EFFECTS OF INTERACTIVE TRANSCRIPTS AND KEY-POINT ANNOTATIONS ON ENGLISH AS A SECOND LANGUAGE STUDENTS' LEARNING PERFORMANCE USING OPEN EDUCATIONAL RESOURCES INSTRUCTIONAL VIDEOS

by

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(Under the Direction of Robert Maribe Branch)

ABSTRACT

This study investigated the effects of two onscreen text options, interactive transcripts and key-point annotations, on the learning performance of English as a second language students by using open educational resources instructional videos. A pretest-posttest experimental design was used. Participants saw the same instructional videos in one of four randomly assigned treatment groups: 1) no onscreen text support option; 2) interactive transcript; 3) key-point annotations; and 4) both interactive transcript and key-point annotations. Results of a 2 X 2 ANCOVA indicated that the effect of either interactive transcripts or key-point annotations was dependent primarily on the pedagogy of a set of instructional videos. Key-point annotations, but not interactive transcripts, significantly affected students learning performance when the video instructor spoke clearly and used real-life examples. Key-point annotations, interactive transcripts, or both did not significantly affect students learning performance when video instruction lacked practical examples and used audio narration that was too fast. Review of participants' opinion data indicated that learning experiences were affected primarily by learner control through video interactivity, video instructional design, and limited internet access.

INDEX WORDS: Redundancy principle, Open educational resources, Instructional videos, Interactive transcripts, Annotations, Online learning, Cross-border education, English as a second language

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DEDICATION

To my love, Nana Ama Fosua.

Thank you for your patience, support, sacrifice, and love.

God bless you!

This is our accomplishment!!

To mom, Efia Agyeiwaa.

Well, your silent wish came true.

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CHAPTER 1

INTRODUCTION

The use of instructional videos as a learning object has been gaining widespread adoption over the last decade. From K-12 education, higher education, corporate training, distance and distributed learning to cross-border education, instructional videos continue to be established as a cost-effective viable educational resource (Giannakos, Chorianopoulos, Ronchetti, Szegedi, & Teasley, 2014; Petan, Petan, & Vasiu, 2014). Contributing to the increasing importance of instructional videos are their characteristics of being reusable and able to reach larger and diverse audiences over time and space (Chorianopoulos & Giannakos, 2013). Additionally, instructional videos have been noted to provide students with a simulated real in-class learning experience (Giannakos & Vlamos, 2013). Instructional videos are also a good source of data for learning analytics (Derry et al., 2010). Further, advances in information, communications, and video technology such as the free Opencast and YouTube, which launched in 2005, continue to make the creation, hosting, and delivery of instructional videos relatively easy and very popular.

Presently, hundreds of higher educational institutions and thousands of instructors around the world have posted several thousands of instructional videos online that receive millions of views daily. Associated with the rapid rise of instructional video use is also a steady rise of research on video-based learning (Giannakos, Jaccheri, & Krogstie, 2014). The number of research articles on video-based learning more than doubled to 118 in the period 2007-2012 compared to 48 papers published in 2000-2006 (Giannakos, 2013). Not matching the growing popularity, however, is research evidence on what makes instructional videos effective as an accessible and usable learning resource (Chorianopoulos & Giannakos, 2013). Thus, there is the need for empirical evidence on the specific features that make instructional videos accessible and usable to the many learners of varied backgrounds that use instructional videos.

Open Education through Instructional Videos

Another innovation in learning technology that is further propelling the adoption and importance of instructional videos is the concept of open education. Open education promotes the open creation and sharing of knowledge to support access to education at a global level (Bissell, 2009; McGreal, Sampson, Chen, Krishnan, & Huang, 2012). The concept of open education calls for instructional and learning design that serves the particular needs of learners (Kanwar, Uvalić-Trumbić, & Butcher, 2011). Open education is largely implemented through the use of open educational resources. Open educational resources (OER) are "teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions" (UNESCO, 2012). Examples of materials include full courses, lecture notes, textbooks, course plans, and instructional videos (Kanwar et al., 2011). Materials also include software tools and implementation resources such as design techniques and principles (Atkins, Brown, & Hammond, 2007).

A very popular learning object among all OER are open online courses. Open online courses, therefore, are online courses under a license arrangement that permits their free access, use, adaptation, and sharing without a need for permission from the copyright owner (Bissell, 2009; Caswell, Henson, Jensen, & Wiley, 2008; Kanwar et al., 2011). Open online courses may comprise of course plans, lecture notes, course projects, discussion forums, and instructional videos. Open online courses are a main component of the broader movement of open education.

The specific factors, however, besides open licenses that could support access to open education delivered through instructional videos for learners globally are yet to be explored. The term OER instructional videos is used in this study to refer to instructional videos that are components of open online courses and other open educational resources.

The use of OER instructional videos as a major learning object for cross-border education is now commonplace, particularly of content by provider institutions and persons from native English-speaking countries. Examples of native English countries include Australia, Canada, the United Kingdom, and the United States. Provider institutions and persons of native English-speaking countries also contribute the largest collection of OER content (OECD, 2007; Rhoads, Berdan, & Toven-Lindsey, 2013). For example, Coursera, a popular open online course platform in the US reported over 100 providers of courses, over 22 million student users, and 571 higher education courses, all of which included instructional videos (Coursera, 2011, 2013). Also, during 2014, Khan Academy, another popular English open online course platform, received 10 million unique users a month, had over 2.5 billion lessons completed, had over 500,000 registered teachers worldwide who used the resource in their classrooms, and carried over 5,500 instructional videos (Murphy, Gallagher, Krumm, Mislevy, & Hafter, 2014). Further, the number of open online courses doubled to 2400 between January 2012 and December 2014, with 22 of the top 25 universities in the US News and World Report College Rankings offering courses (Shah, 2014). Also, by the end of 2014, over 400 universities were offering open online courses with more than 3,000 instructors having created courses for 16 to 18 million students worldwide (Shah, 2014). The contention here is that instructional videos continue to be a primary mode for delivering majority of open online courses (Giannakos, Jaccheri, et al., 2014). However, lacking is evidence on what factors make OER instructional videos effective as a learning resource with regard to access and use by the learners of various international backgrounds.

Motivational Concept

Open educational resource instructional videos, like other OER content, present a useful avenue to provide equitable and universal access to quality higher education and knowledge. This is particularly true for students who otherwise do not have access to adequate educational opportunities (Caswell et al., 2008). Students who may have limited educational opportunities also include those from the most need regions of the world with regard to accessible educational opportunities, many of whom reside in English as a second and foreign language countries. English as a second language (ESL) refers to the use of the English language by non-native speakers in countries where English is official (Thompson, 2003). Thompson further refers to English as a foreign language (EFL) to mean the use of the English language by non-native speakers in countries where English is not official (Thompson, 2003). Yet, while the production of OER instructional videos and other OER content continues to grow exponentially, efforts to remove or limit language barriers to access have been minute (Nti, 2015).

The problem is that the English language is not native in EFL and ESL countries. Even for students of ESL nations, where the English language is official, there are marked differences in the "form" of English that students may be familiar, with regard to factors such as dialect and speed of speech. Students must have knowledge of the language of instruction in order to benefit from OER instructional videos. Students must also be able to comprehend what is spoken in order for the process of learning to occur (Bruce, To, & Newton, 2012; Wolvin, 2009). Therefore, there is the need to consider language support options for enhancing access to OER instructional videos for diverse audiences, particularly EFL and ESL students. The primary purpose of this study was to examine onscreen language support options that could support access to native English OER instructional videos for students of ESL countries.

Rationale

The ability to comprehend spoken language is essential in any learning process (Wolvin, 2009), and more so in learning through OER instructional videos by students who may not be familiar with the form of English language instruction. Dunton, Bruce, and Newton (2010) as well as Vandergrift and Goh (2012) provide evidence that even in face-to-face encounters, unfamiliar language inhibits message comprehension. The problem is that the primary mode of delivering OER instructional videos involves the use of the Internet, other information and communication technologies (Atkins et al., 2007; Kanwar et al., 2011) and spoken language. Additionally, “the vast majority of OER [instructional videos] are in [native] English and tend to be based on Western culture. This limits the relevance of the materials for non-English, non-Western settings” (OECD, 2007, p. 104). The dominance of English OER is still true today (Shah, 2014; Trucano, 2013; Willems & Bossu, 2012) with 80% of all open online courses taught in English (Shah, 2014). Also, unlike face-to-face instruction, OER instructional videos tend to be linear, lacking student-instructor interaction (Bruff, Fisher, McEwen, & Smith, 2013). Therefore, associated with more OER instructional videos for cross-border higher education comes challenges. A major challenge being the likelihood for students of receiving countries to encounter education and learning content that is offered in unfamiliar English.

Further, discussions on language barriers mentioned in OER literature have not only been very limited, but have also lacked empirical bases (Atkins et al., 2007; Mtebe & Raisamo, 2014; Richter & McPherson, 2012; Willems & Bossu, 2012). Research in foreign language education and acquisition, however, confirms that onscreen text language support options, such as captions, annotations, and transcripts, enhance students' message comprehension (Akbulut, 2007; Hayati & Mohmedi, 2011; Hsu, Hwang, Chang, & Chang, 2013; Jones & Plass, 2002; Marzban, 2011). Thus, the need for empirical examinations of possible language support options that could help limit language barriers by supporting language access in ESL and EFL contexts is now. The need to consider language support options is more important given a lack of evidence-based research that could inform the design, development and delivery of OER instructional videos to students globally (Hilton, Gaudet, Clark, Robinson, & Wiley, 2013). However, the possible effects of video onscreen text on ESL student learning within the context of OER are yet to be fully explored empirically.

Therefore, this study was an attempt to meeting this need by examining the effects of two onscreen text language support options – interactive transcripts and key-point annotations, in supporting access to native English OER instructional videos for students of ESL countries. Transcripts are the written version of a narration or presentation in another form. Interactive transcripts have the added feature of allowing a user to select or click any word or part of the transcript and skip to the specific point of the video. Key-point annotations include onscreen text display of additional explanation or information on instructional content that requires emphasis or further information.

Theoretical Framework

This study examined the redundancy principle of the cognitive theory of multimedia learning (Mayer, 2005) within the special case of an English as a second language context. Motivated by the concept of communication fidelity, the study examined the redundancy principle facilitated by the recommendations of Dual Coding theory (Clark & Paivio, 1991; Paivio, 1986). Communication fidelity was defined as a receiver [student] assigning to a sent message [instruction] the same meaning as delivered verbally by a sender [instructor] through an OER instructional video (Mulanax & Powers, 2001; Powers & Witt, 2008). Both the cognitive theory of multimedia learning and dual coding theory are based on the principle that the human mind is an active processor of information.

The dual coding theory (DCT) (Paivio, 1986; Sadoski, Paivio, & Goetz, 1991) is a general theory of cognition and cognitive information processing that has provided useful explanations to several education and learning phenomena. Dual coding theory stipulates that human mental structure comprises of two main systems. They include the verbal system, which specializes in the representation and processing of linguistic information of all forms, and the nonverbal subsystem, which represents and processes nonverbal objects and events. The nonverbal subsystem processes information mainly in the form of mental imagery including image, sound, affective, and haptic forms (Sadoski et al., 1991). The two systems are uniquely separate and can operate independently; however, they are also connected with one another and can interoperate as well as operate in parallel.

Processing that occurs within one system is termed associative while processing that interactively occurs between the two systems is called referential (Clark & Paivio, 1991). According to DCT, the additive effect (dual code effect) of referential processing is better for comprehension and learning (Clark & Paivio, 1991). Therefore, within the context of this study, learning design that made use of both the verbal and nonverbal systems was expected to lead to better learning than a design that made use of either system alone.

The cognitive theory of multimedia learning is based on the DCT and states that multimedia instructional design that fits the way the human mind works is more likely to lead to meaningful learning than otherwise (Mayer & Moreno, 2002; Mayer, 2005). Cognitive theory of multimedia learning (CTML) is concerned with how to use words and pictures (both static and animations) for effective learning. The redundancy principle of the CTML posits that when presenting pictures, students learn better from concurrent audio and pictures than from simultaneous pictures, audio, and onscreen text (Clark & Mayer, 2011). However, according to Clark and Mayer (2011), the redundancy principle may not apply under certain special situations. Special situations may include where the learner must use greater cognitive effort to comprehend spoken text than onscreen text, where spoken words are technical, where there is language unfamiliarity or difficulty, and where the learner has control of the multimedia learning object.

Consequently, Clark and Mayer (2011) called for research to investigate cases of the mentioned special situations. However, research examining the redundancy principle is very limited except for few exceptions such as Austin (2009), Clark and Mayer (2011), and Hernandez (2004). Studies that examine the redundancy principle’s special situations of language unfamiliarity and learner control are even more scant. Open educational resources instructional videos for technical modules delivered to non-native English-speaking students fall in the special situations of language unfamiliarity and learner control.

The implication of the study’s theoretical framework is that the combination of video, spoken instruction, and onscreen text was expected to evoke the use of both verbal and nonverbal systems and lead to better comprehension, understanding, and learning. More importantly, where spoken English was unfamiliar, language support options such as interactive transcripts and key-point annotations was expected to fill in the gap and help ESL students to mentally form word associations between unfamiliar sounds and what was known in their mental schema. This associative process, according to dual coding theory, was expected to lead to better comprehension and understanding of instruction and hence better learning.

Research Questions

The purpose of this experimental study was to examine the effects of video interactive transcripts and key-point annotations in technical OER modules on students' learning performance. Students' learning performance was measured by scores on test questions defined according to the first two levels, Remembering and Understanding, of Bloom's Taxonomy (Forehand, 2005). Findings of the study was expected to contribute to best practices to support access to OER instructional videos for worldwide audiences. The study's findings could further provide insights into the socio-technological factors that arise with adapting and incorporating OER for cross-border education through learning technology into limited educationally-resourced contexts. The study addressed the following research questions:

1. Does including onscreen text in OER instructional videos make a difference in ESL students' learning performance?
2. What is the relative effect of interactive transcripts in OER instructional videos on ESL students' learning performance?
3. What is the relative effect of key-point annotations in OER instructional videos on ESL students' learning performance?
4. What are ESL students' perceptions of the use of interactive transcripts and key-point annotations in OER instructional videos?

CHAPTER 2

REVIEW OF RELEVANT RESEARCH

This study examined the effects of two onscreen text language support options, interactive transcripts and key-point annotations, on ESL students' learning through OER instructional videos. The focus was on OER instructional videos delivered in native English that are also intended for cross-border education. Interactive transcripts and key-point annotations could support learning by supporting language access to imported OER instructional videos for students of ESL countries. The purpose of this chapter, therefore, is to support this position through an integrative review of related literature. I review relevant literature on the (1) use of instructional videos for learning; (2) use of onscreen text language support options in learning; (3) cognitive theory of multimedia learning and the redundancy principle; and (4) dual-coding theory. The review also indicates relevant gaps and inconsistencies in the literature and how they were to be addressed.

Including onscreen text language support options in instructional videos could support the learning of students of ESL countries within the OER context. Many OER instructional videos, like other OER content, are also primarily intended for cross-border education (Atkins et al., 2007; Caswell et al., 2008; UNESCO, 2002). Also, the majority of OER instructional videos are delivered in native English (OECD, 2007; Shah, 2014), an English language form that may be unfamiliar to students of ESL countries with regard to factors such as accent and dialect. Familiarity with a language of instruction, however, is essential to students' comprehension of instructional messages (Dunton et al., 2010; Vandergrift & Goh, 2012). The ability of students to also resolve spoken language differences in their mental schema is important for the comprehension of instructional messages (Hernandez, 2004; Mai, Ngoc, & Thao, 2014).

Use of Instructional Videos for Learning

The use of instructional videos for learning continues to gain global widespread practice. The number and variety of educational and non-educational institutions that use instructional videos, particularly in distance and online learning, are large and continue to grow rapidly (Chen & Wu, 2015; Giannakos, Chorianopoulos, et al., 2014; Kay, 2012). Instructional videos have been referred to as educational webcasts (Giannakos & Vlamos, 2013), educational video podcasts (Kay, 2012), instructional videos (Zhang, Zhou, Briggs, & Nunamaker, 2006), video lectures (Chen & Wu, 2015; Chorianopoulos & Giannakos, 2013), and web-videos for learning (Chorianopoulos & Giannakos, 2013). Instructional videos for this study refer to video files that are specifically created for educational, learning, or academic purposes and are made available through the internet.

Instructional videos may be in one of several formats. There is the picture-in-picture format (Chen & Wu, 2015) showing an instructor and a board (See Appendix A or Appendix B). The picture-in-picture format may be a recording of an actual in-class session, examples include the videos of the Massachusetts Institute of Technology's (MIT) OpenCourseWare (MIT, n.d.). The picture-in-picture format may also depict the real image of an instructor teaching with a writing or display board, slides, or a combination of both. There is also the Khan-style format which combines an instructor's voice and writing on a board but does not show the instructor's image (Chorianopoulos & Giannakos, 2013). The voice-over format (See Appendix C) only shows lecture slides with vocal narration of slide content (Chen & Wu, 2015). While OER instructional videos may be found in any of the mentioned video formats, the picture-in-picture format is the most commonly used (Chen & Wu, 2015; Giannakos, Chorianopoulos, et al., 2014). Open educational resources instructional videos that use a combination of the three instructional video formats are also common. Figure1 provides a summary of the various video formats.

Video Format	Description	Examples
Picture-in-picture	Shows image of instructor and a board. May be a recording of an in-class session or display of picture of instructor teaching with a writing or display board, slides, or combination of both.	MIT OpenCourseWare. Coursera. (Appendix A and Appendix B)
Khan-style	Combines instructor's voice and writing on a screen board with digital pen. Does not show instructor image.	Khan Academy. Udacity.
Voice-over	Screen cast of lecture slides together with vocal explanations of slide content. Does not show instructor image.	Webcasts. How-to videos. (Appendix C)

Figure 2.1. Instructional video formats.

Significant advances in information and communications technologies continue to add to the increasing popularity of instructional videos. Strong contributors include increases in the availability of the Internet, high speed bandwidth (Kay, 2012), and relatively free video creation, control, and distribution tools such as YouTube, HTML5, and JavaScript. Instructional videos are now employed in diverse learning contexts including, but not limited to, organizational learning (Petan et al., 2014), K-12 education (Merkt, Weigand, Heier, & Schwan, 2011), higher education (Chen & Wu, 2015), distance education (Ho, Kiyohara, Sugimoto, & Yana, 2005; Petan et al., 2014), and OER (Giannakos, Chorianopoulos, & Chrisochoides, 2015; Giannakos, Chorianopoulos, et al., 2014; McGreal et al., 2012). A number of reasons has been identified in the literature for the increasing use of instructional videos. Some of these reasons include flexible learning with reference to time, cost, and access (Giannakos & Vlamos, 2013) and learner control (Kay, 2012; Zhang et al., 2006). Other reasons include affording slow learners enough time to learn difficult concepts (Giannakos & Vlamos, 2013) and aiding students' performance (Kay, 2012; Zhang et al., 2006). Therefore, video features that support students from varied language backgrounds to access content and learn technical concepts should be of important interest in the design of OER instructional videos.

Kay (2012), in a systematic review of 53 peer-reviewed articles from 2002 to 2011 on the use of instructional videos, identified three reasons for students' use of instructional videos. Student respondents indicated, in order of importance and with reference to the number of studies, that instructional videos helped improve their learning, allowed control of learning, and provided the opportunity to make up for missed classes (Kay, 2012). Kay's systematic review involved searches using the AACE Digital Library, Academic Search Premiere, EBSCOhost, ERIC, Google Scholar, and Scholars Portal Journals databases. Students affective and cognitive attitudes towards instructional videos were also generally positive (Kay, 2012). Chen and Wu (2015), Chorianopoulos and Giannakos (2013), and McGarr (2009) have also noted the aforementioned and other benefits associated with the use of instructional videos for learning.

The exponential rise in the use of instructional videos, including OER instructional videos, should therefore not be surprising. While some of the studies reviewed by Kay (2012) showed gains in students' learning performance, others showed neutral impact of instructional videos on learning. However, the specific factors and features that may contribute to the effectiveness or ineffectiveness of instructional videos for learning have rarely been mentioned or explored (Giannakos, Chorianopoulos, et al., 2014; Kay, 2012; Merkt et al., 2011). It is therefore important to investigate the specific factors that may contribute to gains or losses in students' learning through instructional videos. This need is more important when we consider OER instructional videos because they are also primarily intended for cross-border education. Therefore, investigating specific contributing and limiting factors is necessary if OER instructional videos are also to cater for students of varied linguistic backgrounds. Thus, the issue now is not about whether or not instructional videos are a viable pedagogical option to consider. Rather, the issue is about how to design and deliver instructional videos effectively to meet the specific learning needs of students from diverse backgrounds.

Universal Design for Learning

Open education promotes instructional and learning design that considers the needs of diverse learners. Meeting the needs of learners imply that OER instructional videos must be learner-centered (Chorianopoulos & Giannakos, 2013; Giannakos, Chorianopoulos, et al., 2014). Learner-centered OER instructional videos are accessible, usable, and adaptable with reference to the particular needs of the diverse target audience of OER (Kanwar et al., 2011). Accessible, usable, and adaptable OER instructional videos constitute the very tenets of the open education concept (Bissell, 2009; Kamper & du Plessis, 2014). Therefore, it is appropriate to consider universal design principles in the design and delivery of OER instructional videos.

According to the Center for Universal Design, “Universal design is the design of products and environments to be used by all people, to the greatest extent possible, without the need for adaptation or specialized design” (Mace, 2008). Universal design for instruction (UDI) is a process that goes beyond the design of instruction for the familiar student to designing for the potential student who may have varied backgrounds, abilities, and preferences (Burgstahler, 2015). According to Burgstahler (2012), “the goal of UDI is to maximise the learning of students with a wide range of characteristics by applying UD [universal design] principles to all aspects of instruction” (p. 1). Universal design of instruction is also a set of principles, guidelines, and practices (Burgstahler, 2015). The Center for Universal Design (Connell et al., 1997) outlines seven principles of universal design including:

1. Equitable use: learning design is useful and marketable to learners of diverse abilities. An example of equitable use is making a design appealing to all potential learners.
2. Flexibility in use: learning design accommodates a broad range of individual preferences and abilities. An example is making provision for adapting to different learning styles.
3. Simple and intuitive use: use of the design is easy to understand, regardless of the learner's experience, knowledge, language skills, or current concentration level. An example would be accommodating for different levels of language ability.
4. Perceptible information: learning design communicates necessary information effectively to the learner, regardless of environmental conditions or the learner's sensory abilities. An example would be using multiple modes of instruction such as sound and visuals for redundant presentation of essential material.
5. Tolerance for error: learning design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. Low physical effort: the learning design can be used efficiently and comfortably without unnecessary effort and with minimum fatigue by the learner.
7. Size and space for approach to use: the learning design makes provisions for appropriate size and space for approach, reach, manipulation, and use regardless of the student’s body size, posture, or mobility.

