledge of the domain (Hermard 1997).
Moreover, according to the relevant theories, the interface layout of hypertext contexts should be clearly presented with appropriate background colours, fonts and spaces. Inappropriate interface layout may increase the extraneous cognitive load imposed on learners’ working memory (Waniek & Schafer 2009).

In the present study, the designer took all the above mentioned suggestions into account when designing the hypermedia contexts interface. The interface layout of the experimental materials is shown in Figure 8.1.

**Figure 8.1 The interface layout of the hypermedia contexts in the present study**

The background colours and font colours of the interface layout should be considered as well, and mismatched colours should be avoided (Hemard 1997). If the background colours and font are mismatched, reading difficulties may occur in comprehending (Hemard 1997). It is suggested that the background colour and font colour should be presented in contrasting colours rather than extremely closely matched colours, such as green and yellow.
(Hemard 1997; Tindale 2005a, 2005b). In the present study, the font colour of the hypermedia contexts was mainly black and the background colour was white. Some headings or titles were presented in white against a dark coloured background. Those were presented appropriately as shown in Figure 8.1.

As the relevant design principles instructed, Arial (or another slab-serif or sans-serif font) is the best choice for font when designing instructional hypermedia materials for educational and instructional purposes (Hemard 1997). The line spacing should be 1.5 with a mixture of upper and lower case letters. The font size used in the main textual content and nodes should be medium, and the font size of titles and headings should be large (Hemard 1997). The words presented in the hypertext content should be left-justified. As Figure 8.1 showed above, in the present study, Arial font was selected to present the instructional on-screen text with 1.5 spacing and left-justified text.

Besides this, the influence of the content of the instructional materials should be taken into consideration as well. The following section will briefly discuss several issues which should be considered by designers to possibly avoid cognitive overload being imposed on students' working memory.

8.1.4 The content design of the instructional materials

The content of the instructional materials is another element that should be considered as learning performance may be influenced by the learning materials, such as the level of difficulty, which in turn may lead to intrinsic and extraneous cognitive load being imposed on learners' working memory (Brunken, Plass & Leutner 2003). Firstly, learning content should ensure its accuracy and appropriateness before being presented to participants (McPherson & Nunes 2006a). In the present study, all the instructional materials were selected from reputable and refereed textbooks and
educational resources. The content was further reviewed by the subject convener of Professional Communication Practice who was the subject-matter expert in this area (McPherson & Nunes 2006a).

Secondly, the language used to present the instructional materials should be carefully considered as well as the language may influence learners' performance in comprehending the instructional content (Ivey & Fisher 2006; Schnottz & Kurschner 2007). Therefore, the language used should be in accordance with the education levels of the learners (Ivey & Fisher 2006; Schnottz & Kurschner 2007). Furthermore, a readability test should be used to measure the Flesch-Kincaid Grade Level of the learning content in order to ensure that the instructional content can be fully understood by learners (Ivey & Fisher 2006). Cognitive Load Theory indicated that extraneous load can be increased by long and complex texts (Schnottz & Kurschner 2007). Thus, when organising the instructional content, the length and level of difficulty of the learning materials should be carefully considered.

In the present study, the participants were undertaking undergraduate educational programs and the language of the instructional content matched the participants' level of education. The scores of the Flesch-Kincaid Grade Level of instructional content presented in the five sessions were approximately between Grade 11 and 12. Additionally, the length of each session's text was not very long or complex. The average length of the text was approximately 1,250 words.

However, the English language used to present the instructional content for NESB students should be carefully considered (Schnottz & Kurschner 2007). As they may experience more difficulties in comprehending instructional materials presented in English compared to ESB participants, plain English was used to ensure that all information was fully able to be understood by the
NESB participants (Schnotz & Kurschner 2007).

The data of the present study was quantitative, obtained from the answers to the comprehension questions from the two sample groups. In order to effectively measure the participants’ performance in comprehending the given instructional materials, the design of the comprehension tasks was also important, which will be discussed in Section 8.1.5.

8.1.5 The design of the comprehension tasks

A proper design of comprehension tasks is necessary to fulfil the goals and objectives of instructional materials (Protopsaltis & Bouki 2005). The comprehension questions can be used to measure the learners’ mental representations and general performance in comprehending the instructional materials (Schank, Collins & Hunter 1986; Schnotz & Kurschner 2007).

According to the different levels of comprehension, including literal, inferential and critical as proposed by Clymer (1968), different types of questions should be designed in accordance with these levels of comprehension in order to measure the participants’ comprehension performance. These types of comprehension tasks were applicable in prior research when the intent was to measure participants’ overall performance in comprehending hypertexts. The three types of comprehension tasks employed in Verezub and Wang’s (2008) study were literal, inferential and critical when that study attempted to explore the influence of metacognitive strategy training on participants’ comprehension performance in hypertext reading.

