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The Effects of Audio and Video Encoding on Information Acquisition Among Undergraduates

Todd A. Campbell
Indiana University of Pennsylvania

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THE EFFECTS OF AUDIO AND VIDEO ENCODING ON

INFORMATION ACQUISITION AMONG UNDERGRADUATES

A Dissertation

Submitted to the School of Graduate Studies and Research

in Partial Fulfillment of the

Requirements for the Degree

Doctor of Philosophy

Todd A. Campbell

Indiana University of Pennsylvania

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Indiana University of Pennsylvania
School of Graduate Studies and Research
Department of Communications Media

We hereby approve the dissertation of

Todd A. Campbell

Candidate for the degree of Doctor of Philosophy

_____   _____

Zachary Stiegler, Ph.D.
Associate Professor of Communications Media,
Advisor

_____   _____

Mark Piwinsky, Ph.D.
Professor of Communications Media

_____   _____

Jay Start, Ph.D.
Associate Professor of Communications Media

ACCEPTED

_____   _____

Randy L. Martin, Ph.D.
Dean
School of Graduate Studies and Research

Title: The Effects of Audio and Video Encoding on Information Acquisition Among
        Undergraduates

Author: Todd A. Campbell

Dissertation Chair: Dr. Zachary Stiegler

Dissertation Committee Members: Dr. Mark Piwinsky
                                 Dr. Jay Start

Current literature probes the connections between the impact of multimedia, cognition, and learning. However, aesthetic quality of multimedia content has received little attention from researchers. This purpose of this experimental study was to determine the effects of three different rates of encoding on information acquisition and retention among college undergraduates. Participants in the study were divided into three groups. Prior to the learning activity, participants were asked to complete a short pretest that gathered demographic information. Then, the participants were sorted into one of three groups. Each group viewed the same three videos; the difference was that each group saw the videos presented in different qualities and in a different order of presentation. Following each video excerpt, questions were asked in order to assess post-viewing recall of information contained in the video.

The theoretical framework for the study draws from three distinct yet allied assumptions regarding how people respond to acquire, process and retain information in a multimedia context. Human cognition and processing of incoming sensory information relies on structures that are specifically equipped to handle visual and aural stimuli. Specifically, Information Processing Theory (IPT), Dual-coding theory (DCT), and

cognitive theory of multimedia learning (CTM) all contribute to a deeper understanding of how humans process information in the context of a multimedia presentation or environment.

Post hoc analyses indicated that post-viewing accuracy scores varied in a statistically significant way depending on video, but differences in accuracy scores were not statistically significant by either video resolution or group. In addition, a two-way analysis of variance yielded a main effect for video content, although the interaction effect between video resolution and specific video was not statistically significant.

This study supports the notion that video content, in a streaming context like YouTube, affects information acquisition among college students. It remains to be seen if resolution is a prime determinant in information acquisition through multimedia. Additionally, the results of this study have helped to fill a void in existing research, as previous research in learning cognition and recall in a multimedia environment focused primarily on information processing and cognitive overloading capacities in the learner.

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CHAPTER 1

INTRODUCTION TO THE STUDY

Multimedia content in the classroom has been a formidable and compelling

instructional tool for decades. Early multimedia content, considered primitive by today's

standards, consisted of slideshows that contained visual information accompanied by an

often poorly recorded soundtrack that rarely (if ever) synchronized with the visual

component. These instructional techniques, while novel, still could not fully embrace the

learning opportunities afforded by congruent, vivid and compelling multimedia content.

The World Wide Web, because of its compelling nature and powerful capabilities to

deliver multimedia content, has become a ubiquitous provider of multimedia learning

content in educational institutions, and in the workplace. According to Chapman and

Chapman (2000), "the rise of the Internet as a delivery medium means that more and

more content is being repurposed for the World Wide Web" (p. 539).

Although there is a significant body of research that explores the effects and

interaction of multi-modal presentation and delivery on information acquisition

(Rockwell & Singleton, 2007; Salomon, 1984; Pilling & Thomas, 2011; Moreno &

Mayer, 2000), the effects of data compression of digital audio and video encoding on

information acquisition—particularly among college students—are much less understood.

When multimedia content is presented and streamed online from the content provider to

the learner, data compression is of prime importance because it directly impacts the

quality of the video. Multimedia content that is highly data-compressed results in poor,

pixelated video and low-fidelity, noisy audio. This research seeks to understand if digital

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audio and video data compression and encoding schemes have an effect on information acquisition and retention of multimedia content in a learning context.

Multimedia content, particularly when streamed online, is subject to constraints afforded and created by the available bandwidth of the connection to the World Wide Web. In an effort to reduce the size of a digital file for ease of transmission, digital content undergoes some degree of data compression or encoding so that interruptions of the stream on the user's side are minimal. Digital audio and video can be compressed in a variety of ways; as the compression rate increases, the content becomes further removed from the original until at the extreme, it no longer looks or sounds like the original at all. When a file is compressed through a data-encoding scheme, a balance must be achieved between manageable file size and similarity to the original file (Marshall, 2001, para. 2).

Research into cognition and human learning is not new. Research into computer-generated multimedia content is only slightly more recent, with the roots of this research stream dating from the 1970s. Often, educators assume that multimedia (or multi-modal) presentation of material in an educational setting is a recent occurrence and only matured with the advent of powerful, capable computers, the World Wide Web, and online information repositories including YouTube and iTunesU. However, multimedia content in the classroom was introduced with Skinner's Teaching Machine (1959), a mechanical device intended to automate sequential learning and programmed instruction. In our current environment, computers and the World Wide Web are the predominant modes for delivery of multi-modal (or hyper-medial) content in the classroom. And, although much research has examined theoretical constructs, multimedia effects on cognition and how

interface design may affect student learning, the compression and encoding schemes of digital content and their possible effect on information acquisition has not been explored in depth, as either a confounding, intervening, or fully independent variable.

Problem Statement

Although abundant research exists that examines the efficacy of audio-video presentation in a learning environment (Pilling & Thomas, 2011; Gosselin & Gagné, 2011; Sundar, 2000) and how media-rich modalities influence learning among students (Tavassoli & Lee, 2003; Crigler & Just, 1994), the concept of audio-visual (AV) content encoding schemes and their effect on information acquisition has not been sufficiently explored or addressed at this time. In addition, researchers have stated that in order for future interactive learning systems to be effective, course design elements should be readily identified (McIsaac and Gunawardena, 1996; Berk, 2009; Caladine, 2008). As McIsaac and Gunawardena (1996) observe:

> Research that examines the interaction of learners and delivery media is currently being conducted with multimedia. These studies examine learning and problem solving in asynchronous, virtual environments in which the learner is encouraged to progress and interact with learning materials. (p. 425)

Although the interactions of students with learning materials involving multimedia content has been the subject of a significant amount of research, the aesthetic quality of the content was not a consideration in any of the research that McIsaac and Gunawardena (1996) investigated. Furthermore, it should be noted that existing research does not address the question of whether or not reduced quality as a result of a

bandwidth-limited condition affects cognition and recall of multimedia content. This study will explore how AV content encoding algorithms affect information acquisition among college undergraduates. YouTube is widely used in the classroom environment and often, the video quality is poor and out of control of the instructor (Juluri, Plissonneau, & Medhi, 2011; Dobrian, Sekar, Awan, Stoica, Joseph, Ganjam, Zhang, 2011). Given the predominance of online video and associated multimedia content's ubiquitous position in modern educational environments (Burke, Snyder, & Rager, 2009; Mullen & Wedwick, 2008), the aesthetic quality of the content and its effect on learning is an as yet missing but vital component requiring investigation.

Research Questions and Hypotheses

This dissertation claims that differing digital data compression and encoding rates, coupled with other variables including age, gender, technological aptitude and college major, may have an effect on student information acquisition in a multi-media context. To summarize the expectations of the study, the following research questions are presented and will be addressed in this experimental study:

RQ1*:* What are the effects of digital audio-video (AV) data compression and encoding utilized in an instructional video on information acquisition among undergraduate students?

Multimedia content, specifically the aural and visual channels, place specific cognitive demands on the learner. These aural and visual channels align well to Dual Coding Theory, which contends that learners categorize and process incoming aural and visual stimuli differently, and in distinct parts of the brain. Based upon previous research on

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Dual Coding Theory, and acknowledging associated cognitive factors that may enhance

or inhibit learning from a multi-medial learning module (Paivio, 2013; Plass, 2010;

Mayer, 1999), the following hypotheses are presented:

> H1: It is predicted that the resolution of the video content (low, medium,
>
> or high) will have an impact on the overall accuracy scores (% correct) of
>
> the participants.
>
> H2: It is predicted that the specific topic of the video content will have an
>
> impact on the overall accuracy scores (% correct) of the participants.
>
> H3: It is predicted the overall accuracy scores (% correct) of the
>
> participants will vary among the groups.
>
> H4: It is predicted that there will be interaction effects between video
>
> resolution and video content.