Scott, McGuire, & Shaw (2003) add two more principles specific to learning, including:

8. A community of learners: the learning environment encourages interaction and communication among students and between students and faculty.
9. Instructional climate: instruction and learning are designed to be welcoming and inclusive, and high expectations are supported for all learners.

The design of OER instructional videos that considers the goal and principles of universal design would, thus, be one that is able to adapt video features and its learning resources to accommodate for the varied needs and preferences of learners with minimal effort (IMS Global Learning Consortium, 2010). Therefore, there is the need to examine design features that allow OER instructional videos to accommodate for varied English language needs.

Open educational resources instructional videos, therefore, should not be disabling by creating a mismatch between the language access properties they offer and the language needs of a global student-base (IMS Global Learning Consortium, 2004, 2010). Open educational resources instructional videos should rather provide alternative language support options to meet the needs of students of different language backgrounds. Given that OER instructional videos are also intended for cross-border education (UNESCO, 2002) and are mostly offered in native English (OECD, 2007; Shah, 2014; Willems & Bossu, 2012), time has come to examine language support options that support access to OER instructional videos. The need to examine language support options is an important issue that is yet to gain research attention and was therefore the objective of this thesis research.

Studying the use of instructional videos in eLearning, Zhang et al (2006) examined the effect of interactive instructional videos on the learning outcomes and satisfaction of students in a higher education institution. Zhang et al. (2006) defined interactive instructional videos as the provision of allowing students to be able to skip or browse for specific video segments. Learning outcomes were measured by gains between pretest and posttest scores, while learner perceived satisfaction were collected using a 7-point Likert scale questionnaire. Students were randomly assigned to one of four groups: eLearning group with interactive instructional video, eLearning group with non-interactive instructional video, eLearning group with no instructional video, and a traditional face-to-face group. Students in all three eLearning groups saw an online lecture. In addition, the interactive group had access to stop, pause, back, and forward control buttons, and a table of content for skipping to specific segments of the video. The non-interactive video group only lacked the table of content control option that allowed for skipping to specific video segments. The third eLearning group saw only PowerPoint slides and transcripts of lecture notes.

A one-way analysis of variance and post-hoc analysis showed that the eLearning group with interactive instructional video significantly outperformed each of the other three groups. There were no significant differences in the mean performance between any pair of the other three groups. Also, with regard to student satisfaction, students in the eLearning group with interactive instructional video reported significantly higher levels of satisfaction than those in each of the other three groups; each of the eLearning groups reported significantly higher levels of satisfaction than the traditional group; and there were no significant differences between students' reported satisfaction between the eLearning groups of non-interactive instructional video and no instructional video interaction.

The findings of Zhang et al. (2006) suggest that the video functionality that helped students' learning was the availability of interactivity. The purpose of including static transcripts in the instructional videos was not indicated in the Zhang et al. (2006) study. The affordances of interactivity as defined by Zhang et al. (2006) is now exceeded by the features of interactive transcripts. Not only can interactive transcripts be used to skip to segments of a video without the need for control buttons, but as also indicated previously, interactive transcripts can be used to seamlessly navigate to any point in a video, predefined or not, just by interacting with the transcript itself. The control characteristic makes interactive transcripts a viable language support option to investigate for use in OER instructional videos that teach technical or complex concepts. It also makes interactive transcripts a potential option to consider for instructional videos delivered in native English that may be unfamiliar to certain student groups. This important but lacking research issue was one problem that this study sought to address.

Use of Onscreen Text Language Support Options in Learning

The foregoing discussion suggests that use of onscreen text support options could help better ESL students' learning through OER instructional videos by supporting language access. The use of onscreen text language support options could also contribute to making English OER instructional videos that are also intended for cross-border education more student-centered.

Research by Hernandez (2004), and Vandergrift and Goh (2012) confirm that onscreen text language support options such as annotations, transcripts, and captions enhance students' message comprehension in second language education and vocabulary acquisition. An annotation is a note or comment that explains or provides additional information on a text, visual, or word. Annotations may be text or pictorial (Jones, 2009). Several studies have investigated and found positive effects of annotations on listening comprehension (Aldera & Mohsen, 2013; Jones & Plass, 2002), vocabulary acquisition (Akbulut, 2007; Jones & Plass, 2002), and reading comprehension (Akbulut, 2007; Marzban, 2011). Few studies, however, have considered the relationship between transcripts and learning (Grgurovic & Hegelheimer, 2007; Ho et al., 2005; Jadin, Gruber, & Batinic, 2009). A transcript is a written version of a material that was spoken or presented in another form. The rest of this section on the use of onscreen text language support options is organized into three subsections: captions as a language support option; annotations as a language support option; and transcript as a language support option.

Captions as a Language Support Option

An onscreen text language option that has been studied extensively and reported in research literature is the use of captions (Grgurovic & Hegelheimer, 2007; Hayati & Mohmedi, 2011; Hsu et al., 2013; Mitterer & McQueen, 2009; Vandergrift & Goh, 2012). Captions are primarily aimed at making television and video content accessible to viewers who are deaf and hard of hearing (Federal Communications Commission, 2012). Captions, therefore, display as onscreen text spoken dialogue and other audio cues such as music and sound effects. This is done by using symbols as well as non-audio and off-screen information, such as certain actions or gestures. Most of the studies on captions have been in the area of second and foreign language education (Hayati & Mohmedi, 2011; Hsu et al., 2013; Vanderplank, 2010). The many studies on captions could be attributed to captions having long been promoted both as a policy and design feature requirement to support video access for the deaf and hard of hearing (Federal Communications Commission, 2013).

The benefits of using captions in supporting access to multimedia content including video, sound, television, and audio accessibility have been recognized in foreign language education, by community developers, and by national and international policy makers (Federal Communications Commission, 2013; Vandergrift & Goh, 2012; Vanderplank, 2010). However, the definitions of disability and accessibility within the multimedia learning context (IMS Global Learning Consortium, 2010) imply that time has come to also investigate all possible onscreen text language support options that could potentially support a different group of instructional video users - students whose access may be limited by language barriers (Vanderplank, 2010). The use of instructional videos is growing significantly (Chen & Wu, 2015; Kay, 2012) and also in the open education context (Giannakos, Jaccheri, et al., 2014). Captions may work well with helping with passive listening of spoken dialogue. However, the learning of actual academic content such as technical courses through OER instructional videos places more cognitive demands on students. Time has come to investigate probable onscreen text language options that may be more appropriate for non-native English speaking students who use imported OER instructional videos, especially in ESL geographical and economic contexts (Nti, 2015).

Annotations as a Language Support Option

The use of annotations in multimedia learning has been found to significantly aid vocabulary recognition and recall but not listening comprehension for EFL learners learning English (Aldera & Mohsen, 2013). Annotations in Aldera and Mohsen (2013) were highlighted colored words placed within captions in animations. Upon mouse-over, the animations paused and displayed the definition of the highlighted word together with a corresponding picture. The students in Aldera and Mohsen (2013) who were in the annotation group performed significantly better in vocabulary acquisition but significantly worse in listening comprehension tests when compared to the student group without annotations. This finding should not be surprising because the annotations in the study were essentially vocabulary acquisition aids that focused students' attention on reading certain keywords onscreen over listening to the audio narration. This study designed key-point annotations to aid students in their learning of subject content.

Text annotations designed to support certain cognitive processes have also been found to aid in the reading comprehension of web-based onscreen scientific text that may be unfamiliar to students (Wallen, Plass, & Brünken, 2005). The cognitive processes include selecting relevant information, organizing information in memory, and building mental schema by integrating new information with existing mental information. Similar to the study by Aldera and Mohsen (2013), annotations in the study by Wallen et al. (2005) were keywords or terms within text that students had to select to display additional text information onscreen. Unlike the design of Aldera and Mohsen (2013), the design of Wallen et al. (2005) used screen shots of reading text with no animations, sound, or pictures. The use of text annotations for unfamiliar reading text with no associated sound or pictures suggests that, annotations in Wallen et al. (2005) used only the associative characteristic of students' mental verbal system as described by dual-coding theory. Nevertheless, student groups that received annotations showed better average comprehension than student groups that did not. The use of annotations helped higher verbal ability students more than those with low verbal ability. Additionally, for more challenging text comprehension tasks, low verbal ability students performed even worse (Wallen et al., 2005). Students of ESL countries are not of low verbal ability (Thompson, 2003) and were therefore expected to benefit from the use of annotations in OER instructional videos.

The potential benefits of using annotations as a learning aid goes beyond second or foreign language education. Beyond displaying definitions of unfamiliar words and providing additional information on unfamiliar or complex texts, annotations may also be used to aid students' comprehension of key concepts in non-language education courses. These courses may include math, science, and the social sciences. Annotations have been found to help students learning introductory arts, calculus, and management mathematics to significantly perform better on formative tests than students who did not use annotations (Lai, Tsai, & Yu, 2011). Examining the use of text and picture annotations that were displayed on a separate projector screen side-by-side a screen for PowerPoint-supported lectures, Lai et al. (2011) also reported general positive student perceptions on the use of annotations.

Additionally, research by Bargeron, Gupta, Grudin, and Sanocki (1999); Fu, Schaefer, Marchionini, and Mu (2006); Hosack (2010); LeeTiernan and Grudin (2001); and Wallen et al.

(2005) show that several attempts have been made to develop multimedia annotation tools that enable asynchronous collaborative notes-taking and sharing among students who watch web-based instructional videos. Instructors, however, could also use annotations to emphasize, as well as help support students' capacity to recognize and better learn key concepts (Lai et al., 2011; Risko, Foulsham, Dawson, & Kingstone, 2013; Wentling, Park, & Peiper, 2007).

The use of instructor-defined annotations such as key-point annotations are more relevant to OER instructional videos for cross-border education. This is because instructor-defined annotations could better help ensure the authenticity and the relative correctness of concepts that are taught and emphasized. Instructor-defined annotations are more important because in the OER instructional video context, it is almost impossible for instructors to address students' questions and needs for understanding key concepts at the individual or personal level.

Transcript as a Language Support Option

Open educational resources instructional videos continue to be an important learning object for cross-border education. Consequently, the design of the specific features of OER instructional videos that could limit language barriers and support access for a broader student audience should become an important research concern. The discussion thus far has argued that for students of ESL countries who want to learn through OER instructional videos, onscreen text language support options such as key-point annotations could provide needed language support in cases of English form familiarity breakdowns. Another, and probably more important for ESL contexts, onscreen text language support option to consider would be interactive transcript. Unlike studies on annotations and captions, however, few studies have considered the relation between using transcripts and learning (Grgurovic & Hegelheimer, 2007; Ho et al., 2005; Jadin et al., 2009). Research on transcripts and learning are discussed in the next few sections.

Motivated by the need to address the real limitation of language barriers in a synchronous cross-border pre-MBA program, Ho et al. (2005) described an instant transcript and translation system that was developed to help students of non-native English countries to better comprehend web video lectures delivered in native English. According to Ho et al. (2005), "while distance education has dramatically reduced the barriers between different geographic regions, it has not yet had a similar impact on reducing the barriers between different languages" (p. 1). A major challenge the authors encountered was the problem of voice recognition accuracy during the instant transcription and translation process. Ho et al. (2005) attempted to address the problem through a noise cancellation device and by the use of re-talker isolated in a quiet room.

Open educational resources instructional videos are used mostly for asynchronous distance and cross-border education (Giannakos, Jaccheri, et al., 2014). Today technological advances have produced tools such as provided freely by YouTube that can generate instant transcript of video speech. Users can then use editing features provided by the same tools to correct inconsistencies in the transcript. Empirical support, however, about the effectiveness of the video transcript feature as a way to support language access in real video-based cross-border higher education remains missing. This study took on the challenge to examine the potential for interactive transcripts in limiting native English language barriers when ESL students choose to learn through OER instructional videos.

Grgurovic and Hegelheimer (2007) conducted a study to compare the effects of onscreen English subtitles and lecture transcripts on ESL students' listening comprehension of an academic video lecture. Eighteen students of the English language enrolled at a research university in the US participated in the study. The study also examined students' usage behavior of the subtitles and transcripts. Participants in the study viewed ten 30-90 seconds video segments, each followed by one multiple choice comprehension question in addition to four summative questions at the end of the final video segment. Participants were presented with the option to view a video segment again with the added choice of either subtitles or transcripts only in instances where they had answered a question incorrectly. Thus, those who answered correctly to all questions never got to use the onscreen text options. Grgurovic and Hegelheimer (2007) found that participants accessed the subtitle help option about two to three times more often than they accessed the transcript help pages. Also, higher English ability students interacted more with the help options and participants who interacted more with subtitles and/or transcripts performed significantly better on comprehension posttests than those who did not.

Although Grgurovic and Hegelheimer (2007) provides some useful needed evidence, the study was not without limitations. Students in the study probably chose the subtitle option more often because it was what they knew or were familiar with, an observation that some of the students in the study alluded to. Also, the activity involved academic listening and not learning a subject content per se, so students' motivation may have been different. In the study by Grgurovic and Hegelheimer (2007), transcripts were static and the design of the video lecture offered students no control. Few participants were observed on relatively many variables - transcripts, subtitles, transcripts and subtitles, and onscreen dictionary. Additionally, students' grouping was not based on randomization limiting the study's external validity. By design, the student groups were largely systematically different so findings of statistical significance were not surprising and probably should not have been conducted at all. We want the groups to probabilistically differ solely on the factor being studied before conducting such a study, which did not appear to be case here. There were pre-existing systematic differences between participants that were not controlled. Additionally, Grgurovic and Hegelheimer (2007) found significance only on behavior measures and not on learning measures.

English as a second language students may prefer to read when listening is a problem. Thus, participants who preferred reading chose transcripts while those predisposed to subtitles chose that option. The design of this dissertation study addressed the above mentioned limitations of the design of Grgurovic and Hegelheimer (2007). This thesis study was conducted in a non-native English-speaking country where student participants were more likely to be relatively high English ability students except for differences in the form between spoken native and non-native English. Also, this study used interactive transcripts and key-point annotations that provided more control to students simulating an authentic OER instructional video situation. Differences in participants' learning of actual academic content were observed on those onscreen text options only. In addition, this study used an experiment approach that allowed all participants to have an equally likely chance of being in a treatment group.

Recognizing the need for research evidence on how to effectively design instructional videos to promote student learning, Jadin et al. (2009) conducted an experimental study to examine the effect of lecture transcripts on students' knowledge acquisition. Participants were German and Austrian students who viewed a video lecture in native UK English either with or without onscreen transcript that was synchronized with the video speech at a constant pace. The videos in the study by Jadin et al. (2009) were designed with the standard video control buttons of play, stop, pause, skip forward, skip backward, and volume control. In addition, viewers' video screen had different sections each for displaying slides, slide notes, a list of web links to external resources, a table of content, and transcripts. The space for the transcript was left blank for the no transcript group. With the exception of transcripts and the standard video controls, all the other views listed created potential legitimate confounders.

Unlike Grgurovic and Hegelheimer (2007), Jadin et al. (2009) found no significant differences in the posttest performance between students in the group with transcript and the group with no transcript. They however found significant differences between students who focused on and interacted with video lectures through video control buttons over those who focused on the external web links. Thus, the deciding factor of student performance in the study was learner control through interactivity with the video lecture and not just the inclusion or non-inclusion of transcript.

Transcripts are visual text repeats of video speech, web links are not and may have contained extraneous information not necessarily helpful to students' learning. In the context of Jadin et al. (2009), web links were distracting violating a basic multimedia instructional design principle of avoiding the inclusion of extraneous material, what is called the coherence principle (Clark & Mayer, 2011; Mayer & Moreno, 2002). Students in the study by Jadin et al. (2009) who spent more time on the video lecture itself over external web links showed significant learning gains, making it difficult to ascertain what features - transcripts or video control, actually affected students' learning. Unlike the transcripts used in the study by Jadin et al. (2009), interactive transcripts provide students with much viewing control of video content. A better design would also avoid the inclusion of extraneous material such as additional web links.

Interactive versus static transcript. The transcripts in the literature discussed so far were static, in that they were non-interactive and linear. Further, whether in print, synchronized, or non-synchronized onscreen form, students had no direct control over the transcript options. The transcripts discussed had also been employed mainly in static graphics, animations, or

PowerPoint presentations. Interactive transcripts are usually used with online videos. In addition to providing the feature of automatic synchronization that can be controlled, interactive transcripts allow for the selection of a word or portion of the transcript and being taken to the specific portion of the video. Interactive transcripts may also provide a keyword search feature that may be used to navigate specific parts of a video. The effects of interactive transcripts within the context of learning with instructional videos, however, is yet to be explored in research.

Onscreen text language support options may not be suitable for students with low English proficiency (Vanderplank, 2010). This unsuitability is because the simultaneous presentation of images, sound, and onscreen text may place relatively higher demands on their cognitive capacity (Danan, 2004; Grgurovic & Hegelheimer, 2007). However, for students who have higher English proficiency, onscreen text support options may be helpful (Danan, 2004; Grgurovic & Hegelheimer, 2007; Wallen et al., 2005). The potential usefulness of onscreen text support in situations of unfamiliar spoken English can be partly explained by the dual-coding theory (Clark & Paivio, 1991). The reinforcement afforded by the combination of video, spoken and written text would be expected to initiate referential connections between the verbal and nonverbal mental systems and lead to improved comprehension and hence learning performance. The latter was expected to be the case for students of ESL countries learning through OER instructional videos. Students of ESL countries were expected to benefit from the use of onscreen text support because they are of relatively higher English proficiency except for differences in native and non-native spoken English forms.

Cognitive Theory of Multimedia Learning

This dissertation study examined for the redundancy principle of the cognitive theory of multimedia learning (Clark & Mayer, 2011; Mayer & Moreno, 2002) on non-native English-speaking students of an ESL country learning through OER instructional videos delivered in native English. Cognitive theory of multimedia learning states that multimedia instructional design that fits the way the human mind works is more likely to lead to meaningful learning than otherwise (Clark & Mayer, 2011; Mayer & Moreno, 2002). The cognitive theory of multimedia learning is based on three cognitive-based learning principles including cognitive load theory (Chandler & Sweller, 1991; Leahy & Sweller, 2011), the dual-channel memory concept (Baddeley, 1992; Paivio, 1986), and the concept of the human mind as an active processor of information (Mayer & Moreno, 2002; Mayer, 2005).

Cognitive Load Theory

Cognitive load theory is an instructional theory concerned with how to use the affordances and limitations of a human working memory that is limited both in capacity and duration. Cognitive load theory draws on the dual-channel memory structure and how it interacts with a limited working memory and an unlimited long-term memory to maximize learning (Kirschner, 2002; Leahy & Sweller, 2011). Learning, defined as change in performance, requires the processing of information in working memory (Kirschner, 2002).

The demand (load) placed on working memory during information processing comprises of what are called intrinsic, and extraneous cognitive load (Kirschner, 2002). Intrinsic cognitive load is imposed by the inherent nature of a learning content or event. The learning environment and manner in which learning material is organized and presented also place load on working memory. If the organization of information presentation or learning events is extraneous or interferes with the process of information processing, it leads to extraneous cognitive load (Paas, Renkl, & Sweller, 2003; Sweller, Ayres, & Kalyuga, 2011). Both intrinsic and extrinsic cognitive load require the limited working memory to use resources that are relevant (germane) for information processing and transfer to long-term memory (Sweller et al., 2011).

Learning design should therefore consider the inherent nature of the subject matter and/or task as well as how to organize and present instruction to minimize cognitive load and maximize learning. Cognitive load theory recommends that the events of instruction should be organized such that the use of cognitive resources neither leads to outstretching of working memory capacity (cognitive overload) (Chandler & Sweller, 1991) or underuse of working memory, which is not efficient (Lohr & Gall, 2008). According to cognitive load theory, the limitations of working memory can be overcome and the likelihood of information transfer to long-term memory increased by organizing instruction such that both dual memory channels are used over either the auditory or visual channel alone (Kirschner, 2002; Leahy & Sweller, 2011).

Redundancy Principle

The redundancy principle is one of five multimedia learning principles outlined by the cognitive theory of multimedia learning. These principles are summarized below:

1. Multimedia principle: choose a combination of words and graphics over words alone.
2. Contiguity principle: present words and their associated graphics simultaneously.
3. Coherence principle: avoid the use of extraneous material, words or pictures.
4. Modality principle: present words as spoken narration rather than onscreen text.
5. Redundancy principle: explain visuals with either text or audio but not both.

The redundancy principle or effect states that in presenting static or moving pictures, learning is promoted and not hindered when corresponding words are presented as auditory narration only, rather than as narration together with visual onscreen text (Clark & Mayer, 2011; Mayer, Heiser, & Lonn, 2001). The cognitive processing assumption behind the redundancy principle is that presenting the same words as both audio and onscreen text will overload the verbal system according to dual coding theory (Clark & Paivio, 1991), or the visual channel according to Baddeley's working memory model (Baddeley, 1992).

According to the same redundancy principle, however, there are boundary conditions where using pictures, corresponding word narration and onscreen text could be better for learning than word narration and pictures alone. According to Clark and Mayer (2011), one boundary condition is where the learner has control of the multimedia learning material. Both OER instructional videos and interactive transcripts allow users to control and interact with video and its content. Another boundary condition is where the learner is likely to have difficulty processing spoken words such as where the learner is not a native speaker of the language of instruction. This study was conducted on non-native English-speaking students of an ESL country. A third condition involves where a few keywords are shown next to a corresponding picture (Clark & Mayer, 2011; Mayer & Johnson, 2008). Key-point annotations as defined for this study met the criteria of the keyword boundary condition.

Since Mayer et al. (2001) put forward their multimedia learning principles, the redundancy principle in itself has received relatively little research focus especially when compared to the modality principle. Several more studies, however, dating back at least three decades to 2002, have examined verbal redundancy in computer-based and multimedia learning (Adesope & Nesbit, 2012; Barron & Kysilka, 1993; Neuman & Koskinen, 1992; Severin, 1967). Verbal redundancy in video and other multimedia learning refers to concurrently presenting spoken narration and written text of the same spoken narration (Adesope & Nesbit, 2012). Some studies that specifically examined the redundancy principle include Austin (2009), Hernandez

(2004), Mayer and Johnson (2008), and Yue, Bjork, and Bjork (2013), all of which were conducted in universities in the native English context of the United States.