In the present study, there were also three types of comprehension questions provided. They were literal, inferential and critical questions in order to evaluate the participants’ performance in comprehending the
experiment-provided instructional materials (for the details refer to Section 5.8.4). The literal questions accessed the surface meaning of the learning contexts and the answers could be found in the text explicitly. The answers to the inferential questions could not be found explicitly in the text. The participants were required to draw on their prior knowledge and to make inferences which were based on the information stated in the text combined with their deep understanding of the text to give the answers. In order to provide the answers to the critical questions, the participants were required to apply their prior knowledge to the given topics and to refer to their past experience. Also, the participants were required to analyse and evaluate the information in the text.

In addition, the questions were worded clearly to ensure that participants were able to fully understand them. Furthermore, these questions were printed out as hard copies for the learners to write down the answers which minimised the impact of learners’ typing skills on answering questions (Sanchez-Alonso & Vovides 2007). In the present study, the comprehension questions within each session were printed on A4 paper with sufficient space for students to write their answers. During the process of learning, the influence of unexpected technical errors should also be avoided.

According to Schank, Collins and Hunter (1986) and Schnottz and Kurschner (2007), questions should be designed consistent with participants’ prior knowledge on the given topics as learning performance can be affected by participants’ previous knowledge and experience. On the other hand, the rate or accuracy of answers is closely connected with learners’ prior knowledge (Schank, Collins & Hunter 1986). Thus, the factor of participants’ prior knowledge should be taken into account by designers, which will be elaborated in Section 8.1.6.
8.1.6 The participants’ prior knowledge

When designing a multimedia learning program, the learners’ prior knowledge should be taken into account by designers. According to Waniek and Schafer (2009), there are two components included in participants’ prior knowledge, which are domain prior knowledge and system prior knowledge. Domain prior knowledge refers to learners’ existing knowledge of the instructional materials in a particular domain (Waniek & Schafer 2009). As Schnotz and Kurschner (2007) indicated, extraneous cognitive load would be imposed on learners’ working memory if the given instructional content goes beyond their prior knowledge on that domain. In this regard, the participants’ prior knowledge in the present study was based on the professional communication discipline. The participants who took part in the present study were enrolled in Professional Communication Practice (LPR100) and the instructional content was selected in this area according to the weekly lecture topics.

System knowledge refers to the readers’ knowledge related to computer systems manipulation, which is general computer experience, and the particular experience of using hypertext and the Internet (Mitchell, Chen & Macredie 2005b). Nowadays, computers and Internet accessed technologies are widely available. Students are familiar with computers and Internet manipulation. The students who were born in or after 1990 are referred to as the Net Generation by some researchers, as computers and the Internet have become the essential parts of their study and life (Jones et al. 2010). The participants’ system knowledge in the present study is their knowledge of the hypermedia system used to present the experimental contexts. The contexts were presented with linearly structured hypertexts which were simple and clear to navigate and were controlled by the participants. Moreover, a brief instruction about how to manipulate the hypermedia system was provided to participants in each reading session in order to avoid any confusion while they
were interacting with the hypermedia learning contexts (Fastrez 2002; Galindo 2002, cited in Gómez, López & Marin 2011; Shen & Liu 2011).

8.2 The delivery of the instructional materials

The delivery of the instructional materials is another key element that should be considered by designers. According to Acha (2009), computer-based multimedia learning programs have provided a great support to participants, allowing them to interact with different types of resources, including words, images, audio and video, at their own pace. Also, computer-based multimedia resources could significantly affect learners’ preferences to process the content and their perception of the quality of the content (Chen, Ghinea & Macredie 2006). As Gill et al. (2012) found, computer-based multimedia materials could positively engage Chinese international students when learning in the domain of professional communication. The goals and objectives of the present study were to supplement the participants’ knowledge acquisition in the field of professional communication so it was recommended that computers should be employed to present the instructional materials. Additionally, in order to widely deliver the instructional materials and help a broader body of learners to access instructional materials without any limitation on locations, the Internet should be employed.

Also, participants should be given instructions on a weekly basis, attempting to effectively reinforce their knowledge acquisition on a particular subject (Farmer, Yue & Brooks 2007). It is important to revise the instructional materials given in each learning session before it commences, in order to make sure the instructional content is logical and effective (Kalyuga et al. 2003; McNamara et al. 1996; Shen & Liu 2011).
Finally, face-to-face instructions should be employed during the process of instructing students in order to provide appropriate and immediate answers to readers’ questions raised in the learning process whenever they have them (Fastrez 2002; Galindo 2002, cited in Gómez, López & Marin 2011; Shen & Liu 2011). A face-to-face instruction mode was offered in the present study which also encouraged the participants to learn actively and generate questions corresponding to the instructional contexts. Besides this, the participants were told that they were welcome to raise questions whenever they felt confused, in line with the study conducted by Galindo (2002, cited in Gómez, López & Marin 2011).