While RQ1 considers the broad effects of aesthetic quality on recall of information

presented in a multimedia context, there may be other variables that contribute to overall

scores. Thus, the second research question asks:

> RQ2: Is the degree or amount of information acquisition among students
>
> influenced by demographic factors and video resolution?

Based on the research of Page (2002), Passig (2000), Sanders (2005), and Gunn (2003) in

which educational level, gender and socio-economic status all can have a statistically

significant effect on learning within a multimedia environment, the following hypotheses

result from RQ2:

H2a: It is predicted that video resolution, combined with gender, will not

have a statistically significant impact on overall score accuracy.

H2b: It is predicted that video resolution, combined with class rank, will not have

a statistically significant impact on overall score accuracy.

The third and final research question examines other variables that may contribute to

higher scores on less than optimal multimedia content, as represented by the medium and

low-quality conditions. This research question has been included in an effort to examine

and understand other variables that may impact and effect student learning in a

multimedia environment and that may reinforce or transcend limitations imposed by the

aesthetic quality of the multimedia content.

RQ3: Will other variables of age, college major, and self-reported

technical aptitude affect the degree or amount of information acquisition

among students, regardless of how the digital audio-visual content is

compressed or encoded?

The following hypotheses will also be tested based on the variables articulated in RQ3:

H3a: There will not be a significant difference in overall test scores

(accuracy) by age.

H3b: There will not be a significant difference in overall test scores

(accuracy) between Communications Media Majors and non-

Communications Media majors.

H3c: It is predicted that participants who have a high technological

aptitude will have higher overall accuracy than those who report having a

low technological aptitude.

According to Reinhard (2006), the generally accepted alpha risk for research in

communication studies is .05. As a result, all data will be analyzed at the $p < .05$ to

determine the presence of statistical significance when utilizing one-way and two-way

ANOVA (Reinhard, 2006). In the event that the ANOVA reports a statistically significant

result(s), the post-hoc test Tukey's HSD will be run to determine the source and amount

of the difference(s).

Purpose of the Study

The purpose of this study is to examine the effects of digital audio-video

compression / encoding schemes on information acquisition among undergraduate

college students. For decades, research has been done on the effectiveness of multimedia

content in an educational environment (Narey, 2003; Savenye, 2007; Alessi & Trollip,

2001; Mayer, 2006). As Narey (2003) observes, "computer technology and interactive

media rely heavily on images, sounds, colors and movements" (p. 212).

YouTube is widely used for educational purposes, yet most of the content is not

deemed suitable for educational needs (Chenail, 2011; Snelson, 2008). In addition, the

use of YouTube and other video sharing sites has become immensely popular, as

educators seek to employ communicative structures that are familiar to students who have

grown up as the technology has matured (Duffy, 2007). The study seeks to understand if

additional variables including educational level, gender and socio-economic background have an effect on information acquisition from a heavily data-compressed multimedia presentation on undergraduate students. Previous research has not addressed the issue of aesthetic quality in classroom multimedia content. This is important because the end quality of the video (i.e. poor quality, pixelated, or high quality and extremely detailed) may have profound effects on learner recall and cognition. Additionally, the study will investigate whether other variables including gender, class rank, age, college major, and self-reported technical aptitude have an effect on student post-test accuracy scores from an informational video, regardless of its data compression rate.

<div align="center">**Need for the Study**</div>

Research is needed that examines how the data compression rates and encoding of digital audio and video affects information acquisition among students. Simply put, will highly compressed digital AV content impact information acquisition? Will higher-quality (less-compressed) digital AV content enhance information acquisition? Similarly, will the efficacy of information acquisition be different among males and females, different age groups, or college majors? As Fee (2009) observes, "most schools in the more developed countries…provide computers and Internet access in the classroom, and e-learning is integrated in to the curriculum of every university in the world" (p. 2-3). None of the studies I have examined thus far have considered the variable of digital data compression and content encoding quality as a factor or determinant in information acquisition and retention.

Theoretical Framework

There are many different theoretical frameworks that examine how people respond to, process and acquire information through multimedia, particularly in an educational context. Prior to 1970, most human learning models were rooted in the Skinnerian understanding of human behavior as seen through the lens of stimulus-response-reward (Skinner, 1959). The roots of information processing theory (IPT) can be traced to the mid-1950s, when George Miller and his team at Harvard became frustrated at the limitations of pure Skinnerian behaviorism as a method to explain human learning. As Miller (2003) observes, "psychology could not participate in the cognitive revolution until it had freed itself from behaviorism, thus restoring cognition to scientific respectability" (p. 141).

Differing views exists as to whether or not IPT alone can fully account for how incoming sensory information is processed—without context, the mind cannot associate and process the incoming input to the fullest extent possible (McKinney, Charles, & Yoos, 2010). MacInnis & Jaworski, (1989) noted that the level of student information acquisition depends not only on a willingness and motivation to decode the input, but also on the motivation to process the information contained in the message. Brünken, Plass, & Leutner (2004) concur with the importance of context, noting that there is a modality effect in cognition, particularly in the context of information acquisition from multimedia sources: "when textual and pictorial learning materials are presented simultaneously, an audiovisual presentation (narration and picture) is more beneficial for

learning than a visual-only presentation (written text and pictures) of the same material"
(p. 118).

Information processing theory (IPT) proposes that humans do not merely react to
sensory input, but, depending on the type and amount of stimuli, they analyze, process
and channel it with different parts of the brain and other associated cognitive functions
(Caladine, 2008; Simon & Feigenbaum, 1964). In addition, the complexities of learning,
when supplemented with problem solving skills and deeper thinking, can enhance,
support and leverage traditional behavioristic learning principles (Childers, Houston &
Heckler, 1985; Goh, Dexter, & Murphy, 2007).

According to IPT, humans possess three types of memory that support and
reinforce human cognition: sensory memory, short-term (working) memory, and long-
term memory (Miller, 2003). Information processing theory may help to explain whether
the quality of audio-visual material afforded by differing compression and encoding rates
impacts the acquisition and retention of content by establishing possible ties between
compression quality and short-term memory recall.

Dual-coding theory (DCT) is a theory of human cognition that is closely related to
information processing theory, particularly in the realm of multimedia presentation.
Developed initially by Allan Paivio, DCT looks at the process of human cognition as a
series of dynamic associations; depending on the person's experiences, real-time
cognitive connections are made that integrate and assimilate verbal and non-verbal
sensory input (Clark & Paivio, 1991). Specifically, Paivio alludes to these connections as
referential processing, which calls attention to the "cross-system activation required in

imaging to words and naming objects" (Clark & Paivio, 1991, p. 259). Associative

processing, operating in tandem with referential processing, entails a broader cognitive

activation that incorporates and connects associations with previously learned words or

images (Paivio, 2010).

DCT's theory of cognition is directly impacted by how the multimedia

presentation is delivered. Specifically, dual-coding theory proposes that there are discrete

areas of the brain designed to process different types of incoming sensory input.

Multimedia presentations generally consist of a visual channel and an aural channel, and,

according to Dual-Coding Theory, these channels align with how the brain processes the

incoming information. As a result, DCT corresponds comfortably with the dual-channel

form of presentation. As Pavio (2010) observes, "the interconnected multimodal systems

[consist of] an internalized nonverbal system that directly represents the perceptual

properties and of nonverbal objects and an internalized verbal system that deals directly

with linguistic stimuli" (p. 206). From a standpoint of human cognition, there are

cognitive structures in place that are primarily suited for different types of incoming

information, particularly nonverbal (visual) and verbal (aural) stimuli. Additionally, the

two channels implicit in dual-coding theory, when mapped to the corresponding channels

in a multimedia presentation, may be more powerful and result in stronger mental

connections than if the information was uni-modal, i.e. presented in only one channel

(Hunt, 1980; Sadoski, Goetz & Fritz, 1993; Yadav et al., 2011).

Mayer's (2005) work fuses elements of dual-coding theory, multi-modal

information delivery, and cognitive function and resulted in the cognitive theory of

multimedia learning (CTM). CTM examines and extends dual-coding theory and cognitive processing by proposing assumptions regarding how the human cognitive processes sort the incoming information via dual cognitive channels. There are certain types of information that are best presented through the visual channel (for example, video, illustrations, and graphics) and there are certain types of information (e.g. narration or other sonic events that are best suited for the aural channel (Mayer, 2005; Mayer, Heiser & Lonn, 2001; Mayer & Moreno, 2003). Kounios & Holcomb (1994) also recognize that within dual-coding theory, the two cognitive processes responsible for making meaning of the incoming sensory data are "functionally distinct, yet interconnected such that the activation of a representational unit in one system can referentially (i.e. indirectly) activate the corresponding representational unit in the other system" (p. 804).