The redundancy effect has been replicated in a number of studies (Austin, 2009; Yue et al., 2013). In four different experiments, Austin (2009) examined the redundancy principle to determine what cognitive individual characteristics and variations in multimedia display affect students' test performance. Using the exact script, timing, images, and transfer test of Mayer (2001), Experiment 1 replicated Mayer's research design for testing the redundancy effect. Experiment 2 examined students' cognitive individual differences including working memory, multimedia comprehension skill, and fluid intelligence. Experiment 3 examined variations in onscreen text positioning - below versus next to animation. In all first three experiments, Austin (2009) found that average transfer test scores of students in an animation with audio narration group were significantly higher than the scores of students in an animation with audio narration and onscreen text group, confirming the redundancy effect. The redundancy effect, however, was not found in Experiment 4 where onscreen text was placed next to the animation and was made static – not motioned to synchronize with narration.

Unlike the authentic context of an OER instructional video, the research context of Austin (2009) did not simulate authentic learning environments but used short 140 seconds animations made up specifically for the study. Under such circumstances, the learning material may be of no interest to students. As a result, students may have had no real motivation to learn the material used in the study. Longer study durations have been found to be associated with better student performance when animations are combined with audio and audio text (Adesope & Nesbit, 2012). Also, authentic video-based learning such as by OER instructional videos is not linear where students have to view a short animation from start to finish with no option to control or interact with the video learning object. Departing from studies such as Austin (2009), this thesis study involved the redundancy principle's boundary conditions of non-native speakers of English in an ESL context, the real learning object of OER instructional videos, key-point annotations, and student controlled videos and interactive transcripts.

The design of the studies that supports the redundancy effect such as by Austin (2009) and Mayer et al. (2001) mostly employed experimental design. Adesope and Nesbit (2012), in contrast, conducted a meta-analysis of 33 articles involving 57 independent studies on the use of verbal redundancy in multimedia learning. Adesope and Nesbit (2012) found that in general, students who learned with presentations that combined text with spoken narration significantly outperformed those who learned with audio narration only, a conclusion that was contingent on a number of moderating factors. The factors included whether or not images or animations were used, learners' reading fluency of the language of instruction, learner or system control of a presentation, and the degree of correspondence between spoken and associated onscreen text. Where images or animations were used, adding spoken with onscreen texts did not enhance learning compared to narration only (Adesope & Nesbit, 2012). However, Adesope and Nesbit (2012) did not make specific reference to authentic video instruction. Narration with associated onscreen text was found to be especially beneficial to ESL students, students with lower reading proficiency in their first language, and students who had low prior knowledge of content.

According to Adesope and Nesbit (2012), instructional presentations that used partially redundant onscreen text with spoken narration were found to have produced better students' performance than presentations that used fully verbatim onscreen text. The finding involving the boundary condition of partially redundant onscreen text such as keywords and abridged key-points was also made by Mayer and Johnson (2008) and Yue et al. (2013). Presenting students with two or three keywords with narration resulted in they significantly outperforming students in a non-redundant verbal group on a retention test but not on a transfer test (Mayer & Johnson, 2008). Compared to a verbatim redundant onscreen text group however, a student group that received an abridged onscreen text version that preserved the main point of a narration scored significantly higher on both retention and transfer tests (Yue et al., 2013).

Whereas Mayer and Johnson (2008) used two PowerPoint presentations, one lasting between 128 to 160 seconds and the other 64 to 80 seconds, the study by Yue et al. (2013) used a slightly longer presentation of 253 seconds. This adds to the evidence that combining audio narration and onscreen text in longer multimedia presentations may lead to better student performance. The discussion on the use and effect of onscreen text language support options on learning through videos may be explained by the dual-coding theory.

Dual Coding Theory

Dual coding theory is not only a theory of learning and cognitive information processing (Clark & Paivio, 1991; Paivio, 1986) but also, it has provided useful explanations to several education and learning phenomena (Sadoski et al., 1991). Dual coding theory (DCT) better explains the core message of cognitive load theory relevant to this study, which is to maximize the limited working memory by designing instruction to make use of both dual memory systems over one system only. Perhaps the strongest justification for choosing DCT is that Mayer's theory, the only cognitive theory of multimedia learning discussed, is based on DCT (Mayer & Moreno, 2002; Mayer, 2005).

Dual coding theory provides a lens for examining the effects of using onscreen text language options such as interactive transcripts and key-point annotations on ESL students' learning through OER instructional videos. Both the associative and referential characteristics of

DCT provide important implications for this study. The associative assertion has been found to be true in the listening comprehension of ESL listeners (Robinson, 2004). Secondly, the DCT, according to Clark and Paivio (1991) stipulates that the additive effect (dual-code) of referential processing (i.e. imagery and verbal representation and processing) is better for comprehension than either of the two representations alone. Several studies have tested and found support for this hypothesis (Hernandez, 2004; Mayer & Moreno, 2002; Muhirwa, 2009). According to the DCT, the associative characteristic of the verbal system allows for the association of words, phrases, and sentences through learning and experience/schemata (Sadoski et al., 1991). Instructions that have applied the associative characteristic of the DCT have been found to be effective at enhancing listening comprehension (Clark & Paivio, 1991; Jones, 2001; Mayer & Moreno, 2002; Mayer, Sobko, & Mautone, 2003).

Therefore, the nature of OER instructional videos, video with audio instruction, would be expected to allow for the use of both the verbal (audio) and nonverbal (video) mental subsystems. It was expected in this study that including associated onscreen text would help remove or minimize the language barrier of seemingly unfamiliar words that may be as a result of unfamiliar spoken native English. By simultaneously presenting audio instruction and associated words, non-native English speaking students were expected to mentally associate the words they hear, but that may have sounded unfamiliar with the corresponding transcript or key-point annotations. Going by the associative characteristic of the DCT, the mental word associations would allow for better words (verbal) associative processing into concrete language, increasing the likelihood of better listening and hence aid the learning process. The mental linkages created between what students hear and the corresponding onscreen text was expected to enable students to subsequently associate their linked words to their own mental representations (schema) of familiar English words. Further, the additive effect of video, audio, and onscreen text, which allows for the use of both mental subsystems during the associative and referential processes was expected to lead to better comprehension and hence learning than video and audio alone.

Summary of Relevant Research

Instructional videos have now become a de facto standard for delivering open online courses and other OER content. The challenge now is to examine specific video design features that could support students from varied language backgrounds to access content and learn through OER instructional videos. While longer instructional video length has been found to be better for student performance (Adesope & Nesbit, 2012; Yue et al., 2013), previous experimental studies (Austin, 2009; Mayer & Johnson, 2008) have mostly used made-up videos of short length lasting few seconds. Previous studies by Adesope and Nesbit (2012), Jadin et al. (2009), and Zhang et al. (2006) also indicate that the most salient contributors to student learning through instructional videos include the ability of learners to interact with, and control video features and learning material. However, research that examines the redundancy principle's boundary conditions of learner control, language limitation, and technical or complex academic content is lacking. Further, the authentic learning object of OER instructional videos for cross-border education and the particular limitation of language are yet to be explored.

Therefore, this thesis study investigated how two potential language support options could support ESL students’ learning through OER instructional videos that were delivered in native English. Key-point annotations and interactive transcripts in particular make it possible for learners to control as well as interact with instructional videos and learning content. On the one hand, onscreen text may be truly redundant to native English speaking students who watch

OER instructional videos delivered in native English. In that case, onscreen text may be a nuisance that unnecessarily consume cognitive resources. On the other hand, onscreen text may not be redundant for non-native English speaking students, especially in situations where native English instruction may be unfamiliar. In those cases, onscreen text would be expected to aid learning through schema acquisition by linking known but unfamiliar terms with what is already known in ESL students' memory. Therefore, interactive transcripts and key-point annotations would be expected to aid ESL students learning through OER instructional videos delivered in native English to fill in the gaps in cases of language comprehension breakdowns. Interactive transcript and key-point annotations were expected to aid instructional message comprehension and lead to better learning performance.

CHAPTER 3

RESEARCH DESIGN

The purpose of this study was to examine the effects of interactive transcripts and key-point annotations on ESL students' learning through OER instructional videos. A two-factor experimental design was used. The two factors were interactive transcripts and key-point annotations, each with two levels – present and absent, as indicated in Figure 3.1. The four treatment combinations include: 1) instructional videos with no onscreen text support option (control group); 2) instructional videos with interactive transcript (transcripts group) (See Appendix A); 3) instructional videos with key-point annotations (annotations group) (See Appendix B); and 4) instructional videos with both interactive transcript and key-point annotations (both treatments group). The study also used focus group interviews and an online survey to collect participants' opinions about their experiences with using the onscreen text language support options and the OER instructional videos.

		Interactive Transcripts	
		Absent	Present
Key-point Annotations	Absent	1) Control group	2) Transcripts group
	Present	3) Annotations group	4) Both treatments group

Figure 3.1. Treatment Combinations

Participants

Participants included volunteer second and third year undergraduate students enrolled in two technology university colleges in Ghana. Two instructors, one from each college, were contacted through phone and email to help recruit students for the study. Also, a letter requesting permission (See Appendix D) to conduct the study was sent to each college.

Sample Size Determination

In order to obtain an estimate of a sample size for the study, the standard significance level of $\alpha = 0.05$ was assumed. The study's design involved two treatment factors, a posttest score as the outcome variable, a pretest score as covariate, and two colleges as blocking factors. An Analysis of Covariance (ANCOVA) model was therefore used. An equivalent study was not found, thus, no predictions about means of the four treatment groups were made. Instead, the grading scale of the two colleges was used. Both colleges use the same grading scale as described in Figure 3.2.

Percentage	Letter Grade	Definition
70 and above	A	Excellent
60-69	B	Very Good
50-59	C	Good
40-49	D	Pass
0-39	F	Fail

Figure 3.2. Grading scale of the two colleges.

Participants were expected to have little to no prior knowledge of the content of the instructional videos. A certain high level of English proficiency is required for students to be admitted into the two colleges, all treatment groups were therefore expected to perform better after watching the instructional videos. However, the control group was expected to record the lowest mean score. The following assumptions were made for the sample size estimation:

1. A mean score of 60% for the control group after the viewing of instructional videos.
2. A common within group standard deviation of 10.

3. A mean final score of 75% for the best performing group.
4. A mean score of 65% for the other two treatment groups.
5. A balanced design, no block (college) effects, and no interaction effect.
6. A correlation of 0.3 between the outcome variable and the covariate.

A power analysis using the SAS statistical software determined that about 34 participants per treatment group for a total sample size of about 136 participants would be needed for a statistical power of 0.80.

Context

The research study was conducted onsite at two technology university colleges in Ghana. One college was private and the other public. Ghana is an official English-speaking country. Applicants to the two colleges and all colleges in Ghana must obtain a set pass in English on a regional or entrance exam in order to qualify for admission. Both schools offered programs that were mostly in the disciplines of information technology, computer science, computer and telecommunications engineering, and business administration. Data was collected separately at each college under controlled settings using a computer lab or classrooms with computers. The data collection process was controlled in the sense that students were randomly assigned to treatments and were allowed no interaction with colleagues or unauthorized resources.

Data Collection Tools

The primary sources for collecting data were participants, instructional videos, a pretest, a posttest, focus group interviews, and a post-study opinion survey. Background and demographic data including gender, college major, and the number of months that participants may had spent studying and/or working in a native English country were also collected. Examples of native English-speaking countries are the United Kingdom, the United States of

America, Canada, and Australia. Gender and college major were not variables of interest but were collected for the purpose of descriptive statistics. Participants' consent (See Appendix E), background, demographic, and opinion data were collected through the University of Georgia (UGA) Qualtrics platform. The pretest and posttest were administered through Google Forms. The open source online learning management system, edX Studio (See Appendix F), was used as the primary platform for the study. edX Studio was used to host participant registrations, course modules, instructional videos, and links to the knowledge tests and Qualtrics surveys.

Instructional Videos

Two sets of videos on content that were likely to be unfamiliar to participants were downloaded for the study in consultation with the two instructors. One set of videos covered portions of a module on the topic of Quantitative Methods in the Social and Behavioral Sciences, which was delivered through the Coursera platform by Dr. Annemarie Zand Scholten of the University of Amsterdam. The videos on the Quantitative methods course is referred to as Research Methods Module in this study for convenience, and also because the videos used mainly covered topics on research methods. The videos on research methods had a picture-in-picture video format that showed a depiction of the real image of the instructor teaching with a display board, slides, or a combination of both (Appendix A or Appendix B). The set of videos consisted of three videos covering the subtopics of Non-Scientific Methods (4:00 minutes), Scientific Method (8:50 minutes), and Disconfirmation (2:30 minutes) adding up to a total of 15:20 minutes of video length. The videos on research methods had a creative commons license that allowed for them to be copied, displayed, used, repurposed, and shared provided the author or licensor was given the appropriate credit, the videos were used for non-commercial purposes, and any derivative works were also placed under an identical license.

The second set of videos was downloaded from the edX platform and covered portions of a module on Introduction to Cloud Computing. The module was delivered by Dr. Phillip A Laplante of the Institute of Electrical and Electronics Engineers (IEEE). This set of videos had a voice-over format that only showed lecture slides together with verbal narration (Appendix C). The cloud computing videos displayed no creative commons license, thus, the IEEE was contacted through email. After a brief telephone conversation with an IEEE representative, the IEEE consented to the use of the videos for the research and provided written approval (See Appendix G). The cloud computing set also consisted of three videos of 1:50, 5:20, and 6:20 minutes for a total of 13:30 minutes of video length.

Parts of the downloaded videos were time-edited without compromising relevant content in order to maintain a maximum total video length of not more than 30 minutes. All instructional videos were hosted on the YouTube platform. All editing and treatment of instructional videos were done using YouTube's Creator Studio tool.

Pretest and Posttest

All questions on pretests and posttests were obtained through the same means as the instructional videos. The choice to use test items that were part of the downloaded video modules was for the main objective of simulating the real OER instructional video learning situation as much as possible. Two separate pretests were administered, one for each module. Pretest 1 (See Appendix H) comprised of five multiple choice questions covering the research methods module. Pretest 2 (See Appendix I) covered the cloud computing module and also comprised of five multiple choice questions. Likewise, two separate posttests, each comprising of 10 questions, were administered for each module. Each module's posttest comprised of all the pretest questions for that module in addition to five additional questions. Thus, posttest 1 (See Appendix

J) comprised of 10 questions covering the research methods module, while posttest 2 (See Appendix K) had 10 questions on the cloud computing module.

Test items that were considered to address the levels of remembering and understanding of Bloom's Taxonomy (Forehand, 2005) were used. Remembering was measured by test items that required students to recognize and recall concepts in the approximate form in which they were delivered. Understanding was measured by items that required students to infer from concepts. Bloom's Taxonomy addresses the cognitive domain of learning by categorizing in hierarchical order, thinking behaviors that are considered essential to the learning process (Forehand, 2005). Bloom's Taxonomy consists of six cognitive levels of complexity – remembering, understanding, applying, analyzing, evaluating, and creating, where attaining lower levels are necessary for achieving higher ones. The relatively controlled setting and short time period of the study made testing remembering and understanding appropriate. Also, similar studies had involved testing recall and comprehension tests (Austin, 2009; Chen & Wu, 2015; Mayer & Johnson, 2008).

Correct answer choices of test items categorized as remembering questions were scored with one point, while correct answer choices categorized as understanding questions were scored with two points. Categorization of test items was based on the results of expert validity reviews of the test items. One test item on research methods and four test items on cloud computing had a two-point score. One point was possible on all other test items. Together, a total pretest score of seven points and posttest score of 14 points were possible on the Cloud Computing module. A total pretest score of eight points and posttest score of 15 points were possible on the research methods module. Final scores were converted to percentages.

Test items were examined for validity and reliability. Validity was taken to mean the degree of congruence between a test item and the content delivered in the instructional videos. Thus, if participants saw the instructional videos for a module, then they should have the information needed to answer test items on that module. Reliability was taken to mean the internal consistency in participants' scores on test items (Crocker & Algina, 1986). Initially, the instructors for both the cloud computing and research methods modules were contacted through email for information on the validity and reliability of the test items. After follow-up emails, no response was received from the research methods instructor. The IEEE, however, generously provided student test response data for a course session that was offered in 2015.

Data Collection Procedures

Data was collected during the second (Spring 2016) school semester. An initial in-person contact and briefing was held with prospective participants at each of the two colleges. At the briefing session, the purpose of the study as well as any commitments required of participants were explained to prospective participants. Prospective participants' questions were also addressed. Students who volunteered to participate were asked to register, in no systematic order, with their first names, email addresses, college major, college year, and institution name. Registered participants were then randomly assigned to treatment groups and added to the study on edX Studio. One participants signed up, they were automatically taken to content for their respective treatment groups on edX Studio.

Data collection sessions for non-opinion data occurred in a computer lab or in class using personal computers. During data collections sessions, participants were introduced to how to complete the study including using the edX Studio platform, instructional videos, onscreen text options, and online surveys. Participants were then given about 15 minutes to practice using dummy instructional videos. The actual study began after the tutorial session. A data collection session for each participant began with the signing of a no signature online consent form, and then lasted for about two and half to three hours. All participants saw the same videos and content except for differences in onscreen text options according to treatment groups.

Participants Opinion Data

Participants' opinion data on their experiences with the study were collected through an open-ended survey (See Appendix L) administered online through UGA's Qualtrics platform and through face-to-face focus group interviews. Participants were given the option to participate in a focus group session upon signing the online consent form. A focus group interview protocol (See Appendix M) was developed and used to conduct the sessions. Two focus group sessions were conducted, one at each college. Meeting times and places on the college campuses, referred to as College_R and College_G, were arranged with participants who volunteered for the focus group sessions. The meeting at College_R was held at a students' lounge at about 4pm on March 24, 2016, while the meeting at College_G took place in a classroom at about noon on March 30, 2016. Eight students participated at College_R and five students participated at College_G. Interviewees were representative of all treatment groups. The sessions lasted about 30 minutes each and were audio-recorded with the permission of participants. The focus group sessions were quite informal and all attendees contributed. To summarize, a complete data collection session for participants involved doing the following using a personal computer in a lab or class:

1. Completing a consent form.
2. Providing basic demographic information.
3. Completing pretest 1 on Research Methods.
4. Viewing set of instructional videos on Research Methods.

5. Completing posttest 1 on Research Methods.
6. Completing pretest 2 on Cloud Computing.
7. Viewing set of instructional videos on Cloud Computing.
8. Completing posttest 2 on Cloud Computing.
9. Completing post-study opinion survey.
10. Participating in a focus group session for participants who volunteered.

Data Analysis Procedures

Data analysis involving five main processes followed the data collection procedures: 1) Data preparation; 2) Descriptive statistics; 3) Analysis of covariance; 4) Validity and reliability analysis; and 5) Analysis of participants' opinion data. Data collected through the experiment was used for data analyses processes one through four. Separate analysis was conducted for the research methods and for the Cloud Computing modules for two main reasons. Firstly, not all participants were able to complete both modules. Secondly, it was observed that the differences in pedagogy and content focus between the two modules affected the study's outcomes in ways that necessitated separate analysis. Analysis of participants' opinion data was conducted using data collected through the opinion survey and focus group sessions.

Data Preparation

A number of participants who began the study by signing the online consent or completing one pretest were not able to complete the study primarily due to low internet bandwidth challenges. Only participants who fully completed a data collection process involving at least one module, research methods, cloud computing, or both were included in the analysis. College major was not used in the analysis because all participants had about similar majors – computer science, information systems science, and information technology. Also, almost all participants recorded zero months of studying or working in a native English-speaking country; the variable was therefore omitted in the analysis. Data preparation was done using MS Excel.

Descriptive Statistics

Descriptive statistics were produced for participants' demographics data, all variables, and the distribution of pretest and posttest scores across treatment groups. Exploratory data analysis was conducted using the SAS and R statistical programs.

Analysis of Covariance

The design of this experimental study involved two treatment factors, interactive transcripts and key-point annotations, each having two categories – present and absent, giving a 2 x 2 factorial treatment structure. Participants' prior knowledge of the content of the experimental modules was also controlled for through pretest scores to help reduce error variance (Dimitrov & Rumrill, 2003). In order to control for potential nuisance sources of heterogeneity resulting from differences between the two colleges, and appropriately detect treatment differences, college was used as a blocking or grouping factor. The design of the study was therefore a randomized complete block design which assigned all treatments equally within each college (block).

A two-way analysis of covariance (ANCOVA) was therefore conducted. The ANCOVA involved posttest score as the response variable, interactive transcripts and key-point annotations as independent variables, pretest score as covariate, and college as blocking factor. The ANCOVA also examined for possible interaction effects between interactive transcripts and key-point annotations. Information gathered from descriptive statistics and model diagnostics, including checking for all ANCOVA assumptions, were used to determine an appropriate analysis model. Planned contrasts, estimates of treatment means and associated confidence intervals were also conducted using appropriate adjustments for controlling error rate. ANCOVA using the SAS statistical software was conducted to answer the following research questions:

1. Does including onscreen text in OER instructional videos make a difference in ESL students' learning performance?

   Planned comparison:

   a. No onscreen text (control) group vs. All groups with onscreen text option

2. What is the relative effect of interactive transcripts in OER instructional videos on ESL students' learning performance?

   Planned comparisons:

   a. No onscreen text option vs. Interactive transcript group

   b. Interactive transcript vs. Key-point annotations group

3. What is the relative effect of key-point annotations in OER instructional videos on ESL students' learning performance?

   Planned comparisons:

   a. No onscreen text option vs. Key-point annotations group

   b. Interactive transcript vs. Key-point annotations group (same as 2b above)

Validity and Reliability Analysis

Validity. A panel of experts evaluated each test item for validity. The panel of experts included a professor of instructional design with over 25 years of academic and professional experience, and a professor and specialist of educational measurement and assessment with 10 years of experience. Also included in the panel were a professional instructional designer with over seven years of experience and a sixth-year doctoral student of Learning, Design, and Technology at the University of Georgia. A Qualtrics link with all and the same instructional videos which participants eventually saw was sent to each member of the panel. The panel watched the instructional videos and completed an online validity questionnaire (See Appendix N). The validity questionnaire asked reviewers to categorize each test item as remembering, understanding, or neither. Reviewers also rated the degree of congruence among content of the instructional videos, each module's objectives, and associated test items.

Reliability. Test items were administered in a single test administration. Also, although the tests were multiple choice, not all test items were dichotomously scored. Therefore, a reliability estimation method based on item covariances, Cronbach's alpha, was used (Crocker & Algina, 1986). The reliability estimate for the cloud computing module was obtained using the year 2015 student test response data which the IEEE provided because the test items for this study were taken from the same question pool. The reliability estimate for the research methods module was obtained using participant responses to test items after completion of the study because no response was received from the creators of that module.