8.3 Concluding remarks

This chapter has provided some suggestions for instructional materials design and delivery based on the empirical research findings of the present study and the prior research in order to effectively instruct a large number of learners who come from English speaking backgrounds and non-English speaking backgrounds.

Initially, this chapter gave an overview of the instructional materials design. It was suggested that the general design approach should be based on the goals and objectives of the instructional materials. Firstly, in the present study, the instructional materials were used to examine the influences of various formats of learning materials on ESB and NESB participants’ comprehension performance. Thus, there were five different formats of learning materials provided. Secondly, in order to reach a broader body of participants, the instructional materials were associated with hypermedia contexts. Thirdly, the goals and objectives of the instructional materials were to reinforce the participants’ knowledge acquisition in the domain of professional communication so the concepts and topics were selected in this area. Finally,
there were five different formats of learning materials employed, which were hypermedia materials with image links, hypermedia materials with audio links, hypermedia materials with video links, hypermedia materials with animation links and hypertext materials with text links.

In the present study, the hypermedia context was the medium used to present the multimedia instructional materials. Based on the findings of prior research and the present study, it is suggested that linearly structured hypertexts should be employed to present multimedia learning materials in order to reduce the intrinsic and extraneous cognitive load imposed on learners’ working memory. According to the findings of the present study, the most effective format used to satisfy ESB participants is hypermedia materials with audio links, while the most facilitative format used to instruct NESB participants is hypertext materials with text links.

It was also suggested that comprehension tasks should be carefully designed in order to fulfill the goals and objectives of the instructional materials and should be consistent with the education level of the participants. There were three types of questions employed, including literal, inferential and critical questions, attempting to measure the participants’ performance in comprehending the given instructional materials on the given topics in professional communication. In addition, it was suggested that the learners’ prior knowledge should be considered in order to effectively diminish the extraneous cognitive load raised during the process of learning.

It is suggested that delivery issues should be considered by designers as well. According to the findings of the present study, computers and Internet technologies should be employed, with materials which contain multiple media elements, in order to effectively instruct a large number of participants. Furthermore, it is suggested that the instructional materials should be given on
a weekly basis in order to reinforce the participants’ knowledge acquisition in accordance with the lecture topics. Moreover, the instructional content should be revised to make sure the information is logical and effective. Finally, it is suggested that a face-to-face instructional approach should be employed when participants are processing the instructional materials in order to answer students’ questions whenever necessary.

The practical design and instructional approach discussed in this chapter was mainly based on the findings of the present study. The following chapter will provide the conclusion, recommendations and limitations of the present study, as well as suggestions for possible future work.
Chapter 9
Conclusions, recommendations, limitations and future work

The present study has extensively presented the aims, hypotheses, research methodology, results, discussion and design approach. This chapter finalises the study, presenting the conclusions, recommendations, limitations and possible work for future research.

This chapter is divided into four sections as follows:

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9.1 Conclusions

The aim of the present study was to explore the influences of various formats of learning materials on ESB and NESB participants’ comprehension performance using hypermedia with image links, hypermedia with audio links, hypermedia with video links, hypermedia with animation links and hypertext with text links. It further compared the performance between the two sample groups in comprehending each format of learning materials. The present study also compared the performance within each sample group in comprehending the various formats of learning materials. The findings conclusively support the stated hypotheses of the present study, indicating that:

- Not all formats of learning materials could facilitate participants’ comprehension performance equally;
• A significant difference between ESB and NESB participants’ performance in comprehending the given learning materials was produced by hypermedia materials with audio links;
• ESB participants’ comprehension performance could be the most effectively facilitated by hypermedia materials with audio links; and
• NESB participants’ comprehension performance could be maximised by hypertext materials with text links.

The current findings were in line with prior conclusions which were made by a number of research studies and relevant theories in literature. The contribution of the present study is presented below.

9.1.1 The contribution of the present study

The findings of the present study indicated that in authentic learning environments, ESB and NESB participants’ comprehension performance was significantly improved by different formats of learning materials. In fact, the sub group differences between ESB and NESB participants were demonstrated by a number of prior Australian studies, including Ramburuth and McCormick’s (2001) study and Carstairs et al.’s (2006) study. However, the arguments in Ramburuth and McCormick (2001) were made based on their research methodology. The data in Ramburuth and McCormick’s study was collected from a questionnaire survey which provided qualitative data. The present study employed a quantitative research methodology and all data was from participants’ answers to comprehension tasks. Thus, in the present study, the performance was measured by the participants’ scores obtained in comprehending the various formats of the given materials. In this regard, the present study has stated meaningful quantitative findings that contribute to understanding the comprehension performance diversity between ESB and NESB students.
The findings of the present study filled the gaps by identifying the diversity of performance between ESB and NESB undergraduate students in comprehending various formats of learning materials. Also, according to the current findings, the instructional materials presented to ESB and NESB participants should be different in order to meet their different needs and facilitate their performance in comprehending the given materials. The study further provided the most effective structure(s) used to facilitate ESB and NESB participants.