Even as distinct yet complimentary cognitive processes work together in dual-coding theory, there exists a possibility of sensory, or channel, overload. When incoming sensory data inundates and overwhelms the cognitive process responsible for making sense of the input data, other cognitive processes may suffer as a result, thereby negatively affecting the cognitive processing of information. This concept is known as cognitive overload, and the idea is implicit in Miller's (1994) and Mayer & Sims' (1994) work in cognition and multimedia: the brain and its associative cognitive functions can only process a certain amount of input at one time—if this amount is exceeded, cognitive overload may result.

Cognitive load theory (CLT), according to Paas, van Gog & Sweller (2010), "is concerned with the learning of complex cognitive tasks, in which learners are often overwhelmed by the number of interactive information elements that need to be processed simultaneously before meaningful learning can commence" (p. 116). If meaningful learning is to occur, not only should the multimedia presentation be sensitive to cognitive load or overload, care should be taken regarding specific cognitive resources and how these requirements align with dual-coding theory (Brünken, Plass, & Leutner, 2004; Mayer & Moreno, 2003).

Cognitive load theory, dual-coding theory, and information processing theory all contribute to a fundamentally deeper understanding of how humans process information, particularly in the context of a multimedia presentation or environment. Mayer, Heiser, & Lonn (2001) propose multi-modal presentation may create optimal conditions for meaningful learning in situations where the cognitive load across channels is equitable and balanced. In addition, Mayer & Sims (1994) observe that students who are less experienced with the content being covered find it beneficial to have the channels as coordinated as possible. In addition, the coordination and sharing of cognitive load among the channels allows the learner to absorb varied types of information while also reducing the load and increasing the possible efficiency of her short-term working memory (Jareb, 2006; Lan & Sie, 2010).

Limitations

Due to the differences in audio playback level and video monitor calibration discrepancies among different computers, each participant may not have viewed and heard the audio-video content in exactly the same manner. However, in order to mitigate differences among computers, the researcher set up the components of the study in such a way as to prevent variability and to maximize uniformity across the computers in the lab.

Experimental research studies are often concerned with population generalizability. As Fraenkel & Wallen (1993) observe, "generalization is made more plausible if data are presented to show that the sample is representative of the intended population" (p. 104). Although a representative sample of undergraduate college students will be desired, the research participants will be undergraduates drawn from one university, causing the generalization of the findings to the larger population to be somewhat problematic.

Due to the way the test is administered, carry-over effects may arise among the participants. Carry-over effects are observed in within subject designs when something carries over from one experimental condition to the next (Lane, 2004). Participants may begin to anticipate the types of questions based on the first video questions. This limitation is considered to be more tolerable than presenting all video content at once, followed by all content questions. In addition, a counterbalanced design was chosen in part to compensate and control for confounding due to order effects. In other words, each group viewed a low, medium, and high quality video, and did so in a different order.

Finally, although the video quality was varied among groups, the order of videos was consistent for each group.

Definition of Terms

The following terms are defined to deliver insight and to further integrate the concepts, hypotheses and research presented in this dissertation:

Multimedia

In the context of this study, multimedia will be defined as an environment where media objects, including but not limited to text, graphics, video and audio are presented in an integrated and tightly prepared package, with the intent to deliver information, and with a secondary intent to entertain (Simkins, Cole, Tavalin, Means, 2002). Additionally, the multimedia content will be delivered online and will accurately simulate three modes of quality depending on the amount of data compression and resulting pixelated, lossy quality: low, medium, and high. According to Brunyé, Ditman, Augustya and Mahoney (2009), multimedia is defined as being an information source that can be "presented within a single modality, such as visual (e.g. pictures and text), or across multiple modalities, such as visual and auditory (e.g. pictures and spoken narration)" (p. 109).

Bit Rate

Bit is a portmanteau that describes the binary digits that comprise a digital data stream. Bit rate describes the speed at which the digital information is being transferred from the server to the client. As the bit rate decreases, less data is used to describe the video and audio information, which produces a lower quality video on the client side. As the bit rate increases, more data is used to produce the image on the client side. This

results in the video quality improving and the creation of a larger file size. Bit rate is measured by the number of bits per second, and in the context of a multimedia file being transferred over the Internet via the World Wide Web, the bit rate specifies the amount of digital data that is being transferred in real time from the server that is streaming the file to the user who is viewing the content (Schmoyer, 2011, para. 3).

CODEC (enCOde/DECode)

A codec is an algorithm that is positioned at both ends (transmission and reception) of the digital multimedia file. The goal of a codec is to remove certain types of digital information so that the transmitted file is much smaller, yet still retains high quality (Follansbee, 2004).

Technology

Technology is not new and does not depend on the efficacy or effectiveness of hardware or software innovations. Throughout this study, the technological underpinnings afforded by access to multimedia resources will be understood with a broad comprehension of the term, and will be taken to mean that "computer technology and interactive media rely heavily on images, sounds, colors, and movements" (Narrey, p. 212, 2003)

Distance Education

Distance education, including courses that are offered either entirely online or in a hybrid format where some components are offered asynchronously online with the class, is continuing to incorporate multimedia content as a learning tool (Fee, 2009). Distance education is regarded as the component where interaction between the teacher and

student is fully online and where both are separated by time, and in some cases, space (McIsaac and Gunawardena, 1996).

Sound

For the purposes of this study, sound will be defined as anything occurring in the audio channel of the multimedia presentation. This may include spoken text, background music, ambient noise, or sound effects. Chapman and Chapman (2000) define sound as "a complex mixture of physical and psychological factors, which is difficult to model accurately" (p. 376).

Audio is less demanding for space than video. Full-bandwidth, CD-quality audio requires ≈ 10 megabytes per stereo minute (≈ 5 megabytes per minute per channel, left and right). 10 megabytes per stereo minute is still considered a relatively large amount of data, particularly when streaming high-definition, high-bandwidth multimedia content. Due to the large size of the full bandwidth audio files, there is a need to compress, or reduce the size of, the digital audio component of the multimedia file (Chapman and Chapman, 2000).

Defining the Population

The participants selected for this study are Indiana University of Pennsylvania students and will be recruited from introductory Communications Media courses, specifically COMM 101: Communications Media in American Society and COMM 150: Aesthetics and Theory. The participants in the study will range in age from 18-23. Responders to the research instrument under the age of 18 will be excluded from the

study. In addition, there will be no differentiation in the sample based on gender. All individuals in the targeted pool will be invited to participate.

Significance to the Field of Communications Media

The field of education has embraced multimedia as a powerful method for learning and has devoted significant research to multimedia learning and cognition (Azevedo, Moos, Johnson & Chauncey, 2010). Since so little research exists on the effect of data compression on learning acquisition, this research can be of broad interest because it can serve the purpose of identifying the effects of digital audio and video compression and encoding as independent variables that affect information acquisition and retention (Mayer, Heiser & Lonn, 2001). It can assist instructors, instructional designers and corporate trainers with information as they design multimedia content for their training sessions, lectures, and online/offline course offerings (Miller, 2003; Najjar, 1998).

Organization of the Study

The remaining chapters are structured in the following order: Chapter Two, the review of the literature, examines related research that informs and illuminates key aspects of this study. In particular, studies that examine cognition and learning in a multimedia context are a strong research thread that is decades old. However, one area that has received little attention is the aesthetic quality—the actual appearance of the audio-video content—and its effect on cognition and later recall of information. The literature review then provides an overview of the state of synchronous and asynchronous online tools that involve multimedia and how the lack of identification and understanding

of quality and fidelity as a variable may impact learning. Finally, the literature review concludes by examining data compression as a variable and the Cognitive Effect of Multimedia Learning as the theoretical framework of the study.

Chapter Three presents the research design and method of the study. The research instrument, video content and all independent and dependent variables are detailed. Additionally, study specifics regarding sampling, population and participant selection are given. In addition, the steps that generated the videos and resulting questions used in the questionnaire will be detailed (Appendix A). A discussion of the method of data collection concludes this chapter.

Chapters Four and Five outline the results and findings of the study and a discussion of the implications of those findings. Chapter Four provides specific details regarding the data analysis and includes data tables where applicable and appropriate. Finally, Chapter Five analyzes and evaluates the results provided in Chapter Four, as well as examining the implications of the data with an eye toward future directions in this research stream and for the field at large. For the purposes of this dissertation, Chapter 2 gives deeper insight and explores relevant literature that further illustrates the connection between multi-media, its effect on learning and cognition, and how applicable theoretical perspectives point toward a research design that is at once rooted in theory and fundamentally strong.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

Multimedia content in learning environments and its effect on learning has been the subject of study for over five decades (Skinner, 1959; Pea; 1994; Collis, 1991; Salomon, 1994; Mayer, 2009). Previous studies have focused on instructional methods that facilitate efficacy of learning with multimedia content, as well as scenarios where the use of multimedia resources inhibit the cognitive process. Various theories have been suggested that support cognitive processing through hyper-medial and multi-modal means. Furthermore, instructional designers, instructors, and learning facilitators have all made an attempt to improve learning outcomes by integrating multimedia content into educational lessons and environments. While this research is important, necessary, and worthwhile, one area left uncovered is aesthetic quality. In other words, we must seek to gain an understanding of how the aesthetic quality of the multimedia content—how it looks and sounds, particularly in the context of a streaming environment like YouTube— impacts deep and meaningful learning.