Analysis of participants' opinion data. Focus group sessions included participants from all treatment groups. Audio recordings of the focus group sessions were reviewed severally for recurring points and themes. Identified themes and associated participant statements that supported those themes were written down. Participant responses to the open-ended opinion survey were also reviewed for themes. Themes were assigned unique codes. Each response to the open-ended survey was then reviewed again and labeled with theme codes. Some responses were assigned multiple themes. Others did not have enough information to be labeled with a theme. Survey themes were organized by counts and examined according to the survey questions. Descriptive statistics was then used to highlight recurring and probably salient themes from the survey. The opinion survey was setup to allow for the collection of participant perceptions within treatment groups. This allowed for examining and comparing opinion data among treatment groups for possible relations about opinions expressed. Data from both the survey and focus groups were examined. Themes collected from the opinion surveys were compared with the themes from the focus group sessions. Attempt was also made to find possible relations between treatment group participants' opinions and group mean performance on the posttest scores. Direct quotations of participants' opinions were also used to support analysis findings.

CHAPTER 4

RESULTS

This chapter presents the findings of the study and the analytical processes conducted to answer the study's research questions. The chapter is organized into four main sections. The first section presents descriptive statistics of participants regardless of module. The second section presents analysis and findings of data collected on the research methods module. The third section presents analysis and findings of data related to the cloud computing module. Analysis of qualitative data collected through the focus group sessions and opinion survey are presented in the last section of the chapter.

Analysis of Data

Participants

Participants in the study included second and third year undergraduate students of two colleges, referred to as College_R and College_G in the analysis. The number of consenting participants from both colleges was 176. However, not every participant who started a data collection process was able to finish primarily because of low internet bandwidth. A balanced design was therefore not feasible.

There were 129 distinct participants regardless of college. College_R had 74 participants while College_G recorded 55 participants, representing 57.36% and 42.64% respectively. Ninety-one students were able to complete the research methods module representing 70.54% of the total of 129 distinct participants, while 119 students (92.25%) completed cloud computing. Seventy-nine students, representing 61.24%, were able to complete both modules. Twelve females (9.3%) participated in the study all of which completed both modules. Table 4.1 summarizes the number of participants who completed at least one module of the study. Tables 4.2 and 4.3 provide summary data on the distinct participants regardless of module. Raw test scores were converted to percentages for convenience and consistency. Using raw or percentage scores did not change the outcome of the statistical analysis. All analysis were conducted using an $\alpha = 0.05$ significance level unless indicated otherwise.

Table 4.1

Number of Participants Who Completed at Least One Module

	Research Methods	Cloud Computing	Both Modules
College_R	68	67	61
College_G	23	52	18
Total	91	119	79

Table 4.2

Number of Distinct Participants by Treatment Group Regardless of Module

	Control	Key-point Annotations	Interactive Transcripts	Both Treatments	Total
College_R	17	20	19	18	74
College_G	14	11	14	16	55
Total	31	31	33	34	129

Table 4.3

Number of Distinct Participants by Year of College Regardless of Module

	2nd Year	3rd Year	Total
College_R	29	45	74
College_G	55	0	55
Total	84	45	129

Validity and Reliability Analysis

Validity. The main objective of the validation process was to ensure that there was congruence between the test items and the content of the instructional videos. Also of importance was for each test item to be categorized as remembering or understanding as explained previously. The results of the expert reviews indicated that the objectives and content of the instructional videos for both modules were generally aligned with the test items. Other reviewer comments were related to issues such as possibly adding items that measured higher levels of knowledge complexity. Table 4.4 presents reviewer responses to the validity questionnaire on the test items for the research methods module. Four reviewers provided responses to the research methods questionnaire, while three reviewers responded to the cloud computing questionnaire. Reviewers chose to respond to either or both modules according to their areas of knowledge and professional practice. Table 4.5 presents reviewer responses to the validity survey for the test items on the cloud computing module. Three reviewers responded to the survey. Reviewers were also asked to rate the degree of congruence among the objectives, test items, and the content of the instructional videos on a scale of 0 to 100. Results are provided in Table 4.6.

Table 4.4

Reviewer Responses (Votes) to Validity of Test Items for Research Method Module

Test Item	Remembering	Understanding	Neither	Total Number of Votes
1	3	1	0	4
2	3	1	0	4
3	0	3	1	4
4	2	2	0	4
5	1	3	0	4
6	3	1	0	4
7	3	1	0	4
8	4	0	0	4
9	2	2	0	4
10	2	2	0	4

Table 4.5

Reviewer Responses (Votes) to Validity of the Test Items for Cloud Computing Module

Test Item	Remembering	Understanding	Neither	Total Number of Votes
1	3	0	0	3
2	2	1	0	3
3	3	0	0	3
4	2	1	0	3
5	2	1	0	3
6	0	3	0	3
7	1	2	0	3
8	0	3	0	3
9	1	2	0	3
10	2	1	0	3

The results indicate that reviewers judged all test items as either remembering or understanding with the exception of test item 3 on the research methods module, which received one neither vote. Test item 3 on the research methods module, however, also received three understanding votes and was therefore of little concern. Disagreements among reviewer votes were not of much concern provided an item was categorized as either remembering or understanding. Reviewers also judged the objectives, test items, and the content of the instructional videos for the respective modules as generally aligned. Comments on the relatively low rating of 61% on the research methods module indicated that the reviewer expected the test items to have been written to measure higher levels of cognitive complexity. Measuring higher levels of cognitive complexity was however not in the purpose of this study.

Table 4.6

Reviewer Rating of Congruence among Objectives, Test Items, and Instructional Videos

Module	Min	Max	Mean	SD	Number of Responses
Research Methods	61	100	83.67	20.26	3
Cloud Computing	90	100	95	7.07	2

Reliability. As explained in the Data Collection Tools section of Chapter 3, all test items were taken from the respective course sites for each module. Reliability for both the research methods and cloud computing modules was estimated using data from participants' responses to each module's set of 10 test items. Reliability estimates obtained by using the data from this study is reported in Table 4.7. Reliability for the cloud computing module was also estimated using the data that the IEEE generously provided. The IEEE data had 23,917 observations. Observations with missing data were omitted leaving 740 observations. Cronbach's alpha for the set of test items from the IEEE data set which was used for this study was 0.904.

Table 4.7

Reliability Measures by Module Using Data from this Study

	N	*Cronbach's alpha*
Research Methods	91	0.59
Cloud Computing	119	0.30

Analysis of Research Methods Module Data

This section presents analysis and results for data on the research methods module. Table 4.8 summarizes the number of participants by treatment group and college. Tables 4.9 and 4.10 provide summaries of pretest and posttest scores by treatment group, while average change in pretest and posttest scores are provided in Table 4.11. Figure 4.1a shows mean scores, while Figure 4.1b shows the distribution of pretest and posttest scores by treatment group.

Table 4.8

Number of Participants by Treatment Group for Research Methods Module

	Control	Key-point Annotations	Interactive Transcripts	Both Treatments	Total
College_R	15	18	18	17	68
College_G	6	3	6	8	23
Total	21	21	24	25	91

Table 4.9

Summary of Pretest Scores (%) by Treatment Group for Research Methods Module

	N	Min	Max	Median	Mean	SD
Control	21	0	75.00	25.00	29.17	21.04
Key-point Annotations	21	0	62.50	37.50	29.17	16.93
Interactive Transcripts	24	0	75.00	25.00	26.04	21.15
Both Treatments	25	0	75.00	37.50	29.00	23.03

Table 4.10

Summary of Posttest Scores (%) by Treatment Group for Research Methods Module

	N	Min	Max	Median	Mean	SD
Control	21	6.25	87.50	56.25	52.38	19.71
Key-point Annotations	21	31.25	93.75	56.25	59.23	18.29
Interactive Transcripts	24	6.25	100.00	37.50	44.79	23.29
Both Treatments	25	31.25	93.75	56.25	59.75	14.56

Table 4.11

Mean Change Scores by Treatment Group for Research Methods Module

	Control	Key-point Annotations	Interactive Transcripts	Both Treatments
Change Score (%)	23.21	30.06	18.75	30.75

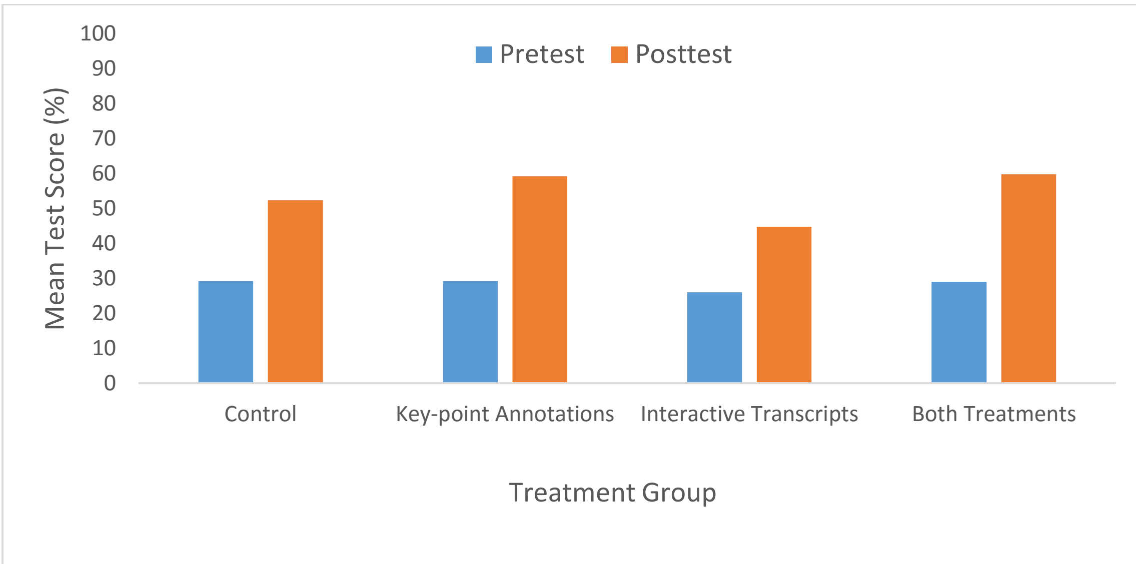

Figure 4.1a. Mean test scores for research methods module

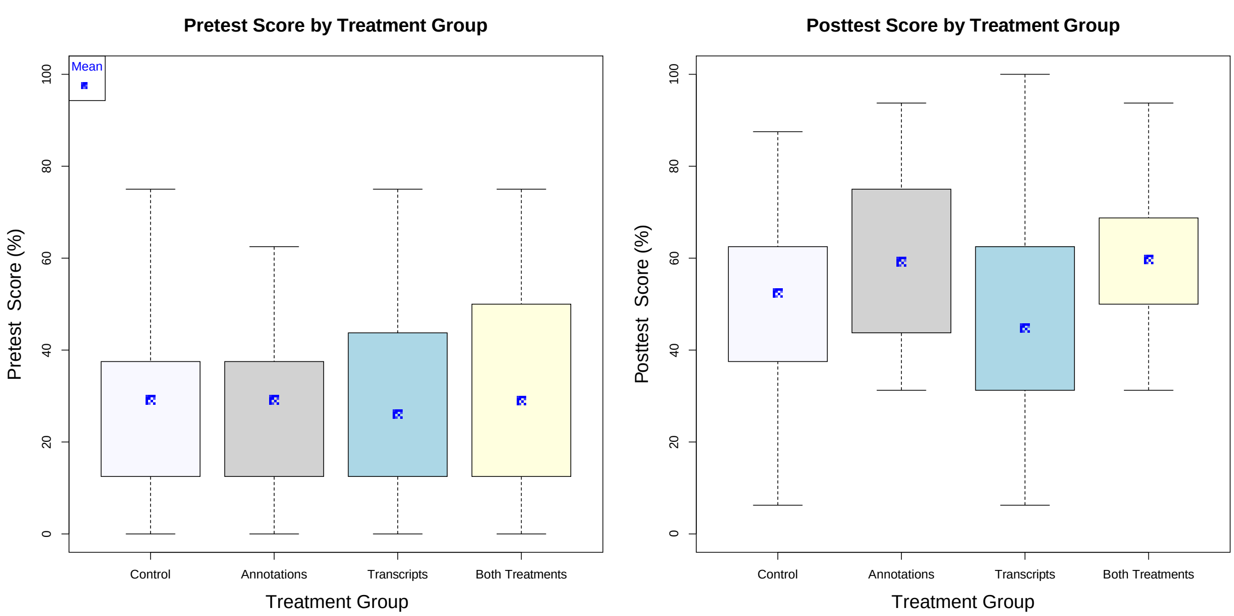

Figure 4.1b. Distribution of scores by treatment group for research methods module.

Examining for Assumptions of Analysis of Covariance for Research Methods Module

An ANCOVA model was used to analyze the research methods data and answer the research questions. Therefore, the assumptions of ANCOVA, as listed below, were examined:

1. Independence of samples
2. Homogeneity of variances among treatment groups
3. Normality of error terms
4. Independence between covariate and treatment
5. Homogeneity of regression slopes

The study randomly assigned volunteer participants into treatments groups at each college. Therefore, Assumption 1 was assumed to have been satisfied. Assumptions 2 and 3 can be tested by examining residual plots for the response variable, posttest. The ANCOVA model, *Model 1*, was specified and used to examine Assumptions 2 and 3.

Model 1: ANCOVA Model for Research Methods Module

$$\begin{aligned} Posttest\ score = {} & Grand\ Mean + Interactive\ Transcript + Keypoint\ Annotations + College \\ & + Pretest\ score + (Interactive\ Transcript \times Keypoint\ Annotations) \\ & + Experimental\ Error \end{aligned}$$

Figure 4.2 shows diagnostic plots for examining the ANCOVA assumptions of homogeneity of variances and normality. The residual versus fitted plots show no apparent pattern in the residual variation with the mean. Also, Brown and Forsythe's Test for Homogeneity of variances (modified Levene’s test) produced no significant results, $F\ (3, 87) = 0.88$, $p = 0.453$, indicating that the assumption of constant variance had been met. The normal probability (quantile-quantile) plot in Figure 4.2, and the not-significant results of Shapiro-Wilk tests for normality on the error terms, $W = 0.995$, $p = 0.976$, indicate no deviation from the assumption of normality.

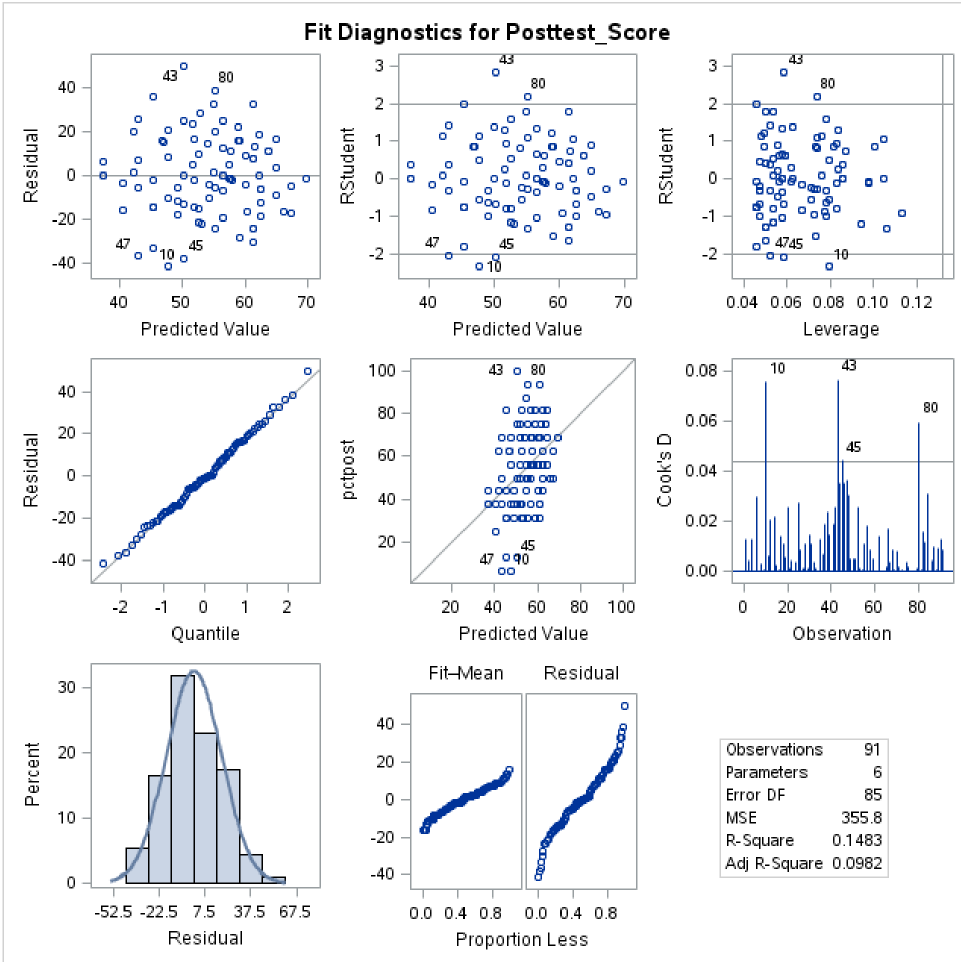

Figure 4.2. Diagnostic plots for ANCOVA assumptions for research methods module. Posttest score as outcome variable and pretest score as covariate.

Performing an analysis of variance (ANOVA) with the covariate (pretest score) as the response variable and the treatment as independent variables showed that the relationship was not significant, F (1, 86) = 0.06, p = 0.807 for interactive transcript, and F (1, 86) = 0.07, p = 0.786 for key-point annotations. The Type III analysis results are presented in Table 4.12 below. A not-significant finding, as it is in this case, indicates that the assumption of independence between the covariate (pretest score) and treatment has been satisfied.

Table 4.12

Test for Independence between Pretest Score and Treatment for Research Methods Module. Pretest Score as Outcome Variable

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Key-point Annotations	1	31.3923	31.3923	0.07	0.786
Interactive Transcripts	1	25.418	25.418	0.06	0.807

The assumption of homogeneity of regression slopes assumes that the relationship between the response variable and the covariate is similar across groups. The test for this assumption is provided in Table 4.13. The interaction between pretest score and key-point annotations was not significant, F (1, 85) = 3.25, p = 0.075. The interaction between pretest score and interactive transcripts was also not significant, F (1, 85) = 0.11, p = 0.742. Both results indicate that the assumption has been satisfied.

Table 4.13

Test for Homogeneity of Regression Slopes for Research Methods Module. Posttest Score as Outcome Variable and Pretest Score as Covariate

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Pretest Score x Key-point Annotations	1	1126.3662	1126.3662	3.25	0.075
Pretest Score x Interactive Transcripts	1	37.9361	37.9361	0.11	0.742

Model Estimation for Research Methods Module

The research questions for this study sought to investigate the effects of the onscreen text options of interactive transcripts and key-point annotations on ESL students learning performance through OER instructional videos. The ANCOVA model, as previously specified by Model 1, was estimated and the results in Table 4.14 were obtained. The ANCOVA results (Table 4.14) indicate that there is a difference in at least one pair of treatment means controlling for pretest score and college, *F* (5, 85) = 2.96, *p* = 0.016, $\eta_p^2 = 0.148$. College, the blocking factor, was not significant, *F* (1, 85) = 0.50, *p* = 0.480. The effect of pretest score on mean posttest score was not significant, *F* (1, 85) = 3.85, *p* = 0.053. The interaction between transcripts and annotations was not significant, *F* (1, 85) = 1.06, *p* = 0.306, indicating that the effect of the levels of annotations (present or absent) on posttest score was independent of the levels of transcript and vice versa. It is therefore appropriate to proceed to interpret the main effects of annotations and transcripts.

Table 4.14

Analysis of Covariance for Posttest Score: Research Methods Module

Source	DF	Type III SS	Mean Square	F Value	Pr > F	η_p^2
Model	5	5266.2107	1053.2421	2.96	0.016	0.148
Error	85	30242.8896	355.7987			
Corrected Total	90	35509.1003				
Key-point Annotations	1	2483.5482	2483.5482	6.98	0.010	0.076
Interactive Transcripts	1	199.2148	199.2148	0.56	0.456	0.007
Interactive Transcripts x Key-point Annotations	1	377.1905	377.1905	1.06	0.306	0.012
Pretest Score	1	1371.1571	1371.1572	3.85	0.053	0.043
College	1	178.8104	178.8104	0.50	0.480	0.006

The effect of interactive transcript on posttest score was not significant, *F* (1, 85) = 0.56, *p* = 0.456, holding the levels of annotations constant. The effect of key-point annotations on posttest score was significant, holding the levels of transcripts constant, *F* (1, 85) = 6.98, *p* = 0.010, $\eta_p^2 =$

0.076. A Fisher's LSD test indicated that the significance favored key-point annotations present over annotations absent with mean difference of 10.49%. Table 4.15 presents the least square means and associated confidence intervals of posttest score for the treatments.

Table 4.15

Least Square (LS) Means of Posttest Score by Treatment for Research Methods Module

Treatment Group	LS Mean	95% Confidence Limits	
Control	51.50	43.08	59.92
Key-point Annotations	57.87	49.05	66.70
Interactive Transcripts	44.40	36.36	52.44
Both Treatments	59.02	51.34	66.70

A preliminary review of the least square means of Table 4.15 suggests that the group that received both treatments recorded the highest mean posttest score at 59.02%. The group with both treatments was followed by the annotations group at 57.87%, the control group at 51.50%, and the interactive transcripts group at 44.40% in decreasing order. Further investigation, however, was performed to ascertain possible significant group mean differences.

Research Questions

Research Question 1: *Does including onscreen text in OER instructional videos make a difference in ESL students' learning performance?*

Research Question 1 examines whether there were significant learning performance differences, as measured by posttest scores, between the control group and the other three treatment groups, that is, groups that received any form of onscreen text. The results of the planned contrast that was used to examine Research Question 1 is provided in Table 4.16. Table 4.16 shows that there was no significant difference between the no onscreen text option (control group) and any form of onscreen text, interactive transcripts and/or key-point annotations, F (1, 87) = 0.21, p = 0.645. Table 4.17 presents pairwise comparisons among treatment group means using Tukey-Kramer's Adjustment.