Moreover, the majority of studies on multimedia learning were conducted in the 1990s, thus the comprehension materials were print-based. In comparison with print-based materials, learning in a hypermedia system increases learners’ cognitive load due to more interactivity elements and navigation control in cyberspace which was confirmed by several studies, such as Astleitner and Leutner (1996), McEneaney (2003), Dillon and Jobst (2005) and Akbulut (2008). In the present study, a hypermedia system was employed as the medium to present the learning materials so the current findings have also contributed practical evidence for hypermedia learning.

Finally, the findings of the present study contributed to reinforcing the participants’ knowledge acquisition in the domain of professional communication. The instructional materials of the present study incorporated the information in this area.

In general, the present study confirmed the previous findings and contributed to the understanding of diverse cognitive rationales between ESB and NESB participants in the process of multimedia learning. It provided practical evidences that indicated the importance of cognitive activities in the process of multimedia learning for students who come from English speaking backgrounds and non-English speaking backgrounds. In addition, the study
suggested the most effective formats of learning materials to use to instruct students across different language backgrounds for instructional and educational purposes in order to maximise their potential for academic success.

9.2 Recommendations

In this section, some recommendations will be provided which are proposed based on the empirical findings of this study in order to meet the needs of learners who come from English speaking backgrounds (ESB) and non-English speaking backgrounds (NESB).

In general, instructional materials which contain multiple media resources should be carefully designed in order to fulfil the different needs of ESB and NESB participants. There are arrays of suggestions provided as follows:

- Dual-modality presentation formats should be applied to multimedia learning materials design in order to facilitate ESB learners’ comprehension performance; and
- Text-only formats should be used to instruct NESB learners.

With regard to hypermedia contexts, the study recommends that:

- Hypermedia materials with audio links are the most effective format to improve ESB individuals’ comprehension performance; and
- Materials which are presented as hypertext with text links should be employed to instruct NESB learners.

The present study has some limitations. They are discussed in the following section.
9.3 Limitations of the present study

Several limitations need to be acknowledged in the present study, for instance the participant variables, the instructional approaches and the disciplinary approaches. The following sections will elaborate on the limitations of the study.

9.3.1 The limitations of participant variables in the present study

The investigations of the present study relied on group-based rather than individual-based qualities. Due to the limited sample size, the investigation on ESB and/or NESB groups tended to combine the individuals from the various geographic locations, such as India, the Philippines and China, as a single homogeneous ethnic group – NESB - which might assume that all the participants who came from non-English speaking backgrounds shared common characteristics in all circumstances. The differences within either the ESB or NESB group were considered nuisance variables, which did not form part of the study. Perhaps the participants from one language background may have some things in common, but differences in terms of ethnicity, culture, language, religion, race, etc. still exist, which might influence their performance in comprehending the given materials (Laanan & Starobin 2004; Yoon & Portman 2004).

In addition, gender and age variables were not taken into consideration in the present study. According to prior research outcomes, female participants performed differently from males in some conditions (Soldan & Bowyer 2009). Younger individuals (<21 years) performed better than individuals who were older than 21 in some conditions (Volet & Ward 2006). Thus, works in this area should be further investigated in order to possibly help the designers to understand the sub group differences between targeted individuals to ensure...
the effectiveness of instructional materials.

9.3.2 The limitations of the disciplinary approach

In the present study, all participants who took part in the present study were students who were enrolled in the unit of Professional Communication Practice (LPR100) and the content of the instructional materials was developed upon the knowledge relevant to this domain, using it to reinforce the students’ knowledge acquisition in this discipline. In this regard, the findings of the present study might have set limitations for this area. Thus, the practical findings of this study should be applied to other disciplines in future, aiming at eliminating the boundary of a single field.

9.3.3 The limitations of the instructional approach used in the present study

A traditional face-to-face instructional approach was included in the present study in order to maintain the students’ participation and provide instant assistance whenever necessary. The instructions ensured the effective delivery of the experimental program. However, the face-to-face instructional approach might produce critical issues when testing the validity of the current findings in the e-learning environment as there is no opportunity provided for teachers and e-learners to experience face-to-face interaction.

Overall several limitations were considered in the present study. The focus of the present study is on the participant’s language backgrounds, the influences of other nuisance variables, such as cultural factors, gender and age, were not taken into account. Also, the explorations of the present study were limited to the discipline of professional communication and a traditional face-to-face instructional approach was employed to deliver the experimental program which might be critical in assessing the validity of the current findings for
e-learning environments.