The following sections of this chapter review the theoretical work that will frame and inform critical aspects of this study, including a historical background on teaching with multi and hyper-medial resources in the classroom. It will then provide an overview of multimedia and its effect on learning, and in particular, the relationship between cognition and user interface design. The difference between fidelity and quality is an important distinction, and is especially relevant in this study; connections between

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fidelity and quality will be examined through cognitive load factors that influence learning and cognition in a multimedia environment. The chapter concludes by giving an historical overview and a picture of the current state of YouTube video streaming technology, as well as an overview of Dual Coding theory and other relevant theoretical perspectives, particularly as applied to the question of how the aesthetic quality of multimedia learning content may affect student learning.

Teaching with Hyper-Medial Resources

Beginning with Skinner's Teaching Machine (1959), multimedia applications in the context of a classroom have become an established and powerful instructional method for educators. In particular, multimedia use with novice learners may increase memory, retention, recall, comprehension, understanding and deeper learning (Berk, 2009; Doolittle, 2002). Indeed, interactive multimedia is rapidly increasing in popularity as the medium of choice for disseminating information in this nation and worldwide (Mohler, 2001). In addition, a multimedia, hyper-medial learning environment may be beneficial because the environment is familiar and plays a role in the learner's ability to learn and retain different types of knowledge while also offering the learner independent and increasingly interactive control over the learning experience (Jereb, & Šmitek, 2006; Yildirim, 2001). Depending on the type of information being presented and on the desired learning outcomes, the balance of video and audio material must support those goals. As Alessi and Trollip (2000) observe, "video may be beneficial when a visual sequence or process is being taught," but audio is desirable and useful when it is "related

to visual but non-verbal information […] as it allows inspection of the visual information while listening to verbal feedback" (p. 116).

For decades, educators have used video as a supplement to other traditional instructional methods. Multimedia presentations that require a higher degree of learner interactivity are a relatively recent development, along with increasingly smooth and complex multimedia (often computer-based) presentations. Consequently, multimedia content can be embedded into a traditional classroom lesson in ways that do not replace the teacher, but rather, supplement and augment her pedagogical objectives. In studies measuring embedded multimedia's impact on children's reading achievement, Chambers, Cheung, Maddev, Slavin & Gifford (2009) observed that the increased student achievement may be because "the combined audio and visual content…is retained better because it is held in both verbal memory and in visual memory" (p. 220). This assertion aligns well with Clark and Paivio's (1991) Dual-Coding Theory (DCT), which suggests that information stored simultaneously in the verbal and visual memories will be retained better than if the information is stored in only one of the memory channels.

Learning is inherently social. People want to share what they know and they want to experience new concepts with others. The social aspect of learning is known as collaborative learning. According to Wiske (2010), "collaborating with others enriches one's capacity to develop and apply ideas" (p. 99). The use of multimedia technology can be positioned in such a way as to leverage the social aspects of learning in order to facilitate a meaningful transfer of information. Furthermore, Wiske's (2010) observations on the application and integration of multimedia into the learning environment are closely

aligned with Mayer's Cognitive Theory of Multimedia Learning (Mayer, Heiser & Lonn, 2001b). As Wiske (2010) observes, "multimedia tools allow learners to express their ideas in a range of forms: drawings or diagrams, flowcharts or graphs, text formatted to highlight key ideas, or sounds, video and hypertext with links that suggest alternative paths through a product" (p. 100). Ultimately, teaching with hyper-medial resources that include multimedia content as part of the learning environment influences and promotes social connections that facilitate learning as well as appearing in an inherently familiar modality to the learners.

The impact of the Web on education is profound and ongoing. Educators and learners are still in the midst of exploring the possibilities and ramifications of the opportunities afforded by this new reality. High-quality and ubiquitous multimedia content has again raised questions about what the optimal learning conditions for students may be, and how computer-mediated adaptive learning frameworks can live up to their potential. In addition, online learning is becoming a powerful platform for social, collaborative learning where learners in different locations have the ability to connect in real-time in cyberspace. Harasim (1987) defined collaborative learning as an environment that is "based upon group discussions and interactions among learners with the instructor as the learning facilitator" (p. 133). As the popularity of online learning continues to grow, and as learning management systems continue to mature at handling multimedia content, sophisticated learning modalities that also promote group work and collaborative learning can be utilized by the instructor.

Multimedia and Its Effect on Learning

The use of technology in and of itself does not affect learning. Many researchers and educators have been too quick to view the benefits of multimedia and technology in general as a panacea and a method to remedy the ills of traditional instruction, particularly when applied in ways that ignore dual-coding theory and promote cognitive overload (Hede, 2002; Pastore, 2012). Furthermore, active cognition and learner motivation are prime determinants in meaningful information acquisition. Knowledge of effective pedagogical and psychological techniques can serve to promote active learning and information acquisition among students (Cohen, 2005; Holzinger, Kickmeier-Rust, Wassertheurer, & Hessinger, 2009). Multimedia can have a measurable and profound effect on learning, and, as Cohen (2005) observes, "musical and visual channels operate within the broader context of other domains such as printed or written text, sound effects and speech" (p. 29).

Everyday, our composite cognitive facilities are faced with an incredibly varied and complex array of sensory stimuli. As Neumann, Hyde, Neumann, Hood and Ford (2012) observe, "in real-world environments, stimuli generally activate several types of sensory receptors at once" (p. 198). In a learning environment, multimedia content can be designed to appeal to the sensory inputs responsible for vision and hearing. Molholm, Ritter et al. (2002) refer to simultaneous acquisition and processing of information as "multisensory" (p. 116). Multimedia content depends on our multisensory cognitive abilities, particularly as applied to aural and visual stimuli and input. According to Molholm, Ritter, Murray, Javitt, Schroeder & Fox (2002), the integration of stimuli

where "information from multiple senses is fundamental to perception and cognition" is common in everyday tasks that involve the "seemingly automatic integration of information from multiple sensory modalities"(p. 115). It is precisely these channels that are fundamental to the understanding and application of Mayer's Cognitive Theory of Multimedia Learning (CTL).

An effective learning environment, particularly one that contains multimedia content and audio-visual materials, can serve as a powerful addition within the context of online learning. According to Haug (2009), "children and youngsters in many countries live an online existence when not in school, with a high consumption of digital technology" (p. 200). Because of the ubiquitous nature of digital technology in young peoples' lives, these same types of technologies that are used for entertainment can also be repurposed and leveraged into meaningful learning opportunities. When digital technologies that were originally aimed at entertainment are repurposed for another task or modality, the multimedia digital tools can have a profound effect on learning. In other words, the power does not lie in the tools themselves, but in how we choose to access and interact with the available digital technologies (Lillejord & Dysthe, 2009).

According to Paas, Ayres & Pachman (2008), "multimedia learning sometimes fails to live up to its full potential, because high cognitive loads are often generated, primarily by the requirement to integrate different sources of information" (p. 11-12). If attention is paid and care is taken to mitigate factors that contribute to cognitive overload in a multimedia environment, then meaningful learning can take place.

In a multimedia environment, there are many tools available for learning. The tools may be delivered synchronously, in real time, or asynchronously, where the learner can access the material at her discretion. Due to the rapid increase in computing power in desktop computers and in handheld devices, there exists a wealth of synchronous and asynchronous tools, including text-based strategies, live audio and video feeds, interactive whiteboard applications and other interactive tools that can be implemented in a multimedia context or environment (Finkelstein, 2009). If synchronous tools are a prominent component in a multi-media learning environment, then the learner will often expect interactions with the instructor and other students that approximate real-time interaction. In other words, there is an expectation of presence on the part of the learner, which as Finkelstein (2009) observes, "is what differentiates chat from an asynchronous form of communication such as e-mail or discussion boards" (p. 34). Although Finkelstein does not identify how the quality of the video may affect cognition and recall, he does implicitly relate bandwidth to quality, stating "quality real-time video, perhaps more than most other tools, relies on a dependable, broadband Internet connection" (Finkelstein, 2009, p. 39). Finkelstein (2009) also recognizes the feasibility of transmitting videos that are of poor quality and small size because video is "still quite susceptible to delays in transmission and Internet traffic" (p. 39).

Audio-visual content has benefitted from Web-based delivery in ways that leverage the material in order to take advantages of the strengths evident with online presentation. Three main features of the web have been successfully exploited in online learning environments: flexible communicative mechanisms, hypermedia, and

accessibility. In addition, all three features contribute to help promote open exchange of thoughts and ideas, accommodation of different learning styles among the participants and students, and unfettered access to information resources including offsite library materials and database access (Fan & Macredie, 2006, p. 10).