Table 4.16

Planned Comparison between Control Group and Onscreen Text Groups for Research Methods Module

Source	DF	Contrast SS	Mean Square	F Value	Pr > F
Control vs. All other groups	1	78.6772	78.6772	0.21	0.645

Table 4.17

Pairwise Differences among Treatment Least Square Means of Posttest Score for Research Methods Module using Tukey's HSD Adjustment

Difference between Treatment Groups*	Mean Difference	Simultaneous 95% Confidence Limits		Pr > |t|
$Contr - kAnot$	-6.37	-21.73	8.98	0.698
$Contr - iTrans$	7.10	-7.70	21.90	0.593
$Contr - Both$	-7.51	-22.15	7.12	0.537
$kAnot - iTrans$	13.47	-28.31	1.36	0.089
$kAnot - Both$	-1.14	-15.93	13.65	0.997
$iTrans - Both$	-14.62	-28.80	-0.44	0.041

**Note on short names: Contr for control; kAnot for key-point annotations, iTrans for interactive transcript, and Both for both treatments.*

Tukey's HSD is used in a family of pairwise comparisons to control for the combined Type I error rate. Information in Table 4.17 also shows that all pairwise comparisons between the control group and any of the three onscreen text groups was not significant, suggesting that groups that received any form of onscreen text did not perform significantly different from the control group.

Research Question 2: *What is the relative effect of interactive transcripts in OER instructional videos on ESL students' learning performance?*

The ANCOVA results (Table 4.14) show that the effect of interactive transcript on mean posttest score was not significant, F (1, 85) = 0.56, p = 0.456. Relatively, results of the pairwise comparisons using Tukey's HSD (Table 4.17) indicate that the mean posttest score of the interactive transcript group was significantly lower than that of the group that received both treatments (p = 0.041), with a mean difference of 14.62%. Table 4.17 also indicates that the transcript group recorded no significant pairwise differences with either the control or annotations group. Results of Fisher's LSD test, however, indicated that the mean posttest score for the transcript group was significantly lower than the mean of the annotations group (p =0.020) and the mean of the group that had both treatments (p =0.008).

Research Question 3: *What is the relative effect of key-point annotations in OER instructional videos on ESL students' learning performance?*

The ANCOVA on key-point annotations yielded a significant effect on mean posttest score, F (1, 85) = 6.98, p = 0.010, $\eta_p^2 = 0.076$. The results of pairwise comparisons using Tukey's HSD (Table 4.17) recorded no significant mean differences between the key-point annotations group and any of the other three treatment groups. Results of Fisher's LSD test, however, indicated that the mean posttest score for the annotations group was significantly higher than the mean posttest score of the interactive transcript group, p = 0.020.

Analysis of Cloud Computing Module Data

This section presents analysis and results for data on the cloud computing module. Table 4.18 summarizes the number of participants by treatment group and college. Tables 4.19 and 4.20 provide summaries of pretest and posttest scores by treatment group respectively. Figure 4.3a shows the distribution of pretest and posttest scores by treatment group. Table 4.21 and Figure 4.3b show mean scores for pretest and posttest scores by treatment group.

Table 4.18

Number of Participants by Treatment Group for Cloud Computing Module

	Control	Key-point Annotations	Interactive Transcripts	Both Treatments	Total
College_R	17	19	15	16	67
College_G	14	10	14	14	52
Total	31	29	29	30	119

Table 4.19

Summary of Pretest Scores (%) by Treatment Group for Cloud Computing Module

	N	Min	Max	Median	Mean	SD
Control	31	0	71.43	28.57	29.49	22.72
Key-point Annotations	29	0	85.71	28.57	33.50	23.93
Interactive Transcripts	29	0	85.71	28.57	35.47	21.47
Both Treatments	30	0	85.71	28.57	33.81	20.02

Table 4.20

Summary of Posttest Scores (%) by Treatment Group for Cloud Computing Module

	N	Min	Max	Median	Mean	SD
Control	31	7.14	71.43	42.86	44.01	16.81
Key-point Annotations	29	0	100.00	42.86	42.86	21.34
Interactive Transcripts	29	14.29	78.57	57.14	52.46	15.19
Both Treatments	30	7.14	92.86	46.43	44.29	20.92

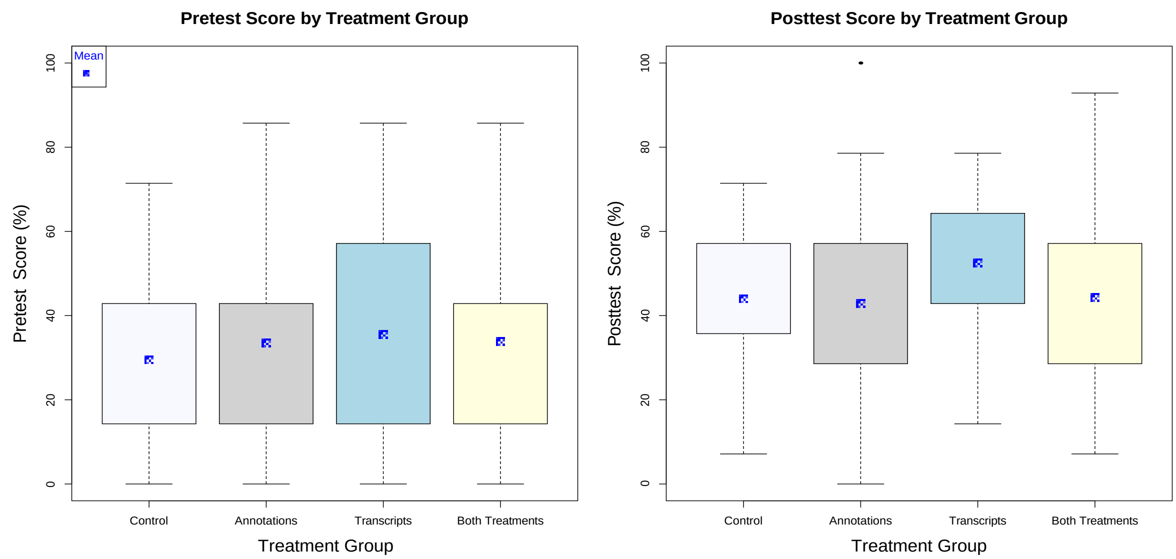

Figure 4.3a. Distribution of scores by treatment group for cloud computing module.

Table 4.21

Mean Change Scores by Treatment Group for Cloud Computing Module

	Control	Key-point Annotations	Interactive Transcripts	Both Treatments
Change Score (%)	14.51	9.36	17.00	10.48

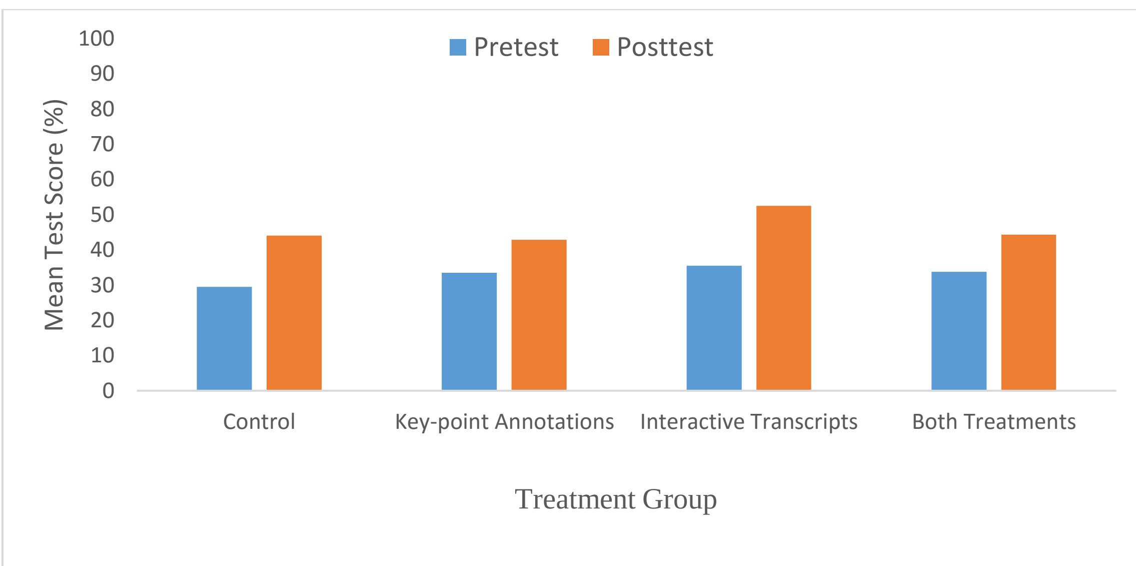

Figure 4.3b. Mean test scores for cloud computing module

Examining for Assumptions of Analysis of Covariance for Cloud Computing Module

Similar to the research methods module, an ANCOVA model was to be used to analyze the cloud computing module data, which called for examining ANCOVA assumptions. The assumptions of ANCOVA are relisted here:

1. Samples are independent
2. Homogeneity of variances among treatment groups
3. Normality of error terms
4. Independence between covariate and treatment
5. Homogeneity of regression slopes

As explained in the research methods module section, this study used a randomized complete block design, therefore, Assumption 1 was taken to have been satisfied. Assumptions 2, 3, and 4 were also satisfied but not Assumption 5, homogeneity of regression slopes. Relevant results of the test for homogeneity of regression slopes is provided in Table 4.22. The interaction between pretest score and key-point annotations was not significant, F (1, 113) = 0.60, p = 0.440. The interaction between pretest score and interactive transcripts was however significant, F (1, 113) = 9.65, p = 0.002. The results suggest that the assumption of equal slopes holds for key-point annotations but not for interactive transcripts, indicating that the slopes differ across the transcript categories. The results also suggest that the effect of transcript differs across certain levels of pretest score. Using traditional ANCOVA is therefore not appropriate (UCLA: Statistical Consulting Group, n.d.). An approach to addressing the violation of equal slopes was to use nonstandard but suggested adapted kinds of ANCOVA such as proposed by Wilcox (2005) and the Johnson-Newman technique (D'Alonzo, 2004).

Table 4.22

Test for Homogeneity of Regression Slopes for Cloud Computing Model. Posttest Score as Outcome Variable and Pretest Score as Covariate

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Pretest Score x Key-point Annotations	1	3.5154	3.5154	0.60	0.4402
Pretest Score x Interactive Transcripts	1	56.5132	56.5132	9.65	0.002

Another option was to use another statistical approach that is also appropriate to answering the research questions such as converting the covariate into a categorical variable and using analysis of variance (ANOVA). Actual pretest scores were not of primary interest in this study; pretest was used as a control variable. Therefore, pretest scores were categorized into letter grades based on the distribution of recorded scores and the ANOVA model, *Model 2,* was used. Figure 4.4 shows the pretest grade categories that were used.

Model 2: ANOVA Model for Cloud Computing Module.

$$\begin{aligned} Posttest\ score = {} & Grand\ Mean + Interactive\ Transcript + Keypoint\ Annotations + College \\ & + Pretest\ grade + (Interactive\ Transcript \times Keypoint\ Annotations) \\ & + Experimental\ Error \end{aligned}$$

Pretest Score Percent	Pretest Grade	Number of Cases
55 or above	A	25
40 to less than 55	B	19
25 to less than 40	C	29
10 to less than 25	D	24
Less than 10	E	15

Figure 4.4. Pretest categorization for analysis of variance for cloud computing module.

Examining for Assumptions of Analysis of Variance for Cloud Computing Module

The first three assumptions of ANCOVA as listed previously also apply to the ANOVA model. The conclusion of Assumptions 1 in the ANCOVA for cloud computing, independent samples, also hold in the ANOVA. Assumptions 2, constant variance, and Assumption 3, normality of error terms, were tested by examining residual plots for posttest. Figure 4.5 shows diagnostic plots for examining the ANOVA assumption of homogeneity of variances and normality. The residual versus fitted plots show no apparent pattern in the residual variation with the mean. Also, Brown and Forsythe's Test for Homogeneity of variances with results F (3, 115) = 1.22, p = 0.305, was not significant indicating that the assumption of constant variance had been met. Also, the normal Q-Q plot in Figure 4.5 and results of Shapiro-Wilk test on the error terms indicated that the assumption of normality was satisfied, W = 0.989, p = 0.458.

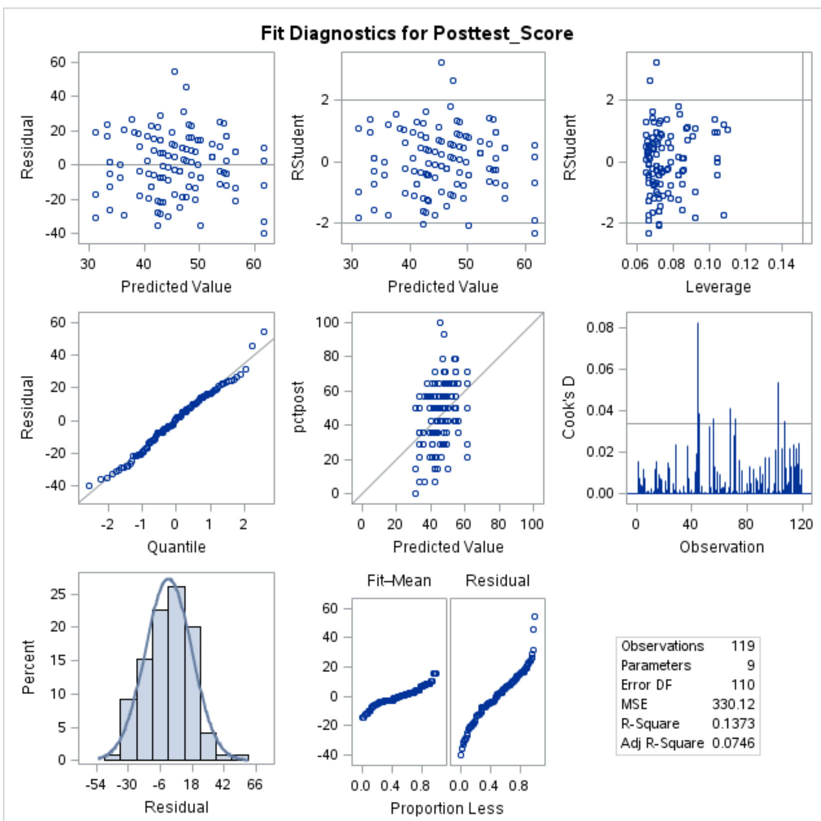

Figure 4.5. Diagnostic plots for ANOVA assumptions for cloud computing module. Posttest score as outcome variable.

Model Estimation for Cloud Computing Module

The same research questions were examined using the cloud computing module data, which is to investigate the effects of the onscreen text options of interactive transcripts and key-point annotations on ESL students learning performance through OER instructional videos. The results of the ANOVA are provided in Table 4.23. The ANOVA results in Table 4.23 show that, college, the blocking factor, was not significant, F (1, 110) = 2.04, p = 0.156. The effect of pretest grade was also not significant, F (4, 110) = 2.19, p = 0.075. The interaction between interactive transcripts and key-point annotations was not significant, F (1, 110) = 0.48, p = 0.491.

Table 4.23

Analysis of Variance for Posttest Score: Cloud Computing Module

Source	DF	Type III SS	Mean Square	F Value	Pr > F	η_p^2
Model	8	5779.1139	722.3892	2.19	0.034	0.137
Error	110	36313.4767	330.1225			
Corrected Total	118	42092.5906				
Key-point Annotations	1	704.8705	704.8705	2.14	0.147	0.019
Interactive Transcripts	1	541.6435	541.6435	1.64	0.203	0.015
Interactive Transcripts x Key-point Annotations	1	158.0010	158.0010	0.48	0.491	0.004
Pretest Grade	4	2890.3707	722.5927	2.19	0.075	0.074
College	1	673.3009	673.3009	2.04	0.156	0.018

The effect of key-point annotations on posttest score was not significant, F (1, 110) = 2.14, p = 0.147. The effect of interactive transcript on mean posttest score was also not significant, F (1, 110) = 1.64, p = 0.203. Table 4.24 presents the treatment least square means for posttest score.

Table 4.24

Least Square (LS) Means of Posttest Score by Treatment for Cloud Computing Module

Treatment Group	LS Mean	95% Confidence Limits	
Control	43.86	37.38	50.34
Key-point Annotations	41.28	34.46	48.09
Interactive Transcripts	50.58	43.65	57.51
Both Treatments	43.31	36.56	50.06

The least square means of Table 4.24 suggest that the interactive transcript group recorded the highest mean posttest score at 50.58%. This was followed by the control group with 43.86%, the group that received both treatments with 43.31%, and the annotations group with 41.28%, in decreasing order. Further investigation, however, was performed to ascertain group mean differences.

Research Questions

Research Question 1: *Does including onscreen text in OER instructional videos make a difference in ESL students' learning performance?*

This research question examined whether there were significant learning performance differences between the control group and the other three treatment groups that received any form of onscreen text. The results of the planned contrast that was used to examine Research Question 1 is provided in Table 4.25. Results of the planned contrast in Table 4.25 show that there was no significant difference between the no onscreen text option (control group) and the three onscreen text groups together, F (1, 115) = 0.42, p = 0.520. Table 4.26 presents results of pairwise comparisons among group treatment means using Tukey’s HSD.

Table 4.25

Planned Comparison between Control and Onscreen Text Groups for Cloud Computing Module

Source	DF	Contrast SS	Mean Square	F Value	Pr > F
Control vs. All other groups	1	146.4128	146.4128	0.42	0.520

Table 4.26

*Pairwise Differences among Treatment Least Square Means of Posttest Score for Cloud Computing Module using Tukey's HSD Adjustm*ent

Difference between Treatment Groups*	Mean Difference	Simultaneous 95% Confidence Limits		Pr > |t|
$Contr - kAnot$	2.58	-9.76	14.92	0.948
$Contr - iTrans$	-6.72	-19.21	5.76	0.499
$Contr - Both$	0.55	-11.76	12.85	0.999
$iTrans - kAnot$	9.30	-3.42	22.03	0.231
$iTrans - Both$	7.27	-5.32	19.86	0.437
$kAnot - Both$	-2.03	-14.65	10.59	0.975

**Note on short names: Contr for control; kAnot for key-point annotations, iTrans for interactive transcript, and Both for both treatments.*

Tukey's HSD results indicate that there was no significant pairwise difference between any pair of treatment groups.

Research Question 2: *What is the relative effect of interactive transcripts in OER instructional videos on ESL students' learning performance?*

The ANOVA results of Table 4.23 show that the effect of interactive transcript on mean posttest score was not significant, F (1, 110) = 1.64, p = 0.203. Relatively, results of pairwise comparisons using Tukey's HSD, as provided in Table 4.26 indicated no significant differences between the mean posttest score of the transcript group and any other group.

Research Question 3: *What is the relative effect of key-point annotations in OER instructional videos on ESL students' learning performance?*

The ANOVA on key-point annotations yielded no significant effect on mean posttest score, F (1, 110) = 2.14, $p = 0.147$. Also, results of pairwise comparisons using Tukey's HSD, as provided in Table 4.26 indicated no significant differences between the mean posttest score of the annotations group and any other group.

Analysis of Participant Opinion Data

The purpose of this section is to answer the research question, *what are English as a second language students' perceptions of the use of interactive transcripts and key-point annotations in OER instructional videos?* The section is organized according to the main question points of the open-ended survey and focus group interview protocol. First, themes that emerged from participant perceptions about benefits obtained from using the onscreen text options are presented. Second, themes from the challenges participants expressed are presented. Finally, emerging themes from recommendations participants made to help improve future learning using OER videos with the onscreen text options are presented. Other issues from the focus group interviews and opinion survey responses that were not necessarily placed under a theme are also mentioned as needed. Also, direct quotations from students' statements were provided to support findings as necessary. The number of responses to survey questions ranged from 12 to 22 according to questions and across treatment groups. Eighty-three out of the total of 129 distinct participants responded to the survey giving a response rate of 64.3%. Respondents, however, may not have responded to every survey question. Table 4.27 presents the number of participants who responded to the survey.

Table 4.27

Number of Survey Respondents by Treatment Group

	Control	Key-point Annotations	Interactive Transcripts	Both Treatments	Total
Number of Respondents	19	19	22	23	83

Perceptions of the Benefits of Using Instructional Video Onscreen Text Support

Participants were asked about the benefits of using interactive transcripts and key-point annotations in their learning process with the OER instruction videos. Focus group interviewees were asked, *what did you like best about using the onscreen text – interactive transcripts, key-point annotations, or both transcript and annotations?* Depending on treatment group, the question prompt in the survey was, *please provide at least one benefit you gained with using the interactive transcript [key-point annotation]*. The control group did not see this question prompt.

The themes that emerged from both the survey and interview responses were related to comprehension, learner control, interactivity, and focus. Comprehension includes student responses about how the onscreen text options helped with clarity, hearing, understanding, and remembering of the video instruction. Comprehension also includes responses that referred to students' ability to "get missed points" (Interviewee at College_G, personal communication, March, 30, 2016), and students' ability to answer quiz questions. The comment about students' ability to review missed points was made by several students with reference to the interactive transcript option. One student noted:

> You know, the way they spoke, sometimes, may be, can be … speaking too fast, sometimes, sometimes you try to pause the video but I don't know, I don't know if it's because of the internet...it's not pausing, so I had to use the text … but the moment I clicked the text [interactive transcript] it will just move the video backwards and you get

> the whole thing again. (Interviewee at College_R, personal communication, March 24, 2016).

The student's statement above introduces the second recurring theme, learner control. Learner control was taken to mean the ability of a student to exercise some level of control, with reference to the sequence, pace, flow, amount and review of the instructional videos (Simsek, 2012). Students' statements related to learner control often had references to the theme of comprehension. According to another student:

> It [interactive transcript] enabled me understand what was said. It was easier for me to scroll back and read the transcript to remind me of something that was previously mentioned that relates to new information that was being offered. I also found myself sometimes pausing the video and reading ahead of the instructor which helped me understand faster when I played the video. (Student, survey response)

Students tended to express their ability to hear and follow the video instruction with the ability to control the videos through the use of the interactive transcripts. Learner control, through students' ability to click parts of the transcript to navigate the videos, and the feature to click to show or hide key-point annotations appeared to have made the use of the instructional videos engaging for some participants. Interactivity, the third theme, was directly cited less often with reference to the onscreen text options. However, respondents in the control group made references to the need for a video design that allowed for taking notes electronically or online, was more interactive, and that would not make them just sit and watch. The fourth theme, focus, represents students' ability to focus on the key parts of the instructional videos. As a student in the annotations group noted, "it [key-point annotations] gives an alert to do more research on the emphasized word or topic," (Student, survey response). Another noted, "aided me in repeating key sentences in order to further digest & understand them," (Student, survey response). Figure 4.6 represents the proportion of each theme among the four themes based on all survey responses. Figure 4.7 summarizes the frequency of themes according to treatment groups.