The above limitations of the present study have a number of important implications for future studies. The following section presents some possible future investigations.

9.4 Future work

This section will suggest some possible topics for future investigations. In particular, they will be from the perspectives of:

- Investigating the influence of other variables of ESB and NESB individuals on learning with multimedia;
- Measuring the facilitative role of the most effective formats for ESB and NESB individuals in interdisciplinary cases; and
- Enabling the effective formats to successfully instruct a broader body of ESB and NESB individuals with the support of advanced educational technologies.

These possibilities are elaborated on below.

9.4.1 Investigating the influences of other variables of ESB and NESB learners on learning with multimedia

As mentioned in Section 9.3.1, the influences of other individual factors of participants, such as their gender, age and cultural backgrounds, could possibly affect the participants’ performance in comprehending the various formats of learning materials. Prior studies proved that individuals’ comprehension performance could be influenced by some individual factors. Also, the personalisation principle of multimedia learning suggests that
personal differences should be taken into consideration when designing multimedia instructional learning materials. For instance, learners’ cognitive styles have been explored in a considerable number of studies in recent literature. Some studies proved cognitive styles could determine learners’ personalities, preferred way(s) to process information and could further influence their performance in comprehending the given contexts (Gardner, Jewler & Barefoot 2007; John & Boucouvalas, cited in Strehler 2008; Paas, van Merrienboer & Adam 1994; Riding 2003, 2005a, 2005b). However, some studies did not find a significant difference between various cognitive styles on learners’ comprehension performance (Chen, Ghinea & Macredie 2006; Parkinson & Redmond 2002). Thus, more investigation should be conducted in order to evaluate the influence of other individual factors on ESB and that NESB learners’ performance in comprehending learning materials to ensure successful teaching and learning.

9.4.2 Measuring the facilitative role of the most effective formats for ESB and NESB individuals in interdisciplinary cases

The present study confirmed that there was a diversity of performance between ESB and NESB participants in comprehending various formats of learning materials and further proved that hypermedia materials with audio links could the most effectively facilitate ESB learners’ comprehension performance while NESB learners’ comprehension performance was the most effectively facilitated by hypertext materials with text links.

However, the given learning materials and comprehension tasks were developed based on a particular unit - Professional Communication Practice (LPR 100) in order to supplement the knowledge acquisition of the participants who were enrolled in this subject. In order to ensure the validity of the current findings, the effective instructional formats should be applied to these learning
contexts based on various disciplines other than professional communication. The unknowability in other disciplines may provide a glimpse of potential benefits of the effective instructional formats for instructing ESB and NESB individuals beyond the boundary of one domain.

9.4.3 Enabling effective instructions to be delivered to a broader body

In order to ensure that the effective learning contexts can be reached by a large number of ESB and NESB learners, the materials presented with the effective formats are expected to be applied in the e-learning environments. E-learning programs enable learners to connect with the Web and get access to the learning materials via computers or mobile devices. In the future, it is possible to incorporate these effective instruction formats in e-learning provision in order to effectively instruct a large number of ESB and NESB students and to maximise their potential in comprehending the learning materials in various disciplines. However, as mentioned in Section 9.3.3, there could be a critical issue raised by the conventional face-to-face instruction used in the present study, thus, a substantial amount of work would be required by designers for planning, designing and delivering the instructional materials in an e-learning community.
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Appendix I The evidence of ethic clearance

To: Dr E Verezub; Miss Xinyang Wang
CC: Dr Sharon Grant REA PHEL

Dear Dr Verezub and Miss Wang,

SUEHREC Project 2010/163 A comparative analysis of performance and cognition in multimedia learning between English speaking background (ESB) and non-English speaking background (NESB) students in higher education

Dr E Verezub; Miss Xinyang Wang; Dr Rob Gill

Approved duration 09/06/2010 To 09/07/2011

I refer to your modification request submitted by the way of an annual report of the 15 December 2010 and email of the 30 March 2011 in which you requested an update of the student status from Masters to PhD level.

I am pleased to advise that, as submitted to date, the further modified project/protocol may continue in line with standard ethics clearance conditions previously communicated and reprinted below.

Please contact me if you have any queries about on-going ethics clearance, citing the SUEHREC project number. Copies of clearance emails should be retained as part of project record-keeping.

As before, best wishes for the project.

Ann Geeth
Secretary, SUEHREC
Appendix II The Statement of fulfilling ethic clearance

The author hereby states that all conditions pertaining to the clearance were properly met in the progression of the experiment. All participants signed consent forms after reading the consent statement. Also annual reports have been submitted.
Appendix III Screenshots from Homepage

This is a research project conducted by Xinyang Wang, a PhD candidate in Swinburne University of Technology.