Learning can take place at any time and in any context. Often, learning takes place without the student (or even the teacher) being aware of the material being learned or the moment in which the learning is happening. Deep, profound learning often takes place in situations where the learner is actively engaged and is making cognitive constructions and connections in a fluid, almost effortless manner. Instructors often refer to events such as this as teachable moments. Learners or performers often look back on these moments where seemingly effortless learning or performing took place and remark that they were "in the zone" and that the learning simply seemed to flow.

The explosive growth of the Web has had a profound impact on how we communicate with one another, and it has also created a new paradigm for teacher-student communication. Further, the Web has enabled the classroom to extend beyond its own walls and into educational opportunities that transcend and exceed limitations that for decades framed our thoughts and actions regarding education and pedagogical theory.

The Web is an extremely dynamic and flexible conduit for content that can facilitate and enable dialog, learning, and communication among learners. In addition, the modes of communication are open-ended and may be synchronous or asynchronous, which in turn allows for communicative channels to exist without time constraints (Alessi & Trollip, 2000, p. 375). Multimedia content presented via the Web is often displayed in

such a way so that both the audio and video channels are utilized. Video presentations that combine visual and auditory information illustrate the potential of Dual-Coding Theory (DCT), and as Alessi and Trollip (2000) observe, a learning environment using multimedia resources is created where "complimentary forms of information, such as a picture and speech describing it, facilitate learning more than a single form" (p. 62). In this way, a multimedia, multi-modal presentation's effectiveness in learning stems from its ability to align with important tenets of Dual-Coding Theory, particularly as applied to human learning and cognition.

Cognition and User Interface Design

The design of a multimedia interface in a learning context often can have profound effects on information acquisition. Effective and meaningful computer aided instruction should incorporate elements that reinforce the learning content and also allow the student to fully focus on the material at hand (Askov & Bixler, 1998; Mayer, 1999; Mayer, 2005; Mayer, Heiser, & Lonn, 2001b; Liu, Liao, & Pratt, 2009). Moreover, there is a lack of research that addresses, in light of what we surmise via dual coding and information processing theories, the issue of content development that enhances learner performance and satisfaction (Chang & Yang, 2010; Sun & Cheng, 2007). However, if the multimedia presentation is skillfully designed and remains mindful of the dangers of cognitive overload, a learning environment may be created where "richer processing of the information may provide more links with which to connect the new information to prior knowledge" (Najjar, 1998, p. 27). In the context of a learning environment, student responses and decisions depend on the situation and the information that is available at

the time, and can vary from behavioristic responses to feedback that is more sophisticated and oriented to critical thinking (Askov & Bixler, 1998). Furthermore, the dual-coding cognitive abilities inherent in the learner can be enhanced by the use of multimedia in ways that fully and efficiently utilize the audio and video channels, enabling and enhancing multimedia variables that enhance learning and information acquisition in many areas of cognition (Fang, Chang, Lee & Tsai, 2010; Hoogeveen, 1997).

As Jonassen and Reeves (1996) observe, "historically, educational media have been developed by teams of educational technologists, including instructional designers, media producers, and media managers, in collaboration with other types of specialists" (p. 694). When educational technologists design educational media, they may have an understanding of the technical aspects of the project, but may lack the expertise in learning theory that may hinder the efficacy of the learning materials. At the very least, the graphical user interface (GUI) should be free of clutter, or anything that is visually distracting. Askov & Bixler's (1998) views on interface design align squarely with the basic tenets and propositions of Mayer's (2005) Cognitive Theory of Multimedia Learning (CTML), and reinforce the need for educational technologists to be aware of how their design may impact learning and how an understanding of cognitive theory may help them to create compelling and powerful multimedia learning material.

As Brunyé, Ditman, Augustya & Mahoney (2009) observe, "some recent research has begun to characterize the cognitive mechanisms that may be responsible for the comprehension and memory advantages typically seen with multimedia learning, as well as the role of individual differences in this process" (p. 108). Recent research such as this

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reinforces current multimedia content and reflects thought based on current multimedia design. This is important because of how pervasive computers and multimedia technology have become in the learning environment of the classroom. However, what is even less explored is what effect, if any, aesthetic quality has on the mental faculties that are utilized as the process of cognition occurs.

The Difference Between Fidelity and Quality

Historically, consumers were not directly in control over the aesthetic quality of multimedia content. Before the rise of the personal computer and throughout the golden age of broadcast television from the late 1940s to the early 1960s (Wilk, 1976), viewers tuned in to an analog signal broadcast over the airwaves, with an ever present and unavoidable amount of video noise, known as snow, and muffled monophonic audio. Cater & Adler (1975) note this lack of fidelity in their definition of television, explaining the technology as a "device which inhabits the living room or bedroom or den of more than 97% of all American households and which displays a smallish electronic image of fairly poor resolution and emits sounds of even poorer fidelity" (p. 25). Although dated, this observation is vital to the discussion of aesthetic quality as it reads like a tacit acceptance of poor quality. In effect, the viewers are relinquishing control over quality because they are helpless to bring about a change in quality. Cater & Adler's implied definition blurs the line between quality and fidelity; they make no distinction between the two terms.

For the purposes of this dissertation, the terms fidelity and quality will be interchangeable and will be understood as the audio-visual integrity of the multimedia

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content. High fidelity, high-quality content will display high similarity to the original signal. Conversely, low-fidelity, low-quality content will bear little resemblance to original. Researchers agree that a balance must be struck between multimedia content quality that is too poor or too high. As Hannifin, Hannifin, Hooper, Reiber & Kini (1996) observe, "it is now widely believed that low fidelity stimuli are often superior to high-fidelity stimuli especially for novices" (p. 382). In other words, high fidelity may place greater demands on working memory and may inhibit learning by distracting or overwhelming the sensory inputs of the student. Specifically, learning may be hindered at the novice level when multimedia content is presented in high-definition because the extreme audio-visual quality itself serves as a distraction from the content.

The aesthetic differences in quality, specifically between low and high quality, are closely allied with McLuhan's concept of hot and cool media. According to McLuhan, all popular media of his day could be viewed the binary terms of hot and cool. The attempt to separate and classify media into two dichotomous terms aligned with McLuhan & Powers' (1989) view of cognition, as they observed, "all Western scientific models of communication are…linear, logical, and sequential in accordance with the pattern of efficient causality" (p. 80). Hot media, typically associated with visual stimuli, is high-definition and is information-rich. This is analogous to the high-quality video content contained within the test instrument for this research study. McLuhan's view of cool media, generally associated with purely aural stimuli, is low definition and is generally associated with band-limited acoustic stimuli like a telephone. Conversely, cool media demands high participation from the user (McLuhan, 1964). Similarly McLuhan's view

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of cool media corresponds with the low-quality video content in the test instrument for this study.

Furthermore, there is a participatory, involved aspect of McLuhan's view regarding hot and cool media. The demands placed on the participant may vary, but they are always present, and always contribute to the efficacy of the experience. According to McLuhan (1964), "hot media are, therefore, low in participation, and cool media are high in participation or completion by the audience" (p. 23). In essence, lower quality multimedia presentations require more active involvement from the participants, and higher quality presentations demand less work from the audience.

Persistence of Vision and Available Bandwidth

Regarding video, as Chapman and Chapman (2000) observe, "all current methods of displaying moving pictures depend on the phenomenon known as persistence of vision. If a sequence of still images is presented to our eyes at a sufficiently high rate, we experience a continuous visual sensation" (p. 300). Here, the authors are referring to the speed at which the images are presented, and this is the foundational principle of persistence of vision. However, they do not address the aesthetic quality of each frame, and whether or not it affects meaningful learning and how quality matters in multimedia design and delivery.

In the context of online multimedia presentation, the available bandwidth is often a prime determinant of quality. Bandwidth limitations, including service interruptions and slow download speed, inhibit the learner from smoothly downloading or streaming large, high-quality audio-visual files (Fee, 2009). Moreover, it is not accurate to assume that

every user, particularly in the United States, has a high-speed connection to the Internet. When viewed in this context, it is reasonable to assume that there is a need to understand how multimedia audio-visual quality affects learning, and how low the quality can become before learning and recall are adversely impacted. There are positions in the existing literature that theorize that the extremes on either end of the aesthetic spectrum, extremely poor quality, or high-definition, both may affect learning in some way. A prime goal of this dissertation is to help to resolve the tension created by these two opposing streams of research by examining the effects of aesthetic quality on student recall of multimedia material.

When large file sizes, particularly those of high quality audio-visual content, are too large for efficient online presentation and transmission, they are reduced through various methods of data compression. All methods of data compression strive to reduce the size of the file but retain the essence of the message, so that its communicative impact is preserved. Essentially, the goal of data compression is to reduce the file size without compromising or distorting the message to the extent that it is no longer recognizable.