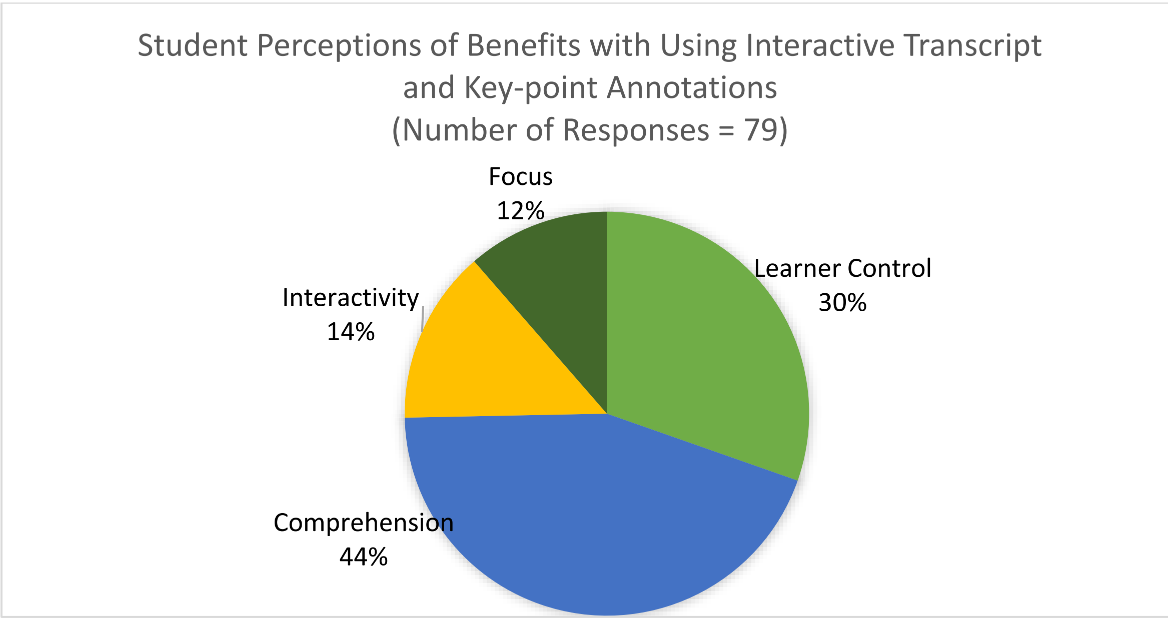

Figure 4.6. Proportion of themes relating to student perceptions of benefits of onscreen text use.

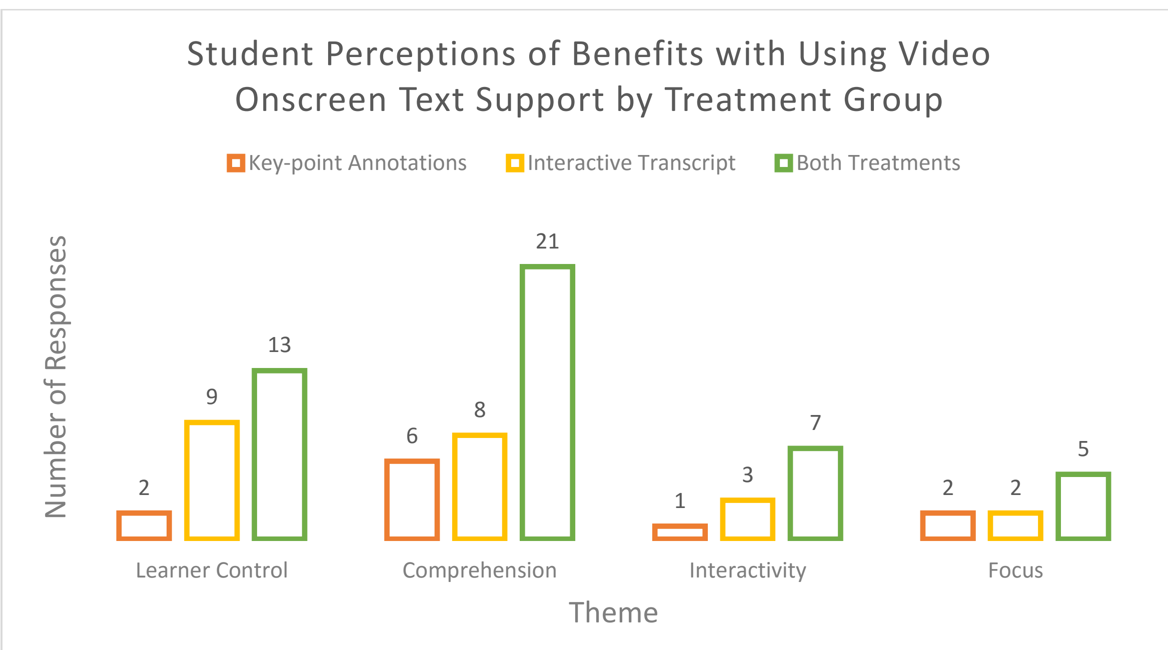

Figure 4.7. Frequency of themes relating to student perceptions of benefits of onscreen text use.

Perceptions of the Challenges of Using Instructional Video Onscreen Text Support

Participants were asked about challenges they experienced with using the onscreen text options in their learning process. Focus group interviewees were prompted to, *tell me about any challenge(s) you faced with using the onscreen text?* The survey had a similar prompt. The control group did not see this question prompt in the survey.

Two themes emerged from data collected from student responses. The limitation of low internet bandwidth or slow internet service (Internet) was the most cited. Unreliable internet service was the main reason for many students not being able to complete the study. As one student noted, “Internet Service was the major problem (Student, survey response).” Participants’ comments suggested no major challenges with their use of the onscreen text options. Except for a couple of suggested additions to the design of onscreen text, cited challenges were mostly with reference to limitations of the available internet service in the schools. The following statement by a student expresses the theme quite well:

> In our own part of the world where internet subscription is relatively expensive and slow, using the interactive transcript is very expensive and slow, this alone discourages me to want to use the interactive transcript and video. (Student, survey response)

The second theme that emerged from both survey and interview data was related to design issues involving both the onscreen text options and the differences between the instructional designs of two course modules. Few students made comments that suggested that the font of the interactive transcript were too small. Other comments suggested some students would have preferred the annotations to provide additional information or links to additional information. Majority of participants’ responses cited no challenges with using the onscreen text options in themselves. Figure 4.8 presents the proportions of themes relating to opinions expressed about challenges based on survey responses. Figure 4.9 presents a frequency summary of themes categorized according treatment groups.

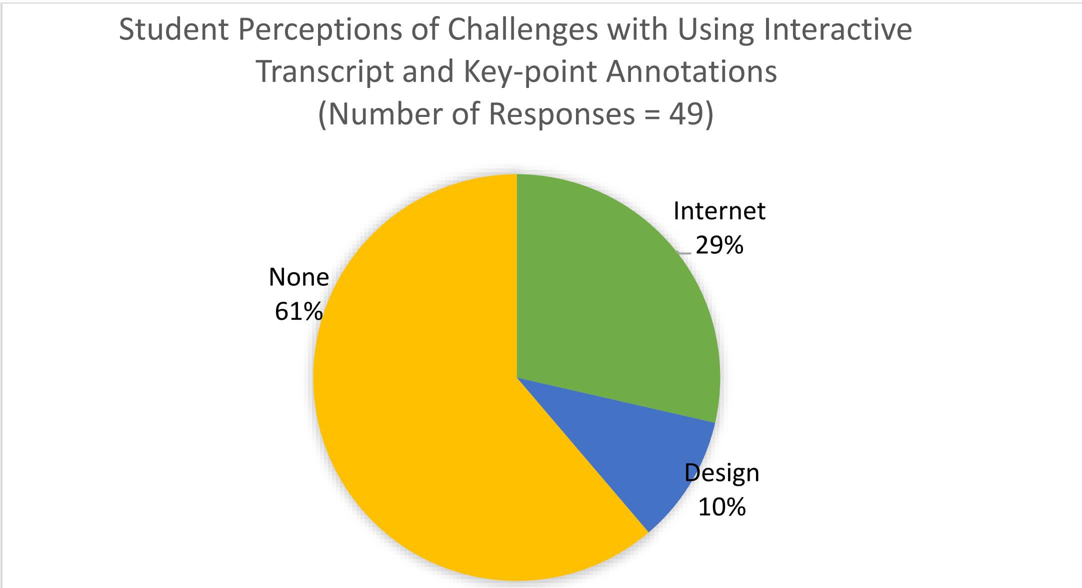

Figure 4.8. Proportion of themes relating to student perceptions of challenges of onscreen text use.

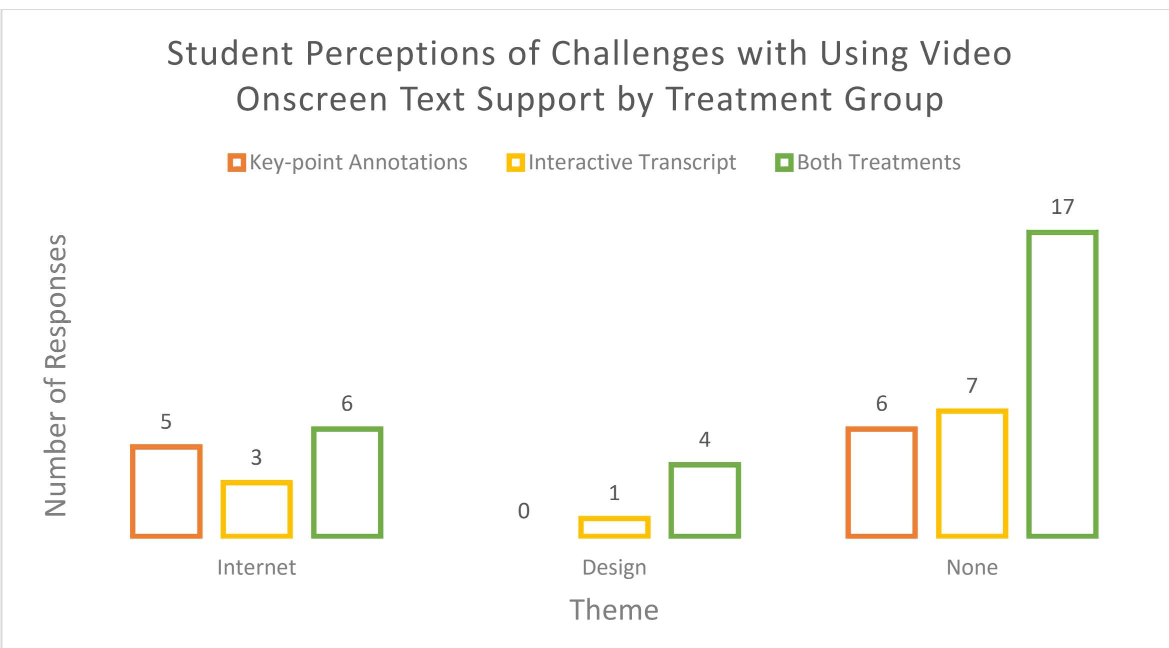

Figure 4.9. Frequency of themes relating to student perceptions of challenges of onscreen text use.

Student Recommendations for Improving their Learning Experiences

Three major themes emerged when students in all treatment groups and focus group interviewees were asked about how their learning experiences could be improved. The three themes are interactivity, pedagogy, and the internet. Comments about interactivity were directly related to the design of the instructional videos. Opinions on the need for interactivity were mostly expressed by students in the control group. Control group participants made comments that indicated a need for an inbuilt electronic feature that they could use to take notes. Few students also expressed concerns about not being able to ask questions of the video instructors. A student from the control group stated: “if there was some sort of interactivity where you could ask questions you did not get from watching the videos, then the learning experience would be much better. But overall, the experience was worth it” (Student, survey response).

The theme of pedagogy was related to opinions expressed mainly about the differences between the instructional design of the research methods and cloud computing modules. Pedagogy was regularly related to interactivity as explained. According to a student in the control group, he or she “Needed short notes, Needed some terms to be explained, needed more daily life examples to explain things more in the cloud computing” (Student, survey response). Another student stated: “… cloud computing … you didn’t feel that kind of interaction … but with the research methods, you could feel like she wanted you to get (stressed) what she was saying” (Interviewee at College_R, personal communication, March, 24, 2016).

Participants spoke more favorably of the research methods module videos. According to some interviewees and respondents, the instructor of research methods spoke clearly and used real-life examples that they could relate to. According to an interviewee:

> It was fast, the video … yeah, yeah, yeah, yeah, the cloud…the narrator … was just speaking, speaking… the woman [research methods] was very good, it was very practical, comparing the cat to how…how the cat may like her…I prefer the research methods. (Interviewee at College_G, personal communication, March, 30, 2016)

The pedagogical differences between the two modules was expressed often in interview and focus group responses. Students' comments suggested that they could relate more to the method of instruction used in the research methods module, which helped their comprehension and learning. Students who expressed preference for the cloud computing module mostly cited reasons relating to the module's relevance to a course of study or to their degree programs.

The theme of internet was not different from what has been previously discussed. The need for reliable internet service was the most recommended by both focus group interviewees and survey respondents. Generally, student participants expressed high satisfaction with their experiences with the learning exercise and the potential for such instructional resources to be useful to their education, provided internet service was reliable. Participants also made suggestions about having offline options of the videos and transcripts that would not require live internet. Comments about offline options, such as references to pdf transcripts, were considered to be a subtheme of internet. Offline options, is however included in the charts below as a separate category to highlight its frequency in participants comments. Student recommendations provided in their responses to the online survey are presented in Figure 4.10 according to theme proportions, and summarized according to frequency by treatment groups in Figure 4.11.

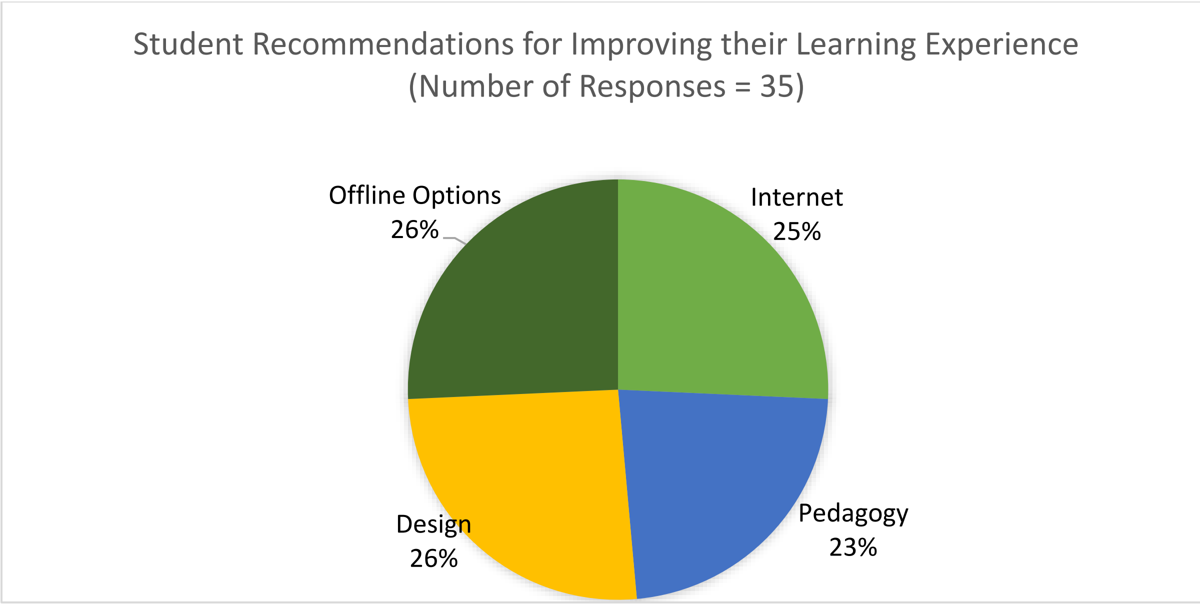

Figure 4.10. Proportion of themes relating to student recommendations for improving their learning experience.

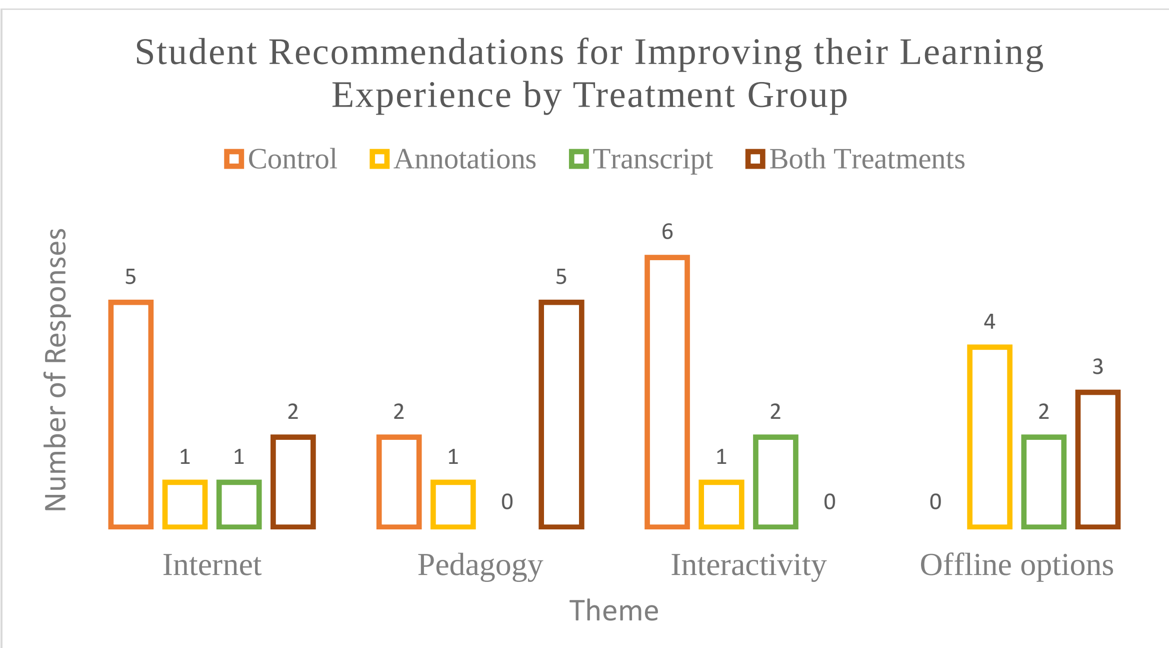

Figure 4.11. Frequency of themes relating to participant recommendations for improving their learning experience by treatment group.

Figure 4.11 shows that students in the control group made the most recommendations regarding internet, pedagogy, and design (interactivity). The control group made no recommendations for offline options probably because they saw no onscreen text options, which were the main subject of offline options. Survey respondents were also asked to rate their learning experiences with the instructional videos; a summary of participant responses are provided in Table 4.28.

Table 4.28

Summary of Survey Respondents Ratings of their Learning Experience by Treatment Group

	N	Min	Max	Mean	SD
Control	12	2	5	3.83	0.94
Key-point Annotations	15	2	5	3.87	0.99
Interactive Transcripts	20	3	5	3.8	0.7
Both Treatments	17	2	5	3.76	1.15

Summary of Results

The results of the analysis of the research questions indicate the following regarding the research methods module data: While there was a significant effect of key-point annotations on ESL student learning performance, there was no significant effect of interactive transcripts on ESL student learning performance. Also, the mean learning performance of the annotations group as well as the group which received both annotations and transcripts was significantly higher than the mean learning performance of the transcript group. The mean of the control group was not significantly different from any other treatment group.

Regarding the cloud computing module data, results of the analysis of the research questions as presented indicated no significant effect of key-point annotations or interactive transcripts on ESL student learning performance. There was also no significant pairwise differences among treatment group mean posttest scores.

Data on participant perceptions indicated that students generally expressed positive opinions about the use of key-point annotations and interactive transcripts in particular, in OER instructional videos. Also, onscreen text options in OER instructional videos helped students comprehend video instruction and gain control of their learning when there were language and technical difficulties. Participant opinions further suggested that onscreen text options helped students maintain focus during the learning process as well as interact with the learning material. According to participants, the main limitation within the ESL context was slow and expensive internet. Also, there were references in participant opinions that indicated that pedagogical differences in OER video instruction affected students' learning experience and performance.

CHAPTER 5

DISCUSSION

This study examined the effects of interactive transcripts and key-point annotations on English as a second language (ESL) students' learning performance using open educational resources (OER) instructional videos. It was hypothesized that the use of interactive transcripts and key-point annotations could provide support in cases of language comprehension breakdowns. The language support options were expected to help with ESL student comprehension of native English OER video instruction and result in better learning performance. Studying the effects of interactive transcripts and key-point annotations as stated also allowed for an examination of the redundancy principle of the cognitive theory of multimedia learning under the boundary conditions of language limitations, use of keywords, learner control, and technical content.

Limitations of the Study

This study used experimental design that was conducted in computer labs and classrooms that had limited technology resources. Experimental designs are known to have internal validity but limited external validity, which limits the generalizability of research findings (Trochim, 2006). This study is one of several that could be conducted under similar settings. The findings of the study, therefore, can be generalized to the sample and setting of this study only. Also, technology limitations, including intermittent power outages and low internet bandwidth, affected the data collection process and may explain some of the variance. Future replication studies are encouraged and should find ways to examine similar research questions under more stable technology conditions.

Second, the study was conducted at two relatively small technology university colleges in Ghana. Volunteering participants were students registered for classes taught by either of two instructors, one from each college. Participants were all students of programs in the areas of computer and information systems, which might explain the very low participation of only twelve females. Therefore, participant characteristics were not representative of the broader postsecondary student population of Ghana and other English as a second language developing countries. Similar studies which use more representative samples should be conducted.

Third, the study used portions of complete sets of course videos. Participants also had a limited time of about three and half hours to familiarize themselves with the online study environment and to complete pretests, view instructional videos, complete posttests and post-study survey. The actual research methods and cloud computing courses are full courses that last several weeks. Also, the content of the videos were technical and would typically require longer periods of time to master. Some participants expressed concerns about the relatively short period of time they had to learn material that was technical and unfamiliar to them. Future studies should consider using full OER courses and longer time periods.

The Cronbach's alpha estimates for this study's data on the posttests were 0.59 for the research methods module and 0.30 for the cloud computing module. These Cronbach's alpha coefficient estimates suggest low reliability of the outcome measure. Reliability of test scores may be affected by test-specific factors such as the number and specific set of test items, as well as conditions of the testing situation. Examinee-specific factors such as fatigue, concentration, and other fluctuations in human behavior may also affect reliability. Factors such as the relatively low number of test items, the limited time that students had to complete the study, distractions in the testing situation due to technology challenges, and observed and possibly unobserved fluctuations in participant behavior, may have contributed to the low reliability estimates of the outcome measure. Future studies should consider using more stable learning and testing situations, longer periods of time, a greater number of test items, and a more reliable measure in general.