Reading is a complex and automatic human cognitive process, which interacts between symbols and readers for the creation of meaning. The advent of computer and internet technology enables hypertext and hypermedia to be involved in the authentic education area. They are connections among different modes of information. Besides text, hypertext systems provide access to multiple media format links applications, such as images, and video clips.

The current study will expose English speaking background (ESB) students and non-English speaking backgrounds (NESB) students to hypertext learning materials presented in different media formats. The aim of the project is to compare the participants' recall and understanding of the information presented across the different formats. During five sessions, students will be undertaken with multimedia learning materials of LINC 155 Professional Communication Practices in hypertext format i.e., text supplemented with links. The format in which the context is presented will differ across each session. For example, the students will read hypertext with image links, hypertext with audio links, hypertext with video links, hypertext with animation links, and hypertext with text links.

The reading comprehension tasks are used to supply and reinforce participants' knowledge around this subject. Furthermore, the results of the study will provide recommendations regarding the most effective multimedia structure for instructional and educational purposes to meet the needs of students from different language backgrounds.

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Appendix V Screenshots from the instructional material (Session 1)

Hypermedia with image links

Session 1 -- Communication concepts and contexts

Communication originates from the Latin word 'communicare' (Schramm 1997). Human activities are inundated with communication. Actually, very little meaning can be understood without communication. Communication is often taken for granted as a simple part of people's lives. It is pervasive, important and complex (Eunison 2008). The systematic analysis of this discipline has evolved since World War II. In fact, human communications have been categorised in various dimensions in a communication model (Eunison 2008). Identifying these categories is an easy and effective starting point to understand communication.

One of the simplest ways to comprehend communication is to look at the models of the communication process. There are various aspects or elements involved in the process of communication. A model is a visual representation like a map. It allows audiences to conceptualise or 'see'. A model can also be a practical method for analysing the structures and functions of human communication (Trumboh 1999).

The following models are put forward: Shannon and Weavers' transmission model, Berlo's S-M-C-R model, Schramm's circular model, and a meaning-oriented transaction model. These models are designed to improve understanding of communication. Later, they can help to analyse the process at this stage.

Sound waves vibrations that travel through air and into the ear, and then to the brain (Adler & Rodman 2006). Moreover, human communication is far more complex than the sound travel and information transmission.

Communication processes can be perhaps be better understood in terms of the models below (Bagg 2009; Nanda 2006).

The Shannon-Weavers model was developed in 1949. It is highly influential and widely adopted in the human communication sphere (Mraz 2008). The model proposes a sender, a receiver, a channel and a set of signals. It is a simple and easily understood framework. "Sender→message→receiver". Shannon-Weavers' model can be applied to most types of communication. In the model, the source puts ideas into words or creates a message. Then, the message is transmitted through a channel to a receiver. The model can help ease the complexities of human communication. It even describes where barriers to communication may arise. It also discusses how to dismantle barriers to possibly achieve successful communication (Eunison 2008; Mohan et al. 2008).

Main text

A sample of image links
Appendix V Screenshots from the instructional material (Session 2)

Communication is a discipline. The early historical records of this subject emerged 2,000 years ago. Originally, the focus of this field was almost entirely on public speaking. Aristotle believed that public speaking was an important and effective communication tool. It can mobilize the public to join into civil affairs. He taught his students how to present addresses by using persuasive principles to effectively impact public opinions. Public speaking is a vital part of communication studies. However, it is not the only focus anymore in communication studies. Human communication applies to communication one-to-one (e.g., telephone) and in small groups. Nowadays, it also can be applied to the Internet, mass media and newsletters (Brochere 2006; cited in Wood 2008).

Different people have different understandings of a message. The differences are primarily produced by individuals. People can past experiences, knowledge, state of mind, and the environmental context from outside are the key factors. These can affect their understanding of meanings (Oliver 1997).

Communication generally takes place via a social interaction between people. However, communication may also occur within a person via an inner conversation. People talk to themselves. When a person communicates with himself it is called intrapersonal communication. In fact, intrapersonal communication is an ongoing process. It happens when people are communicating with all other settings. It lays the most basic foundation for all discourse. A person will take to himself first when communicating with others. Intrapersonal is the most basic level of communication. Thus, it is necessary to understand how people communicate with themselves (Borden 2008; Stenborg 2007).

In some sense, intrapersonal communication can be seen as the ‘sound’ of people’s thinking. The ‘sound’ can strongly influence their perceptions, cognition, memory, emotional responses and self-concept. It is an important factor for people’s decision making processes. In practical, self-talk can be enhanced via people talking to themselves. Accordingly, intrapersonal communication is a focus for many consultants. Recently, the awareness of intrapersonal communication has been increased. They have identified how perfectionist people can be used frequently to develop human positive self-awareness and self-concept. The approach improves appropriate self-expression to oneself. As well, it can help people to realize and overcome their emotional barriers (Borden 2008).