Streaming video content must be at an acceptable level – broadcast quality – or the message risks being compromised, distorted, or lost entirely. As Liu, Rao, Li, & Zhang (2008) observe, when playback quality is poor, "users in video broadcast [computer] applications stay for shorter times and will simply leave" (p. 19). Available bandwidth must be high enough to support a video quality that helps to maintain the viewers' interest. According to Chapman and Chapman (2000), "the fundamental obstacle to streamed video is bandwidth. The network has to be capable of delivering

data with the minimum of delay" (p. 341). When delay is introduced into a multimedia stream, gaps or stutters may occur, or the audio may become unsynchronized with the video. In a learning environment, these issues can cause frustration to the student, which may eventually lead to boredom, or in extreme cases, disengagement from the lesson. The learner may simply become annoyed at the distractions and then click out of the lesson.

Balance Between Download Speed and Quality

Learner attitudes toward the online learning environment are key determinants in the perception of a successful, high-quality learning module or environment. Presentation quality is directly linked to file size; high-quality audio and video create larger file sizes than lower quality audio-visual content. However, a balance must be struck between download speed and the quality of the presentation. Technically speaking, as multimedia quality increases, so does file size. Bandwidth is limited and care must be taken to align the capacity and capabilities of the internet connection with the demands placed on the bandwidth as a result of the quality and size of the multimedia file. As Chumley-Jones, Dobbie and Alfred (2002) found, download speed was identified as a "main predictor of satisfaction with web-based learning" (p. 87). If the learning content is high quality but the user experiences slow download speeds, then the user will be dissatisfied and disengaged, regardless of the quality. As such, it is necessary not only to strive for the most efficient file size relative to the average available bandwidth of the intended audience, but also to understand the effect of lower-quality streaming multimedia content on learning recall and cognition.

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Cognitive Load Factors

Instruction utilizing multimedia content places unique demands on the learner. According to Cook (2009), "multimedia instruction involves presenting educational content through multiple media, primarily through visual and auditory presentations" (p. 35). As such, a learner's innate, individual cognitive ability and learning style can have an impact on the efficacy of web-based learning and instruction. As Souto & Verdin (2006) observe, an understanding of the learner's cognitive ability level (CAL) can aid in the development of more adaptive and interactive web-based learning environments (p. 42). However, as their research instrument was primarily text-based material presented onscreen, multimedia elements including their presentation style did not impact their results. Consequently, there is a need to understand how cognitive processes are impacted or affected by the quality of the aural and visual stimuli that constitute the online, Web-based learning environment.

As Hannifin et al. (1996) observe, "well-documented research on cognitive resource allocation has established conclusively that more is not necessarily better when presenting stimuli" (p. 382). Other distractors can also cause cognitive overload. For example, if a learner is viewing a poor quality multimedia video, the audio quality will be degraded. This degradation may result in a hissing sound in the audio channel that interferes with the intended audio track. In this case, the audible hissing that is present when the videos are played at medium and low quality can also be responsible for overloading the aural channel with noise that may contribute to cognitive overload, thereby causing the learner to be distracted from the original message.

Characteristics that influence student learning and recall in a multimedia environment are generally referred to as cognitive load factors (Cook, 2009; Mayer, 2005). There is difficulty when measuring the effects of multimedia on cognitive load, because, as Cook (2009) observes, "the construct of cognitive load has been defined in a number of different ways in the previous/existing research literature and may in fact involve several components" (p. 36). To further complicate matters, research that has investigated multimedia effects on cognitive load used widely varied measurement techniques, often with vague descriptions (if any) as to what element of cognition was being investigated (Cook, 2009; Sundar, 2000). Because of the ever-present possibility of cognitive overload it is vital for instructors and instructional designers to understand how learners process different types of audio and visual information, so that the information can be conveyed in an effective manner (Moore, Burton, & Myers, 1996).

The introduction of computers into the classroom environment forced a reconsideration and reinterpretation of learning theories. According to Chambers and Sprecher (1983), "the emphasis on information processing (where computers were considered to be analogous to the brain and in which concepts such as memory replaced stimulus-response bonds) was accompanied by a general professional acceptance of the value of such machines" (p. 90). The implication of the shift in learning theories caused by the increasing power and versatility of computers was profound. Computers were becoming more powerful and could therefore be used to introduce and reinforce more complicated learning objectives, and not just simple yes/no, behavioristic goals. Because of the way computers started to become incorporated into the classroom, it became

necessary to apply learning theory in this context, and, eventually, to revisit how human cognition perceives incoming aural and visual stimuli in a multimedia environment.

Cook (2009) delineates three types of cognitive load factors that are applicable to this study: intrinsic load, extraneous load, and germane load. Intrinsic load refers to the inherent difficulty of the lesson. Extraneous or ineffective load refers to cognitive demands that are not directly related to the task at hand and cause the learner to become distracted, dissatisfied, or annoyed. Germane or effective load refers to components embedded in the instruction or in the context of the multimedia environment that facilitate learning and may contribute to more efficient information processing (Chandler & Sweller, 1991; Miller, 1956; Mayer & Sims, 1994). Intrinsic, extraneous, and germane cognitive load factors cannot be viewed as separate, unrelated components; they coexist during the course of a multimedia presentation. As Cook (2009) observes, "within cognitive load theory, intrinsic, extraneous and germane load are additive; when combined, they comprise the overall construct of cognitive load" (p. 37). The additive nature of intrinsic, extraneous and germane loads impacts the effectiveness of a multimedia presentation. Care must be taken to align the aural, graphic, and visual elements in such a way as to maximize germane load, minimize extraneous load, and reduce the opportunities for cognitive overload.

According to cognitive load theory, ineffective learning brought about by extraneous load may cause the learner to become distracted or overwhelmed because they may be preoccupied with trying to make sense of what they are seeing, hearing and experiencing. In this context, the contributor to extraneous load would be the poor quality

of the multimedia content. As Paas, Ayres & Pachman (2008) observe, "in the case of multimedia learning, an additional challenge is created when learners need to allocate extra effort to make sense of the information presented through different sensory modalities; increased effort does not always result in increased performance" (p. 27). Although this study will focus on quality as a primary extraneous load factor, other distractors, even if well intentioned, may also cause inefficiencies in the learning process (Paas, Ayres, & Pachman, 2008; Mayer & Moreno, 2001a).

It is possible to maximize germane load in a multimedia environment by designing and presenting the elements in such a way as to utilize the concept known as chunking. Complicated material can be presented in smaller pieces called chunks that build on one another with the intention of maximizing germane load and building on knowledge as the lesson progresses. Multimedia content that is designed with chunking in mind creates a fluid stream of smaller blocks of information that form larger ideas known as schemas. According to Sorden (2005), "schemas organize simpler elements and can then act as elements in higher-order schemas. As learning occurs, increasingly sophisticated schemas are developed and learned" (p. 266). According to Mayer (1999), "students are better able to understand multimedia explanations when alternating visual and verbal presentations do not overload working memory" (p. 620). Many researchers propose that there is correlation between effective presentation of information through chunking and effective learner recall of information (Paivio, 2013; Sorden, 2005; Moore, Burton, &Myers, 1996). Therefore, the concept of chunking played an important role in the design of the multimedia content for the test instrument in this study. The content is

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intentionally short, and the concepts presented often employ brief video clips underscored with concise audio and graphic support when applicable.

YouTube Video Technology

Since YouTube premiered online in February 2005, it has emerged to become one of the most popular sites on the World Wide Web. According to Alexa.com (2014), YouTube is the third most popular online destination, globally and nationally. Visitors to the site access an average of 9.46 pages daily, and spend an average of 18 minutes 59 seconds on the site per day ("Youtube.com Site Overview," 2014, para. 2). Because of the ubiquitous global reach of YouTube, it is reasonable to look at video quality on the site in order to provide insight into the design of the video component of this study's test instrument. In addition, examining the video technology that drives YouTube is helpful because it provides a major source of multimedia content in the classroom environment, at all levels (Agazio & Buckley, 2009; Berk, 2009; Jones & Cuthrell, 2011).

Since its inception, YouTube's video engine has undergone several revisions and improvements, all in an attempt to provide the highest possible quality to the viewer while simultaneously detecting and adjusting for differing bandwidth limitations. When bandwidth limitations are imposed on the video stream, there are compromises in the picture quality. As McIsaac & Gunawardena (1996) observe, "lower data rates yield less resolution and less ability to handle motion; if an image moves quickly, the motion will streak or jerk on the screen" (p. 413).

Initially, YouTube videos could be viewed in three versions, identified by the labels SQ (standard quality), HQ (high-quality), and HD (high-definition). In time, the

three initial quality designations were replaced by numerical values that provided information representing the vertical lines, or resolution, contained in the video. From a user standpoint, the newer values are more specific, and provide detailed information regarding vertical resolution that was not shown in the earlier designations.