Finally, low internet bandwidth affected the study's sample size, students' learning experiences, and may have affected students' learning performance. There were 179 volunteering participants but only 119 were able to complete the cloud computing module, while 91 participants completed the research methods module mainly because of limited internet access. Compared to the picture-in-picture format of the research methods module videos, the voice-over format of the cloud computing videos required relatively less internet bandwidth to load. The differences in internet bandwidth demands between the two modules may have contributed to more students being able to complete the cloud computing module. Future studies conducted at limited technology-resourced contexts should consider ways to reduce participant attrition that may arise from technological challenges.

Low internet bandwidth and the associated differences in bandwidth demands of the two modules also affected the loading, load speed, and display quality of the interactive transcripts particularly in the research methods module videos. Control group videos were more likely to load faster allowing students more time to focus on the instruction. Participants' opinions suggested that the differences in internet bandwidth demands may have also affected students' use of the onscreen text options. Challenges of limited internet access may have therefore affected the observed effects of the onscreen text options on learning performance across treatment groups and the two course modules. Future OER studies should consider taking steps to minimize probable effects of limited internet access where necessary.

Effects of Interactive Transcripts and Key-point Annotations

This study used instructional videos that had the standard video control buttons of play, stop, pause, and skip giving all participants some level of control over the video learning objects. Students who saw interactive transcripts had relatively more control of the videos because they could interact directly with content by clicking on any word or part of the transcript and be taken to specific points of the video. The study also used instructional videos that covered technical content. Language limitations were expected because participants of the study were ESL students living in an ESL country who viewed native English OER instructional videos. Key-point annotations, representing the boundary condition of keywords, were also used.

Results of the study's analyses were mixed and indicated that the effects of either interactive transcripts or key-point annotations on ESL students' learning performance may have been dependent on the pedagogy of the two different sets of instructional videos. Participants' opinions suggested that students' use of interactive transcripts and key-point annotations were influenced by the way the two sets of instructional videos were designed and delivered.

Research Methods Module

Unlike students who saw interactive transcripts in the research methods module, students who received key-point annotations performed significantly better on the posttest than those who did not. The mean performance of students in the annotations-only group (according to Fisher's LSD test) as well as students in the group that received both transcripts and annotations (according to Tukey's HSD and Fisher's LSD tests) was significantly higher than that of students in the transcript-only group. The annotations-only and both annotations and transcript groups did not perform significantly better than the control group, which received no onscreen text. The mean performance difference between the group that had annotations only and the group that received both annotations and transcript was about one percentage point at only 1.14%. The observed mean performance of the group that received both transcripts and annotations may therefore have been largely due to the presence of key-point annotations.

The significant effect of key-point annotations in the analysis of the research methods module data adds to findings of several previous studies that found positive effects of annotations on listening comprehension (Aldera & Mohsen, 2013; Jones & Plass, 2002), vocabulary acquisition (Akbulut, 2007; Jones & Plass, 2002), and reading comprehension (Akbulut, 2007; Marzban, 2011). Lai et al. (2011) also found annotations to be helpful to students' learning efficacy in the arts and math.

There were research design characteristics that differentiates this study from several other studies that found support for the redundancy principle. Austin (2009), Clark and Mayer (2011), Hernandez (2004), Mayer and Moreno(2002), Mayer (2001), and Yue et al. (2013) all found support for the redundancy principle. Unlike the studies listed, this study used authentic OER videos that were not linear, were longer in length (about 15 minutes), and allowed video replays within the time period of about 45 minutes per module. The previous studies listed used linear animations or PowerPoint presentations that lasted between 128 to 253 seconds. Longer multimedia presentations that combine audio and audio narration have been found to be better for student test performance (Adesope & Nesbit, 2012; Yue et al., 2013). Also, this study used interactive transcripts, and was conducted outside a native English-speaking country using English as a second language students.

In spite of the aforementioned differences, the results of the statistical analysis of the data from the research methods module neither support nor contradict the redundancy principle with reference to verbatim onscreen text (interactive transcript). The redundancy principle states that when presenting pictures (instructional videos), students learn better from concurrent audio and pictures (control group) than from simultaneous pictures, audio, and redundant onscreen text (transcript group) (Clark & Mayer, 2011). The results do not support or contradict the redundancy principle because students who received interactive transcripts (verbatim onscreen text) did not perform significantly worse than students who did not. Also, although the mean of the control group (51.50%) was greater than the mean of the transcript group (44.40%), there was no significant pairwise difference between the two means. Considering mean scores without statistical significance, however, would indicate support for the redundancy principle. The statistical results involving the research methods module, however, found support for the assertion that the redundancy principle may not apply under the boundary condition of use of abridged onscreen text or keywords (Adesope & Nesbit, 2012; Clark & Mayer, 2011; Mayer & Johnson, 2008; Yue et al., 2013), because the effect of key-point annotations on student learning performance was significantly positive.

The research methods module used a picture-in-picture video format which showed a live instructor. A review of participants' perceptions suggested that the set of research methods videos was relatively more intelligible because students could see the instructor speak, the instructor spoke more clearly and also used real life examples that students could relate to. Understanding the English language was not a problem for participants in this study because English was their first and official language. Comprehension difficulties may have existed only in cases of differences in language forms between native and nonnative English. Thus, verbatim onscreen text in the form of interactive transcripts may have been truly redundant in reference to the research methods module.

Drawing from the cognitive load theory (Kalyuga, Chandler, & Sweller, 2004; Sweller et al., 2011), therefore, including transcripts in the research methods module may have created nuisance that unnecessarily consumed students' cognitive resources, which may have negatively affected learning performance. In fact, the interactive transcript group recorded the lowest mean posttest score on the research methods module. Therefore, in offering OER instructional videos that use practical examples and clearly spoken native English, verbatim onscreen text such as interactive transcripts may negatively affect ESL students' learning performance. Abridged onscreen text such as key-point annotations, which point out key instructional points may however help ESL students' comprehension and hence learning performance.

Cloud Computing Module

The results of the statistical analysis on the cloud computing module indicated that the use of either interactive transcripts or key-point annotations did not significantly affect students learning performance. The interactive transcript group recorded the highest mean posttest score (52.46%) while the key-point annotations group recorded the lowest mean posttest score (42.86%) among all four treatment groups. There were however no significant pairwise differences among the treatment groups.

The statistical findings on the cloud computing module neither found support nor nonsupport for the redundancy principle because the use of verbatim onscreen text (interactive transcripts) combined with video and audio narration recorded no significant effect on posttest performance. Also, the findings recorded no significant pairwise difference between the transcript and control groups. Additionally, the statistical findings do not support or contradict the assertions that the redundancy principle may not apply under the boundary conditions of learner difficulty in processing spoken words (Clark & Mayer, 2011) and the use of keywords (key-point annotations) (Adesope & Nesbit, 2012; Mayer & Johnson, 2008; Yue et al., 2013). Further, the findings were inconclusive with regard to whether or not the redundancy principle may hold under the boundary conditions of the learning of technical content as suggested by Clark and Mayer (2011), and learner control over a video learning object, as indicated by Clark and Mayer (2011), Jadin et al. (2009), Kay (2012), and Zhang et al. (2006).

The cloud computing module used a voice-over video format that showed PowerPoint slides combined with instructor audio narration. Review of participant perception data indicated that some participants were more interested in the cloud computing module because it was more relevant to their programs of study. Students however, indicated that they had difficulty following the cloud computing videos because the videos used audio narration, the narration was too fast and not clear, and the instructor did not use practical examples. Participants who had access to onscreen text, and interactive transcripts in particular, indicated that they had to use that onscreen text option in order to follow the video instruction. While students in the control group indicated a need for a way to interact with the videos, students who saw interactive transcripts credited that option with their ability to resolve comprehension difficulties through the capability to interact with, and control the video instruction.

Review of participant perception data provides further insights on the results involving the cloud computing module. Previous studies have used static transcripts, which did not allow for control of pictures or animations by interacting with the transcripts (Grgurovic & Hegelheimer, 2007; Ho et al., 2005; Jadin et al., 2009). Participants' opinion data suggested that students tended to express their ability to hear and follow the video instruction with the ability to control the videos through the use of the interactive transcripts. Participants' opinions indicated that using the interactive transcripts enabled them to follow the video instruction when they missed points or had difficulty following video instructional messages. Some participants indicated that they paused the videos and read ahead of the instructor before viewing. Thus, students who had access to interactive transcripts may have had an advantage in controlling their learning when there were inherent and extraneous difficulties in following the cloud computing video instruction. Better control of the instructional videos may have aided students' comprehension and hence learning performance.

Participant experience data as expressed, however, contradict the results of the statistical analysis on the cloud computing module, which may be due to a number of possible reasons. As previously explained, there were internet connectivity limitations and in few cases, electrical power outage delays that affected participation. Also, differences in demand on internet bandwidth showed that the videos with interactive transcripts were relatively less likely to load or play consistently adding to observed participant frustrations. Instructional videos with no onscreen text options were more likely to load, load faster, and play more consistently. The relatively more stable videos for participants in the control group may have contributed to the no significant pairwise differences between the control and the other groups in both the research methods and cloud computing modules.

The sequence of the data collection process also implied that for the 79 out of 129 participants, representing 61.24%, who completed both modules, completing the posttest on the cloud computing module was their final activity before the optional survey. Fatigue and frustration after a relatively long time of participation may have led some participants to 'click through' the posttest on the cloud computing module in order to complete the study. The latter assertion was in fact, observed in a few instances and may have contributed to some participants choosing not to complete the learning experience survey at the end of the study. The survey response rate was 64.3%. Inattentive participant behavior such as clicking through the posttest on the cloud computing module may have resulted in influential outlier scores. The influential outlier scores may have caused Type II error in the statistical results and contributed to the mismatch between what participants said about their experiences and results of the statistical analysis. Future studies may want to consider using larger samples.

Participants' perceptions, however, indicated a possibly useful recommendation for the design of OER instructional videos. It is recommended that the design of OER instructional videos that teach technical content by using narration in native English and/or fast-paced narration should make special design considerations. Considerations should be made to provide video features that allow for seamless control of the pace, sequence, and exact content ESL learners see. The use of focused video control options such as interactive transcripts may help with ESL students' comprehension of learning content and learning experience.

Implications and Recommendations for Research and Practice

The use of instructional videos as a learning object is major in the open educational resources movement. Like other open educational resources content, OER instructional videos hold promise to bring quality higher education to students globally, and particularly for students who may not have access to equitable educational opportunities. Students who may not have access to adequate higher educational resources may also include those living in English as a second, English as a foreign, and/or developing countries. Also, majority of OER instructional videos, like other OER content are in native English (OECD, 2007). However, while the production of OER content continues to grow rapidly, examinations of features that could limit language barriers and support access for students globally have been lacking.

Therefore, this study investigated the effects of two video onscreen text options, interactive transcripts and key-point annotations, on the learning performance of ESL students using OER instructional videos. The study was conducted onsite in an ESL country. Data on perceptions of student participants indicated general satisfaction with the use of interactive transcripts and key-point annotation in the learning process. Also, the effect of the onscreen text options on students' learning performance was dependent on the way external events of video instruction were organized and delivered. Key-point annotations, but not interactive transcripts, positively affected ESL students' learning performance when the pedagogy of a set of videos provided for clarity and use of real-life examples that students could relate to. Key-point annotations, interactive transcripts, or both did not affect ESL students' learning performance when the pedagogy of a set of videos made it difficult for ESL students to follow the language of the video instruction.

Overall, the primary factor that appeared to have affected ESL students' learning and learning experiences using native English OER instructional videos was the ability to access the instructional videos. The ability to access was affected by technology, expressed as limitations in internet bandwidth, and the pedagogy or design of the OER instructional videos.

Delivering OER instructional videos in native English language was not a limitation to the ESL students in this study. Language limitations were created when the pedagogy of the instructional videos used audio narration that was too fast, not clear, and lacked practical and visual examples. Generally, ESL students tended to associate clarity with speed of speech and whether or not real-life examples were used. According to participants' opinion data, language limitations necessitated ESL student's reliance on interactive transcripts to help with the comprehension of video instruction. Using interactive transcripts in native English OER video instruction that is intelligible and that uses visual onscreen examples may negatively affect ESL students' focus and learning by unnecessarily using up cognitive resources. The use of key-point annotations in clear and intelligible instructional videos may however aid students' learning performance. Onscreen text support options, however, may or may not aid ESL students' comprehension and learning of technical or complex content if video instruction uses narration that is too fast, not clear, and lacks real-life examples. Longer study durations may help draw some definite conclusions on the use of onscreen text support in technical and complex content.

Overall, the design and delivery of OER instructional videos for nonnative speakers of English should incorporate the same science-based universal principles for the design of online learning and eLearning. Clark and Mayer (2011) and IMS Global Learning Consortium (2010) provide examples of such universal principles. Additional considerations, however, should be made when the delivery of OER instructional videos is also intended for cross-border education. Considerations should be made to address possible language and technological limitations as previously discussed. If language support options such as interactive transcripts are necessary but not possible, consider providing offline options such as downloadable time-stamped PDF transcripts. Also, possible internet limitations in some ESL and less-resourced countries suggest that instructors and designers should consider visual ways of pointing out salient instructional points in the delivery of OER instructional videos. Students can then take the key points and use offline options to better focus their learning.

The conclusions drawn from the findings of this study should be considered within the limitations and context of this study. Future research should consider using more representative samples, more colleges, other academic content areas, longer study durations, and other ESL contexts. Similar studies using students of English as a foreign language (EFL) countries may also provide further insights into the findings of the study. Unlike ESL countries, EFL countries do not use English as the first or official language. Together, and over time, the findings of such studies could contribute to building knowledge about how to better support access to OER instructional videos and other OER content for a more diverse student population that may need open educational resources the most.

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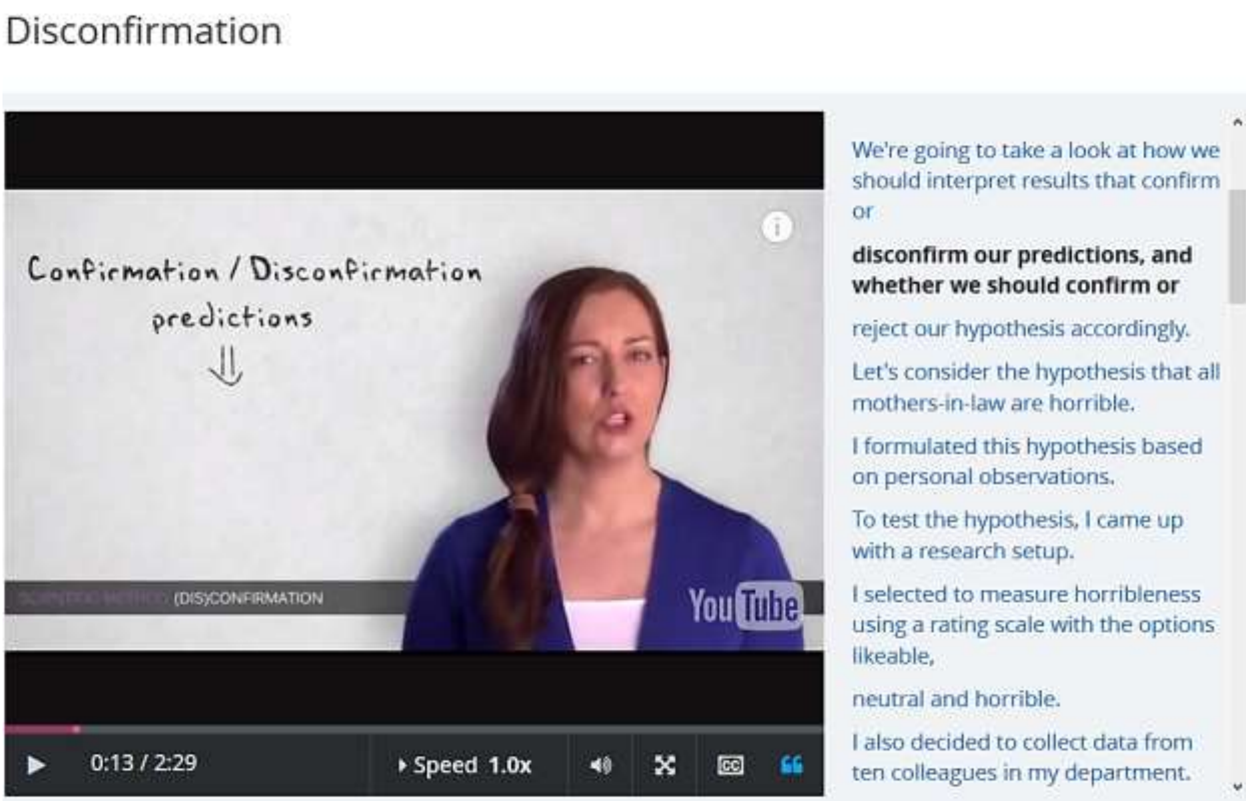
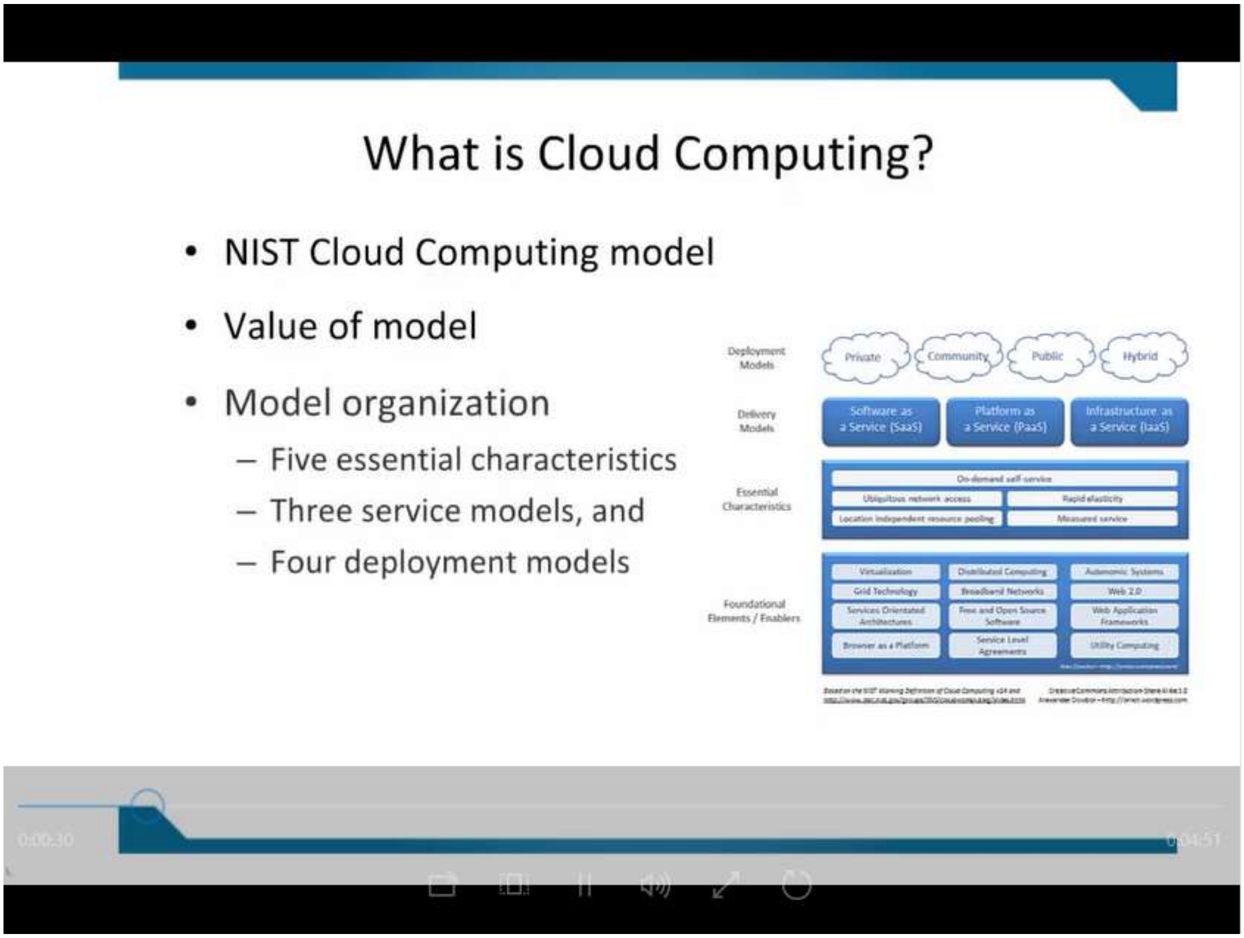
APPENDICES

Appendix A: Instructional Video with Interactive Transcript
Picture-in-Picture Video Format



Appendix B: Instructional Video with Key-point Annotations
Picture-in-Picture Video Format

Appendix C: Voice-over Video Format



Appendix D: Site Request Letter

Date
Address

Dear Sir:

Request for Permission to Conduct a Research Study

I am writing to request permission to conduct my dissertation research study at Ghana Technology University College. My name is Kwame Nti and I am currently enrolled in the Learning, Design, and Technology Doctoral Program at the University of Georgia in Athens, Georgia, USA. The study is entitled "Effects of Subtitles and Key-point Annotations on Learning through Open Online Instructional Videos in an English as a Second Language Context". The purpose of this study is to investigate potential video-based language support options that could help support access to native English open educational resources instructional videos in developing economies such as Ghana.

I hope your administration will allow interested undergraduate students to participate in this study about open education resources (OER). If approved, this experimental study will require the use of a computer lab(s) with Internet access. Prior to participating in the study, students who volunteer to participate will sign an online consent form that will be returned to the researcher. The time per student participant would be about three hours. Participants will:

1. Complete a consent form
2. Provide basic demographic information
3. Respond to questions on a technology topic (pretest)
4. View instructional videos on the technology topic
5. Respond to questions on the technology topic (posttest)
6. Complete a post-study survey

Submissions and the study's results will be used only for the thesis project and individual results will remain confidential and anonymous. Should this study be published, only pooled results will be documented. No direct financial costs will be incurred by individual participants.

Ghana Technology University College (GTUC) was chosen for a number of reasons. First, it is a private university college in Ghana, a developing country. Second, compared to public postsecondary institutions, private institutions in Ghana tend to have relatively fewer instructional resources, making OER a viable option to consider. Third, the primary focus of GTUC is science and technology education, which is also the focus of this study.

I will very much appreciate your approval to conduct this study at the Ghana Technology University College. I will be happy to answer any questions or concerns that you may have. You may contact me at nkwame@uga.edu or at (516) 574-2088.

If you approve of my request, kindly submit a signed letter of permission on your institution's letterhead acknowledging your consent and permission for me to conduct this study at your institution.

Thank you.