Intrapersonal communication is also people’s ideas about their ‘inner conversation’. Intrapersonal communication has...
Appendix VI Screenshots from the instructional material (Session 3)

The 21st century is an era of change. Technologies, businesses, and communication are changing at a rapid rate. The Internet, blogs, or other media forms are familiar to most people today. Few (2007) stated that technologies have influenced on human social relationships. Nowadays, physical location has become less significant. Hence, "globalisation" comes about.

Globalisation is a process rather than an outcome, and as a series of tendencies rather than an end state (Few 2007, p. 87). The regions and continents are becoming interdependent. The distance and relations across the world are getting closer (Hobs & McGraw 2001, cited in Few 2007). Such effects of globalization bring several possibilities for people. They allow people to access information on the Internet anywhere, anytime. Furthermore, the effects provide more chances for people to participate in online activities worldwide.

Globalisation offers the potential for public relation practitioners to extend their organizations overseas. They can create, change and maintain their relationships with the public. Also, they can communicate with others internationally. Thus, they can reflect on the theories of intercultural communication at a practical level (Therup, Roth & Bastian-Gülden 2006).

This perspective implies that globalization has an intercultural meaning. At the same time, intercultural communication takes place following globalization. Intercultural communication theory was developed during the 1980s and the 1990s. It aims the radical dynamics of globalization (McLuhan 1964, cited in Few 2007). Communication is a process of meaning making. Intercultural communication is a special field in communication studies. It is a form of worldwide communication. Usually, intercultural communication focuses on exploring the relationship between communication and culture. It occurs when a message is transmitted from one culture group to another cultural group (Taylor 2005).

"Culture" can be explained in many ways. At present, as people have come to know it, culture commonly includes several elements of life. They are society's history, traditions, family roles, attitudes, expectations, language, non-verbal communication, and socialisation. The elements cover a range of aspects from human transmitted patterns to the products of human work and thought (Mohan et al. 2008). Among these elements, socialisation is an important part of human culture. Socialisation is a process of learning culture.
Appendix VII Screenshots from the instructional material (Session 4)

Hypermedia with animation links

Session 4 – Social media

Over the past several decades, information technologies have brought a revolution. Without a doubt, people are now living in a new age of communication. Many users can subscribe to receive the up-to-the-minute services of news. They have ability to receive information by just clicking an RSS icon in a web browser. When they enter ‘Alexander’ into a Google search engine, then a listing of up to 1000 web pages will be shown with the results best matching ‘Alexander’. These technologies are seamlessly integrated with people’s daily lives. Furthermore, the integrations structure entirely new forms of social interaction through Internet technologies.

To some extent, public relations is a discipline concerned with information exchange. This definition is an almost self-explanatory one. The Internet and especially social media have been revolutionizing people’s communications. The revolution covers communication techniques used by the PR profession and its practices. Electronic mail, Web sites, blogs, online marketing, research engines, and teleconferences are social media tools now available to PR professionals. These tools enable easier communication, business transactions, and information exchange. These can all be used by individuals and organizations and have extended dramatically (Phillips & Young 2005).

The Internet is called as ‘a network of networks’. It began in the 1960s. The role of the Internet has changed radically since then. The Internet was originally a text-based network in academic institutions. Today, the Internet is used as a communication technology. It is a global system of interconnected computer networks. Billions of people surf on the Internet worldwide every day (Brown 2009).

Nowadays, the Internet is one of the fastest growing forms of communication. The meanings of human information exchange have been significantly affected by the technological revolutions. The Internet is a different medium from newspaper, radio and television. Being a network, the Internet is extremely powerful. It is responsible as a carrier, and supports most other media formats (Goggins 2006). The Internet has been dramatically changed thanks to the World Wide Web, which offers a quick and easy way for users to access information worldwide. World Wide Web (WWW) technologies are able to link multiple sources together, to allow people to find them (Brown 2009; Goggins 2006). There are a variety of resources available on the Internet currently. The materials are video clips, sounds tracks, textual content and many other media files. Generally, the content on the Internet can be browsed by clicking the links. Never before has there been such opportunity to communicate with targeted audiences. From email to multimedia

Main text

A sample of animation links
Appendix VIII Screenshots from the instructional material (Session 5)

Main text

Mediated communication

'Mediastated' communication can be understood as a type of communication. In general, human communication uses technological, mechanical and electronic means to convey meaning.

Media to transmit information. At the same, is actually a process of (Branch & Stafford 2005). In communication in, to other words, media can be information. Media can be realised through television, radio or newspaper.

At present, communications is undergoing a radical change. The changes are the result of new media channels used.

A sample of text links
Appendix IX Samples of comprehension tasks

Answer Sheet --- Session 1- Reading comprehension tasks

Student ID & Name: ____________________

English is my □ mother tongue □ second language

Please access the reading materials through http://project.faysoft.com.au/ca/.