Currently, the default streaming technology for most users is Adobe Dynamic Streaming for Flash. On the browser (user) side, YouTube's video playback engine supports the technologies embedded in the Adobe Flash Player. There is also an experimental version of the site that relies on the built-in multimedia capabilities of browsers that support the HTML5 standard, located at www.youtube.com/html5 (Ward & Robertson, 2013; YouTube API v2.0 – Revision History – YouTube – Google Developers, 2014; Google, 2014).

Under normal conditions, when a visitor accesses the site, YouTube's playback engine automatically senses the available bandwidth and adjusts the video stream to a quality that will play without interruption. When the bandwidth is limited or constrained in some way, the video quality will degrade. However, a user can bypass the detected YouTube settings by adjusting the video playback quality, located under Account Settings. As of July 2014, there are two main options available: "always choose the best quality for my connection and player size (always play HD on full screen when available)" or "I have a slow connection. Never play high-quality video" (Playback, 2014, para. 1). In either case, whether one chooses to allow YouTube to automatically stream the most appropriate content based on bandwidth or chooses to override those

settings, the aesthetic quality, and therefore the appearance of the video content, are directly affected.

Piagetian Theoretical Perspectives Applied to Multimedia

An online learning environment can be designed so that knowledge gained from each step in the sequence contains pertinent, essential information required for success in subsequent modules or lessons. The difficulty in constructing effective and authentic online learning content lies in the notion that each learner will construct meaning of the learning materials in a novel, distinct manner. As Ruey (2010) observes, constructivist learning, with its foundation of Piagetian theories of learning, emphasizes "the impact of constructed knowledge on the individual's active, reflective thinking" (p. 707). In other words, as the learner internalizes the online instructional material (for example), she will make meaning from the material based on her own thinking which in turn is influenced by her previous thoughts, feelings and experiences, particularly as related to the subject under study. According to Piaget (1964), "experience of objects of physical reality is obviously a basic factor in the construction of cognitive structures" (p. 178). Piaget's observation regarding how learners' cognitive structures are shaped by their physical realities directly applies to effective multimedia design. When considerations are made that recognize prior experiences and physical realities of each learner and that consider the possibility of cognitive overload, the effectiveness of a multimedia lesson may be maximized.

As Piaget noted, children are best able to learn concepts that align with particular stages in their cognitive maturity and current developmental stage. It is why he observed

that it is beyond the capabilities of a five-year old child to learn advanced mathematics, simply because "he does not yet have the structures which enable him to understand" (Piaget, 1964, p. 180). However, even when a child's cognitive development and abilities align with that which is expected of them, meaningful learning will take place only after equilibration, which happens when the learner constructs meaning to align with her own physical reality, occurs. From the learner's standpoint, at the moment of equilibration, everything falls into place. From the perspectives of learning and cognition, all of the pieces necessary for success seem to fit. Piaget's theory of cognitive development is predicated upon the notion or belief that there should be a hierarchical order in the learning sequence, where learning concepts and objectives are scaffolded in a logical manner, in order of difficulty. As the learner masters one concept, she is then presented with another concept that builds on and is connected to the previous lesson, but just slightly more difficult or demanding. According to Piagetian theory, a student is "only ready to develop a particular concept when he has acquired the schemata that are necessary" (Wadsworth, 1996, p. 121). In a multimedia environment, the aesthetic issue of quality pertains to this situation. If the quality is not at an acceptable level, or if it is interfering with the comprehension of the content, then all of the Piagetian pieces are not fitting in an optimal capacity.

If Piaget saw equilibration as an active cognitive process that, in the end, shaped experience, then the connection to multimedia content and learning is obvious. As Piaget observed, "there is no assimilation without accommodation because the scheme of assimilation is general, and as soon as it's applied to a particular situation, it must be

modified according to the particular circumstances of the situation" (Bringuier, 1980, p.

43). As DeVries (1997) observes, equilibration must be about "establishing equalities"

among (primarily) accommodation and assimilation. Because of this, learning

environments that feature multimedia must ensure that the audio-visual content is of

sufficient quality so as to allow the learner to achieve equilibration among her cognitive

and constructivist facilities (p. 7).

Dual Coding Theory

If the learner recognizes the content that is necessary for learning, then that

information may be coded, processed and internalized into and within the most

appropriate modality according to dual-coding theory (DCT). Dual coding theory

proposes there are certain parts of human cognition that are more efficient at processing

certain types of sensory input, namely aural and visual stimuli. Furthermore, as Askov &

Bixler (1998) observe, "the experience in which an idea is embedded is critical to the

individual's understanding of and ability to use that idea' (p. 173). Human cognitive

structures are assumed to be in place that support, thrive and depend on information

presented through different sensory inputs, e.g. aural and visual modalities. According to

Reiber (2009), "learning involved a complex relationship and dependency between a

learner's prior knowledge, a learner's motivation, the context, the task, and the resources

(e.g. simulations) provided to and used by the learner to support or enable the task" (p.

217). In this context, DCT supports the construct of visualization (Rieber, 2009). Alessi

and Trollip (2000) acknowledge that DCT and its application to multimedia is a powerful

aid in cognition and recall, as they note "learning is best facilitated by a combination of

complementary visual and auditory information" (p. 22). A sound can originate from many different and disparate sources, while the verbal store can align with any aspect of language or verbal communication (Moore, Burton and Myers, 1996). In addition, dual coding theory aligns with the capabilities of multimedia content because the audio and video content is presented via discrete channels in this context.

Although the use of the World Wide Web and its inherent capacity for multimedia learning is powerful, research suggests that existing learning theory must be modified and extended to support the innovations afforded by this technology. According to DeSchryver (2009), "there is a need for reconceptualization of Cognitive Load Theory for comprehension and learning in more ill-structured conceptual arenas, like the World Wide Web" (p. 134). Paivio's Dual Coding Theory aligns well and maps to the aural and visual components of multimedia content. According to Brunyé, Ditman, Augustya & Mahoney (2009), Paivio's dual-coding theory "proposed that strong associative activation of mental imagery (made possible by prior experience, retrieved as imagery) facilitates memory for words and these two processes — one verbal (symbolic codes) and one visual (analogue codes) — were separable in memory" (p. 112). In essence, dual-coding theory bridges the gap and connects constructivist thought (via prior experience) with learning in the context of a multimedia environment by recognizing that a learner's experience shapes the outcome and that the audio and video channels must present the information in a complementary manner.

According to Sadoski & Paivio (2013), "in DCT, the reader or writer constructs texts and their interpretations from sensory-based, modality specific, verbal and

nonverbal mental structures as affected by external contexts of various kinds including social contexts" (p. 6). Since DCT acknowledges the importance and relevance of multiple modalities and how they may affect learning, it is appropriate as a theoretical lens with which to frame this study.

Modality Effect

According to Paas, Ayres and Pachman (2008) the modality effect occurs "when learners are presented a picture or animation accompanied by explanatory text" (p. 24). To avoid cognitive overload, when visual information is accompanied by an explanation, the explanation should occur in a different modality or channel. Delivering the message in this way also takes advantage of the separate aural and visual channels hypothesized in dual coding theory. Modality effect is directly intertwined with Paivio's dual-coding theory (DCT). Basically, dual coding theory holds that "the quality of knowledge acquisition" (Paas, Ayres and Pachman, 2008, p. 25) can be enhanced and increased by involving multiple cognitive processes, specifically the verbal and non-verbal channels. The principles of dual-coding theory were further refined in Mayer's (2001) cognitive theory of multimedia learning (CTML), which is a theory "that stresses integration of audio-visual information at the working memory level" (p. 26). Although a significant amount of research has examined the modality effect and its impact on learning and cognition, there are at present no studies that address the issue of aesthetic quality of information presented across modalities, and whether differences in quality impact learning on a significant level.

Communal Constructivism and Shared Learning

Not only does the Web provide a convenient and powerful platform and framework for the presentation and viewing of multimedia content, but because of the read/write (interactive) nature of Web 2.0, opportunities exist for shared learning to occur. Girvan and Savage (2010) observed how communal constructivism, also known as shared learning, occurred in small-groups that were assigned online learning modules, noting that the online lesson "leverages the view of a top-down community of learners, focusing on the learning that takes place within the group as a whole" (p. 12).

Communal constructivism is closely allied with collaborative learning that occurs in environments ranging from the workplace to educational settings. Collaborative learning is analogous to shared learning and is defined as task-focused project work that is inherently goal-oriented with the problem disseminated across the group members. Mason and Watts (2011) found that collaborative learning "improved average success over independent exploration because good solutions could diffuse through the network" (p. 764). Tasks situated within the context of communal constructivism and shared learning often contain multimedia content, and this content is usually construed to align with constructivist learning philosophy, while diverging from behaviorist views of concept-based learning (Meehan, Holmes, & Tangney, 2001; Rodrigues, 2000). As a result, the aesthetic quality of the multimedia learning content, which has been scarcely investigated, is of prime importance.