Sincerely,

Kwame Nti

Copied to: Dr. Robert Maribe Branch
Dissertation Adviser, University of Georgia

Appendix E: Online Consent Form

Participant Consent

Dear Participant: I am a postgraduate student under the direction of Dr. Robert Branch, Professor and Department Head in the Department of Career and Information Studies at The University of Georgia, USA. I invite you to participate in a research study entitled "Effects of interactive transcripts and key-point annotations on English as a second language students' learning performance using instructional videos in open online courses". This research study is being conducted as part of the requirements for the Ph.D. in Learning, Design, and Technology.   The purpose of this study is to investigate potential video-based language support options that could help limit language barriers and support access to native English open online instructional videos for non-native English-speaking students. Your participation should only take about the time for one weekly class/lab session of three hours and will involve you using an assigned computer to: Complete a consent form Provide basic demographic information Respond to questions on a topic on research methods and technology View instructional videos on a topic on research methods and technology Respond to questions on a topic on research methods and technology Complete an opinion questionnaire on your experience with this study For those who volunteer and are invited, a focus group discussion session   Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time without penalty. Students who choose not to participate will remain in class and have the class time for self-study. In that case, the class instructor will be available to discuss questions you might have. If you decide to stop or withdraw from the study, the information/data collected from you up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed. The results of the research study may be published, but your name or any identifying information will not be used. Individual student results will remain confidential and anonymous and will not be shared with the course instructor(s). In fact, the published results will be presented in summary form only. You may be invited to participate in a focus group session. If you would like to be invited, please indicate your choice when prompted at your computer at the end of this electronic form. The focus group session would occur at a location on campus on a date and time that would be decided by interviewee participants. Anything said during the focus group session will be confidential. Nothing said will be personally attributed to any person in my thesis report or any resulting publication. During the focus group discussion session, we will refer to ourselves using first names only or any participation first name participants choose. The focus group session would be audio-recorded. Audio recordings will be transcribed after all interviews have been completed. Interview transcripts will be anonymized by replacing all direct identifiers such as participant names, and indirect references that could be personal identifying with pseudonyms and pseudo references. The audio recording will be destroyed after data collection is complete. Interview transcripts will be destroyed after data analysis is completed. I have planned a focus group session not to last more than an hour. During the focus group session, I will emphasize to all participants that comments made should be kept confidential. However, it is possible that participants may repeat comments outside of the group at some time in the future. The findings from this study may provide information that could inform best practices for the design of instructional videos for diverse learners within the open educational resources context. The findings from the study could also help improve access and use of open online instructional videos and other open educational resources in Ghana and other developing countries. There are no known risks or discomforts associated with this research. If you have any questions about this research project or your participation, please feel free to call me at (056) 091-0326 or send an email to nkwame@uga.edu. Questions or concerns about your rights as a research participant should be directed to The Chairperson, University of Georgia Institutional Review Board, telephone (706) 542-3199; email address irb@uga.edu. Your decision to participate or not participate in this research will have no bearing on your grades or class standing. Thank you! Sincerely, Kwame Nti

Consent

Please select a choice below regarding your decision to participate in this study

- I choose to participate in this research study.
- I choose NOT to participate in this research study.

Are you 18 years or older?

- Yes
- No

First Name

Email address Note: same as used for edX Edge account

What is your gender?

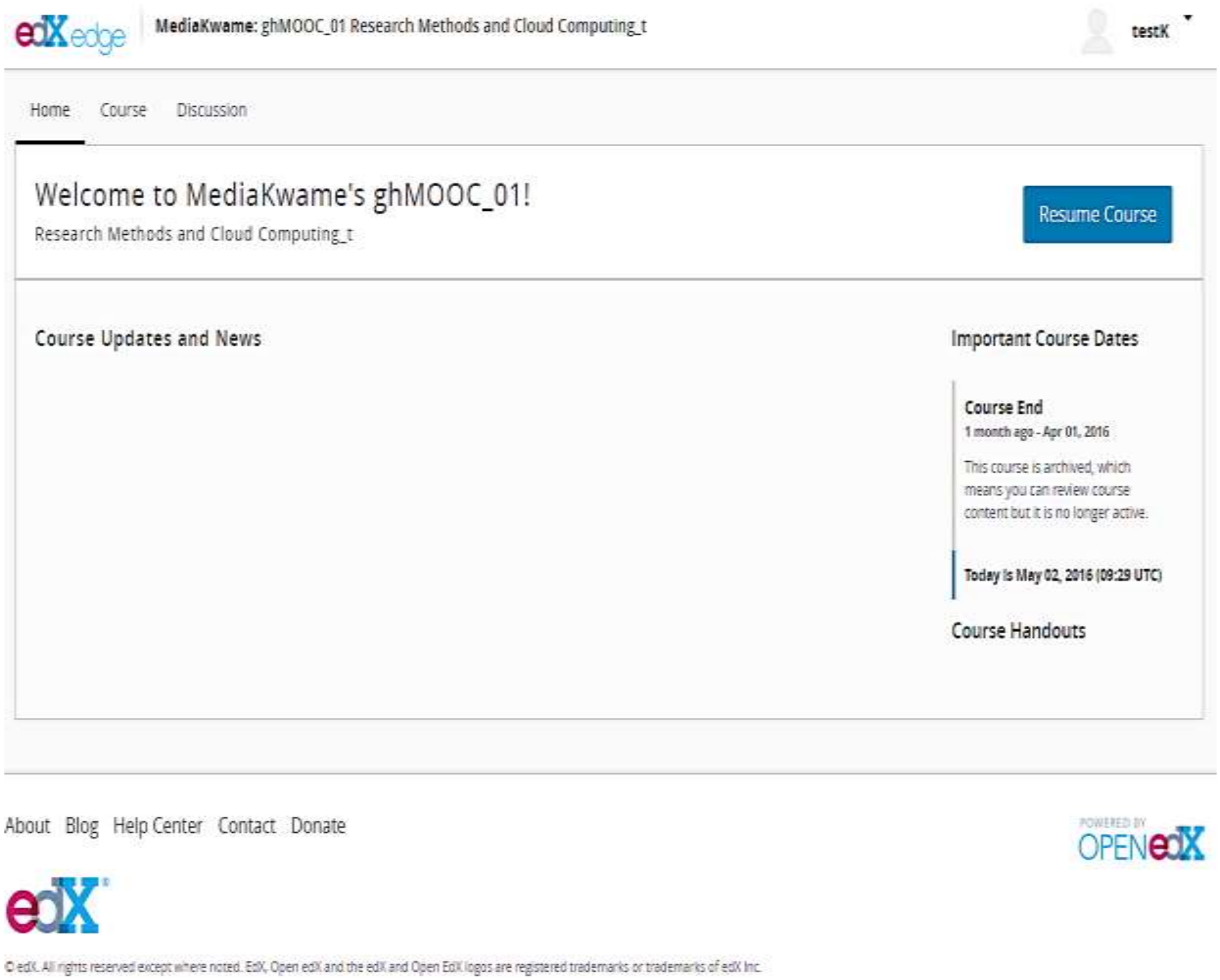
- Male
- Female

Please provide the number of months you have spent studying and/or working in native English-speaking countries. Enter the number zero if none. Examples of native English-speaking countries include USA, Canada, United Kingdom (UK), and Australia.

Would you be willing to join a short focus group session after your participation today? Meeting dates and times for focus group sessions will be communicated later.

- ❍ Yes
- ❍ No

Appendix F: Study's edX Studio Homepage



Appendix G: IEE Approval Email

Re: Reminder: Request for permission to use courseware on edX

Steve Welch <s.m.welch@ieee.org>

Tue 12/15/2015 2:44 PM

Inbox

To:Kwame Nti <nkwame@uga.edu>;

Dear Kwame:

Permission is granted to use, for purposes of your experiment, videos and other parts of the online IEEE course entitled IEEE Introduction to Cloud Computing.

Permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution must be obtained from the IEEE by writing to pubs-permissions@ieee.org.

Best,

Steve

Steve Welch
IEEE Educational Activities
p. +1 732 465 5830
e. s.m.welch@ieee.org

445 Hoes Lane
Piscataway, NJ 08854

Appendix H: Pretest Questions for Research Methods Module

1. Which of the following sources of knowledge are part of the scientific method? (Select all that apply):
   - Intuition
   - What many researchers accept as true
   - Casual observation and Informal logic
   - None of the above

2. Which example fits best with the concept of systematic observation?
   - Asking every fourth person to enter the mall about their favorite sport and recording their response
   - Observing every fourth person to enter the mall
   - Observing everything you do in one day

3. Why are clear assumptions, concepts and procedures important in the scientific method?
   - It enables researchers to include their beliefs in the research process
   - This makes the research subjective, thus replicable for other researchers
   - This makes the research objective, thus replicable for other researchers

4. If in the testing phase our predictions are confirmed by the data, does this mean we have definitively proven the hypothesis?
   - It depends
   - Yes
   - No

5. The scientific method requires that we formulate hypotheses that are (select all that apply):
   - Empirically testable
   - Truthful
   - Replicable
   - Objective
   - Generally consistent

Appendix I: Pretest Questions for Cloud Computing Module

1. Cloud computing is a new concept
    - True
    - False

2. Today's cloud computing systems are similar to previous generations of distributed systems in that they involve
    - Servers coordinating with each other
    - New programming paradigms
    - New paradigms for storage
    - New paradigms for computation

3. Which of the following is an example of Infrastructure as a service (IaaS) in cloud computing?
    - The Internet
    - Amazon Web Services
    - Yahoo Main
    - Facebook

4. Scenario 1: A non-profit organization called WinnerTech decides to use an accounting software solution that is specifically designed for non-profit organizations. The solution is hosted on a commercial provider's site but the accounting information such as the general ledger is stored at the non-profit organization's network. Access to the accounting application is through an interface that uses a conventional Web browser. The solution is being used by many other non-profit organizations. The cloud service model being used by WinnerTech is:

    - Infrastructure as a service (IaaS)
    - Platform as a Service (PaaS)
    - Software as a Service (SaaS)
    - None of the above

5. In Scenario 1 above, the deployment service model being used by WinnerTech is:
    - Public
    - Private
    - Community
    - Hybrid

Appendix J: Posttest Questions for Research Methods Module

1. Which example fits best with the concept of systematic observation?
    - Asking every fourth person to enter the mall about their favorite sport and recording their response
    - Observing every fourth person to enter the mall
    - Observing everything you do in one day

2. Why are clear assumptions, concepts and procedures important in the scientific method?
    - It enables researchers to include their beliefs in the research process
    - This makes the research subjective, thus replicable for other researchers
    - This makes the research objective, thus replicable for other researchers

3. If in the testing phase our predictions are confirmed by the data, does this mean we have definitively proven the hypothesis?
    - It depends
    - Yes
    - No

4. The scientific method requires that we formulate hypotheses that are (select all that apply):
    - Empirically testable
    - Truthful
    - Replicable
    - Objective
    - Generally consistent

5. Why are authority figures' opinions not a good source of valid knowledge?
    - Authority figures' opinions are not objective
    - There are multiple authority figures
    - Authority figures get paid for their knowledge

6. The scientific method requires that we formulate hypotheses that are (select all that apply):
    - Can be supported or contradicted by observations
    - Can be proven to be true
    - Can be tested independently by others
    - Can be publicly shared but not tested by anyone
    - Allow for the finding of contradictory evidence

7. What is an important aspect of a good scientific attitude?
    - Being nice to other researchers
    - Being open to critique on your research
    - Being defensive of critique on your research

8. If the data support our predictions, this leads us to conclude that
    - We need to develop new predictions that can be disconfirmed
    - Our predictions are confirmed, but we cannot say anything about the hypothesis
    - Our predictions were correct
    - Our predictions are provisionally supported

9. Why are hypotheses rarely outright rejected in the social sciences?
    - Alternative explanations are very prevalent in social research
    - Social science research is designed to rarely reject hypotheses
    - Social scientists are very good at forming hypotheses
    - Social scientists have a bias towards confirmation

10. Which of the following sources of knowledge are part of the scientific method? (Select all that apply):
    - Intuition
    - What many researchers accept as true
    - Casual observation and Informal logic
    - None of the above

Appendix K: Posttest Questions for Cloud Computing Module

1. Cloud computing is a new concept
    - True
    - False

2. Today's cloud computing systems are similar to previous generations of distributed systems in that they involve
    - Servers coordinating with each other
    - New programming paradigms
    - New paradigms for storage
    - New paradigms for computation

3. Which of the following is an example of Infrastructure as a service (IaaS) in cloud computing?
    - The Internet
    - Amazon Web Services
    - Yahoo Main
    - Facebook

4. Accessing a non-customized software solution via a Web browser is an example of:
    - Infrastructure as a service (IaaS)
    - Platform as a Service (PaaS)
    - Software as a Service (SaaS)
    - None of the above

5. Storing data through an off-site Internet-enabled provider is a form of:
    - Infrastructure as a service (IaaS)
    - Platform as a Service (PaaS)
    - Software as a Service (SaaS)
    - None of the above

6. Scenario 1: A non-profit organization called WinnerTech decides to use an accounting software solution that is specifically designed for non-profit organizations. The solution is hosted on a commercial provider's site but the accounting information such as the general ledger is stored at the non-profit organization's network. Access to the accounting application is through an interface that uses a conventional Web browser. The solution is being used by many other non-profit organizations. The cloud service model being used by WinnerTech is:

    - Infrastructure as a service (IaaS)
    - Platform as a Service (PaaS)
    - Software as a Service (SaaS)
    - None of the above

7. In Scenario 1 above, the deployment service model being used by WinnerTech is
    - Public
    - Private
    - Community
    - Hybrid

8. Scenario 2: A medium-sized highway construction company, Gray and Forever, has chosen to constrain its investment in computing resources to laptop and desktop computers and the necessary networking hardware and software to access the Internet efficiently. All of Gray and Forever's data is to be stored off-site through an Internet-enabled storage provider that is used by many different companies and organizations. The service model employed for the data storage capability of only Gray and Forever is:

    - Infrastructure as a service (IaaS)
    - Platform as a Service (PaaS)
    - Software as a Service (SaaS)
    - None of the above

9. In Scenario 2, the deployment service model being used by Gray and Forever is:
    - Public
    - Private
    - Community
    - Hybrid

10. The instrument used to guarantee service performance between a government entity, A, using the service, and government entity B, providing the service, is most likely a:
    - Service agreement
    - Service level agreement (SLA)
    - Memorandum of Understanding (MOU)
    - Internal agreement

Appendix L: Post-Study Opinion Survey

Please provide at least one benefit you gained with using the interactive transcript. Interactive Transcript were the verbatim text version of the lecture that appeared on the right side of a video.

Please provide any challenge(s) you may have experienced with using the interactive transcript.

Please provide at least one benefit you gained with using the key-point annotations. Key-point annotations were the popup summary text that appeared at the top right of the video.

Please provide any challenge(s) you may have experienced with using the key-point annotations.

What else could have been provided to improve your learning experience?

Please rate the following video features according to how helpful they were to your learning experience. Interactive Transcript were the verbatim text version of the lecture that appeared on the right side of a video. Key-point annotations were the popup summary text that appeared at the top right of the video.

	Not at all helpful1	2	3	Somewhat helpful4	5	6	Extremely helpful7
Key-point annotations	❍	❍	❍	❍	❍	❍	❍
Interactive transcript	❍	❍	❍	❍	❍	❍	❍

Please rate your learning experience with the video lectures.

______ Rating:

Appendix M: Focus Group Interview Protocol

FOCUS GROUP INTERVIEW PROTOCOL

I would like to welcome you to this focus group interview session. As you may be aware, my name is Kwame Nti.

My purpose for holding this talking session today is to learn more about your perceptions and experiences with using the instructional videos and the associated onscreen text options, key-point annotations and interactive transcript (for some of you). Your contributions may inform and improve future design of instructional videos and open educational resources for cross-border education.

The digital recorder you see is for audio-recording the session because I don't want to miss any of your comments. I know I will not be able to write fast enough to get everything you say down. Only researchers on my project may be privy to the recording which will be eventually destroyed after it is transcribed. We will refer to ourselves using first names only or any participation first name you choose; it doesn't have to be you true first name.

Your participation in this focus group interview session is completely voluntary and you may withdraw at any time without penalty. If you decide to withdraw from this session, the information you provide up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed unless you advise otherwise. Anything you say will be confidential. Nothing you say will be personally attributed to you in my thesis report or any resulting publication. Similar to your responses for the lab session, any published results will be presented in summary form only, with no identifying information.

Understand that you are not being graded and that there would be no right or wrong answers, so speak freely. Please note that I am as interested in negative comments as I am in positive or any other comments. Sometimes, sharing unpleasant experiences may prove the most useful.

I have planned this session to last no longer than one and half hours during which we will have a few questions to address. Thank you for agreeing to participate and attending.

Talking Questions

1. Please talk briefly about your experience with using the instructional videos.

   Possible Probes:

   a. Compared to your regular classes, what was your experience with the instructional videos like?
   b. Do you find that you can learn less, as well as, or better using instructional videos?
   c. What were your expectations going into the lab session?
   d. Were your expectations met and why?
2. What did you like best about using the onscreen text – Interactive transcripts, Key-point annotations, or both transcript and annotations? Are there any additional benefits you would like to talk about?

   Possible Probes:

   a. Did you find need for using the onscreen texts? How so?
   b. Did you find the onscreen text helpful in hearing and/or understanding the instructor? How so?
   c. Did you find the onscreen text helpful in answering the quiz questions? How so?
   d. Would you recommend instructional videos to your lecturers or student colleagues? Why?
3. Tell me about any challenge(s) you faced with using the onscreen text.

   Possible Probes:

   a. What about the instructional videos?
   b. In your opinion, what provision should have been made to limit that challenge?
4. The purpose of my study is to find ways to make such instructional videos more accessible and useful to students like yourself. Did we miss anything - do you have any additional comments about your use of the instructional videos that you would like us to discuss?

Appendix N: Sample Validity Questionnaire - Cloud Computing

The purpose of this review is to assess the validity of the following items. The review is estimated to last not more than about 25 minutes.

Definitions of constructs:

Remembering: items that measure memory Recall.

Understanding: items that measure Inferring or Interpreting.

Module Introduction to Cloud Computing Objective: The objective of this module (set of videos) is to introduce some basic concepts of Cloud Computing to individuals.

Introduction to Cloud Computing

The following test questions are based on the above video - "Introduction to Cloud Computing". Please review the items and identify the construct they measure. (Item answer choices are listed with bullets)

	Remembering (Memory Recall)	Understanding (Infer; Interpret)	Neither
1. Cloud computing is a new concept. True False	❍	❍	❍
2. Today's cloud computing systems are similar to previous generations of distributed systems in that they involve: Servers coordinating with each other New programming paradigms New paradigms for storage New paradigms for computation	❍	❍	❍

Please provide recommendations/comments to help improve the validity of the items and/or video.

The purpose of this review is to assess the validity of the following items. Definitions of constructs: Remembering: items that measure memory Recall. Understanding: items that measure Inferring or Interpreting.

Service Models

The following test questions are based on the video above - "Service Models". Please review the items and identify the construct they measure. (Item answer choices are listed with bullets)

	Remembering (Memory Recall)	Understanding (Infer; Interpret)	Neither
3. Which of the following is an example of Infrastructure as a service (IaaS) in cloud computing? The Internet Amazon Web Services Yahoo Email Facebook	❍	❍	❍
4. Accessing a non-customized software solution via a Web browser is an example of: Infrastructure as a service (IaaS) Platform as a Service (PaaS) Software as a Service (SaaS) None of the above	❍	❍	❍
5. Storing data through an off-site Internet-enabled provider is a form of: Infrastructure as a service (IaaS) Platform as a Service (PaaS) Software as a Service (SaaS) None of the above	❍	❍	❍

6. Scenario 1: A non-profit organization called WinnerTech decides to use an accounting software solution that is specifically designed for non-profit organizations. The solution is hosted on a commercial provider's site but the accounting information such as the general ledger is stored at the non-profit organization's network. Access to the accounting application is through an interface that uses a conventional Web browser. The solution is being used by many other non-profit organizations. The cloud service model being used by WinnerTech is: Infrastructure as a service (IaaS) Platform as a Service (PaaS) Software as a Service (SaaS) None of the above	❍	❍	❍
7. In Scenario 1 above, the deployment service model being used by WinnerTech is: Public Private Community Hybrid	❍	❍	❍

8. Scenario 2: A medium-sized highway construction company, Gray and Forever, has chosen to constrain its investment in computing resources to laptop and desktop computers and the necessary networking hardware and software to access the Internet efficiently. All of Gray and Forever's data is to be stored off-site through an Internet-enabled storage provider that is used by many different companies and organizations. The service model employed for the data storage capability of only Gray and Forever is: Infrastructure as a service (IaaS) Platform as a Service (PaaS) Software as a Service (SaaS) None of the above	❍	❍	❍
9. In Scenario 2, the deployment service model being used by Gray and Forever is: Public Private Community Hybrid	❍	❍	❍

Please provide recommendations/comments to help improve the validity of the items and/or video.

The purpose of this review is to assess the validity of the following items.

Definitions of constructs:

Remembering: items that measure memory Recall.

Understanding: items that measure Inferring or Interpreting.

Terms of Service

The following test questions are based on the video above - "Terms of Service". Please review the items and identify the construct they measure. (Item answer choices are listed with bullets)

	Remembering (Memory Recall)	Understanding (Infer; Interpret)	Neither
10. The instrument used to guarantee service performance between a government entity, A, using the service, and government entity B, providing the service, is most likely a: Service agreement Service level agreement (SLA) Memorandum of Understanding (MOU) Internal agreement	❍	❍	❍

Please provide recommendations/comments to help improve the validity of the items and/or video.

Module Objective: The objective of this module was to introduce some basic concepts of Cloud Computing to individuals.

Consider the following: Stated objective of the module on Cloud Computing, the videos, and test items. Please indicate the degree of congruence among the objective, videos, and items. The number 0 being no congruence and 100 being the highest level of congruence. (Click or Drag inside box)

______ Degree of Congruence

Please provide additional recommendations/comments to help improve the validity of the instruments (test items and videos).

Appendix O: IRB Approval

The University of Georgia

Phone 706-542-3199

Office of the Vice President for Research
Institutional Review Board

APPROVAL OF PROTOCOL

December 16, 2015

Dear ROBERT Branch:

On 12/16/2015, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title of Study:	Effects of Subtitles and Key-point Annotations on Learning Through Open Online Instructional Videos in an English as a Second Language Context
Investigator:	ROBERT Branch
IRB ID:	STUDY00002917
Funding:	None
Grant ID:	None

The IRB approved the protocol from 12/16/2015.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103).

Sincerely,

Dr. Gerald E. Crites, MD, MEd
University of Georgia
Institutional Review Board Chairperson

310 East Campus Rd, Tucker Hall Room 212 • Athens, Georgia 30602