Apply your knowledge and understanding to complete the reading comprehension questions in your words. Each task in this session is to be done individually.

Tasks:

1. What are the dimensions or categories of communication?

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

2. How could the visual models contribute to understanding communication?

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3. What is the role of ‘feedback’ in an interpersonal communication?

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

4. What improvements does S-M-C-R model offer over the Shannon-Weaver model?

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
5. How does Shannon and Weaver’s transmission model of communication differ from the transaction model?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

6. How does Schramm’s circular model build on Shannon-Weaver’s transmission model?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

7. See this sign below. What type of communication model could be applied to this sign? Explain why?

![Do Not Enter Sign](image)
8. Which model(s) of communication can be applied to a telephone conversation? Explain why?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

9. Provide an example to explain that ‘the choice of channel and/or medium can be vital to the success of a communication.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
Answer Sheet --- Session 2- Reading comprehension tasks

Student ID & Name: ____________________

English is my ☐ mother tongue
☐ second language

Please access the reading materials through http://project.faysoft.com.au/ca/.

Apply your knowledge and understanding to complete the reading comprehension questions in your words. Each task in this session is to be done individually.

Tasks:

1. Define ‘intrapersonal communication’.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

2. Define ‘active listening’.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

3. What does ‘propaganda’ mean?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

4. What is the connection between emotional intelligence and successful interpersonal communication?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
5. What is the role of non-verbal cues in day-to-day communication?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

6. How could intrapersonal communication contribute to successful interpersonal communication?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

7. See the advertisement below. How does this advertisement motivate and influence people’s decisions?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

8. How can one be an active listener in their lecture activities?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

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_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________
9. How can one build self-esteem via positive self-talk, in order to speak in public effectively?
Answer Sheet --- Session 3- Reading comprehension tasks

Student ID & Name: ____________________

English is my □ mother tongue
□ second language

Please access the reading materials through http://project.faysoft.com.au/ca/.
Apply your knowledge and understanding to complete the reading comprehension questions in your words. Each task in this session is to be done individually.

Tasks:

1. Define 'globalisation'.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

2. What elements are commonly included in the definition of culture?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

3. What does intercultural communication mean?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

4. How do non-verbal cues lead to 'culture shock' in our communication process?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
5. How does the internet contribute to ‘shared culture’?

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

6. What are the main differences between high-context and low-context cultures?

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

7. Discuss 'the whole world will soon be low context.' Provide a reasonable example to improve the answers.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

8. Provide an example of how globalisation affects your life.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

9. From a professional perspective, how would you effectively communicate with your colleagues from different countries, when you are in a workplace diversity program?

_____________________________________________________________________

_____________________________________________________________________

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_____________________________________________________________________

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_____________________________________________________________________
Answer Sheet --- Session 4- Reading comprehension tasks

Student ID & Name: _____________________

English is my □ mother tongue

□ second language

Please access the reading materials through http://project.faysoft.com.au/ca/.

Apply your knowledge and understanding to complete the reading comprehension questions in your words. Each task in this session is to be done individually.

Tasks:

1. Define ‘social networking’.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

2. What is a ‘message board’?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

3. What does the term ‘social media’ mean?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

4. What is (are) the function(s) of search engines when surfing on the internet?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
5. What are the benefits of podcast?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

6. How could social bookmarking sites help people to extend their social network?

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_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

7. Provide an example of someone’s participation in citizen journalism.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

8. Provide an example of your experience of socializing through social media.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

9. What could social media contribute to Public Relations?

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_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
Answer Sheet --- Session 5- Reading comprehension tasks

Student ID & Name: ______________________

English is my □mother tongue
□second language

Please access the reading materials through http://project.faysoft.com.au/ca/.
Apply your knowledge and understanding to complete the reading comprehension questions in your words. Each task in this session is to be done individually.

Tasks:

1. Define ‘mediated communication’.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

2. What are ‘external media’?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

3. What does ‘framing’ mean in media studies?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

4. What are the differences between ‘controlled media’ and ‘uncontrolled media’?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
5. What is the importance of ‘media relations’ in PR?
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

6. How does ‘generalised news value’ influence news release?
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

7. Is ‘generalised news value’ beneficial for mass audiences? Why?
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

8. From a professional perspective, how would you manage your blog (alternative Facebook, Myspace, YouTube...etc account) to effectively communicate with the public? (Provide an example of managing media from your experiences).
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

9. Give an example to explain how organizations use internal media to improve their business.
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

List of publications

During the PhD candidature, I have two academic papers published:

1. Wang, X & Verezub, E 2010, 'Interacting with e-text in multimedia formats by ESB and NESB students,' ADIS International Conference on International Higher Education 2010, 34-40; and ,