Social Learning Theory

Bandura's (1969) Social Learning Theory suggests that humans can learn quickly (and avoid much trial and error) by watching others successfully perform the desired task. Social Learning Theory is a broad framework that consists of four inter-related components: attention, retentional processes, conversion of symbolic representations into appropriate actions and motivational processes (Chambers & Sprecher, 1983; Bandura, 1969). It may be necessary to present multimedia content in a learning environment at a quality that supports (rather than impedes) observational and social learning. As Chambers and Sprecher (1983) observe, "the computer provides a reality situation in which the student may learn vicariously through interaction with the model" (p. 105).

In computer-aided learning, the quality of the model or simulation is paramount, and as Chambers and Sprecher (1983) observe, it is directly tied to Bandura's Social Learning Theory, particularly the motivation factor (p. 104). According to Chambers and Sprecher (1983), "it has been found that high-status models are more often imitated," and "imitation induced in students decreases as the model is made more dissimilar to a real person" (p. 104). In this context, the authors are equating high status with high quality. Essentially, the researchers are promoting the notion that maximum quality affords the most effective means for learning; if the quality is better, learning will occur and be facilitated in a smoother, quicker manner.

Multimedia content and its effect on learning have been studied for decades. Previous research has examined instructional methods and the efficacy and impact when utilizing multimedia methods, and how the use (or overuse) of multimedia content can

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negatively impact the cognitive aspects of learning (Skinner, 1959; Pea; 1994; Collis, 1991; Salomon, 1994; Mayer, 2009). Skinner's Teaching Machine (1959), considered by many to be one of the first examples of a multimedia application in the classroom, showed the potential for learning with interactive tools. Researchers studying the impact of multimedia in the classroom have concluded that multimedia can enhance learning, particularly if the learners are motivated and engaged in the process (Hede, 2002; Pastore, 2012; Cohen, 2005; Haug, 2009). In addition, collaborative learning has been shown to be reinforced when multimedia content is utilized throughout the process (Wiske, 2010; Mayer, Heiser & Lonn, 2001b).

Multimedia content has been a powerful educational tool for decades, and the use of multimedia in the classroom has had a sweeping effect on learning and educational theory. Not only is there a difference between fidelity and quality; there is a difference in cognitive load, especially when a learner is confronted with stimuli presented in different channels. The research design of this dissertation rests precisely on the shoulders of Piagetian theory and Dual Coding Theory, and the question of aesthetic differences and its impact on information recall directly aid in further framing and informing the research instrument and method presented in Chapter 3.

CHAPTER 3

RESEARCH DESIGN AND METHOD

Introduction

Multimedia and its effects on learning and information acquisition, particularly in the classroom environment, has been the subject of study of a broad and significant body of research spanning over three decades (Rockwell & Singleton, 2007; Salomon, 1984; Pilling & Thomas, 2011; Moreno & Mayer, 2000). Since the late 1960s, instructors have sought to integrate multimedia content into various learning environments and situations. Within the context of a learning setting that integrates and utilizes multimedia content, the primary focus of most of the previous research has been on cognition; the area of aesthetic quality on learning and recall has been largely ignored or minimized. Indeed, as Paivio (1971) observes, "stimulus-evoked imagery is the mechanism responsible for superior learning" (p. 252).

Given the increasing reliance on YouTube in the classroom (Cleveland, 2011; Snelson, 2011), there is a need to understand how the various levels of quality, often changing in unpredictably shifting ways as a result of varying available bandwidth, affect learning. When applied to streaming multimedia content, data compression is not targeted at the dynamic range of the signal. In this context, data compression does not alter the dynamic range (the sonic distance between the quietest and loudest sound level) of the signal. Rather, data compression seeks to remove, through a carefully designed mathematical algorithm, the data that is determined to be superfluous to the signal or masked by other elements of the signal, and therefore unnecessary.

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The reduction of large audio-video files is of prime importance in an online environment where available bandwidth is often at a premium. As Wang and Gearhart (2006) observe, "a major issue in distributing video over the Internet is file size. Video files are larger in size than any other media and require a considerable amount of storage space and user download time" (p. 178). Effective data compression greatly reduces the size of the file while retaining the essence of the audio-visual content.

Data compression has an obvious effect on how multimedia content looks and sounds. Even though content that is highly data-compressed may result in poor, pixelated video and low-fidelity, noisy audio, the effect of moderate to severe data compression on information acquisition and learning recall among college students is less understood than how multimedia content impacts and affects learning and recall. This dissertation attempted to provide an understanding regarding the quality of multimedia content (low, medium, and high) and its effect on information acquisition and recall of multimedia content, represented via post-test accuracy scores, in a learning context among undergraduate college students.

Experimental Design

The method employed a quasi-experiment with a counterbalanced, repeated measure design, with video content resolution (low, medium and high quality), video content topic, group membership, age, college major, and self-reported technical aptitude serving as the independent variables and the post-test accuracy scores as the dependent variable (Creswell, 2008; Buddenbaum & Novak, 2002). A counterbalanced design was chosen in part to compensate and control for confounding due to order effects. In other

words, each group viewed a low, medium, and high quality video, and did so in a different order. The test instrument contained three videos, and each video was presented in low, medium, and high quality formats. In all cases, the video content served as the independent variable (IV). The dependent variable (DV) is the test scores from the post-test questions that were administered after the viewing of each video excerpt. Buddenbaum and Novak (2002) provide a useful blueprint for the test design of this study, where R = random assignment of subjects, Ox = post-treatment observation (questions regarding content), and Xx = the administration of each condition of the independent variable (see Table 1).

Table 1

Experimental Design of the Study

R	Experimental 1	X1L	O1	X2M	O2	X3H	O3
R	Experimental 2	X1M	O4	X2H	O5	X3L	O6
R	Experimental 3	X1H	O7	X2L	O8	X3M	O9

The test instrument was presented via Qualtrics, an online survey tool particularly adept at presenting and handling multimedia content in a testing situation. Prior to the first video example, all participants acknowledged that their participation was voluntary and that they may opt out of the study at any time, with no penalty. If they agreed to proceed, they were then presented with the first video example. The first example for each group was the same video, but of different quality. For example, Group 1 saw video

1 in low quality, Group 2 saw video 1 in medium quality, and Group 3 saw video 3 in high quality. After the viewing of the first video, each group answered the first question block. This sequence was repeated (with differing quality among the videos) for the remaining video content. Each group received one low quality video, one medium quality video, and one high quality video, all in different order to support the counter-balanced test design.

Research Instrument

The research instrument questions for the study can be found in Appendix A. At the beginning of the study, all participants were asked to provide basic demographic data, including age, college major, gender, marital status, time spent listening to music, technological aptitude and commute time (see appendix B).

All questions were multiple-choice and were derived from the content contained in the video excerpts. There were no obvious or intentional distractors in the questions. Prior to the data collection, a pilot study was conducted in order to see if participants agreed with the researcher's quality designations regarding the videos.

At the outset of the study, there were four videos; a specific goal of the pilot study was to see if the low quality versions of the videos were unacceptably poor. In other words, if the low quality versions were deemed to be substandard, it would make the questions based on the video excerpt impossible to answer. The inferior video quality had to straddle the line between bad and so abysmal that the video and audio quality prevented answering questions. The respondents in the pilot study viewed the low quality versions of each video module and then attempted to answer the content

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questions. The respondents were in agreement as to which of the video examples was so deficient (from a standpoint of quality) that it was not possible to correctly answer content-based questions. As a result, specific video content was removed from the testing instrument. All low-quality versions of the videos used in the study were deemed by the pilot study participants to be difficult, but not beyond a point where sufficient information to answer the content questions was not evident or able to be discerned from the excerpt.

Site

The study was conducted at a Communications Media computer lab in Stouffer Hall on the campus of Indiana University of Pennsylvania. It was necessary for each participant to have Internet access and headphones so that they were able to access the test instrument and to hear the audio at a sufficient volume. The researcher provided headphones to each participant to ensure uniform sound reproduction. In addition, each testing computer supported CD-quality audio (16-bit, 44.1 kHz) and video resolution up to 1440 x 900 pixels.

Sampling, Population and Participants

According to Creswell (2008), the experimental unit of analysis is defined as "the smallest unit treated by the researcher during the experiment" (p. 326). In this study, the data was collected from each individual who fully participated in the study from beginning to end. The study was a quasi-experimental design, consisting of three experimental groups. The smallest unit of analysis was the individual student participant, which conforms to the individual level (Buddenbaum & Novak, 2002).

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Participants in this study were aged 18 to 23. This age range was chosen because there was a need to study the effects of audio-video (AV) data compression and encoding on information acquisition in this population of college-age students. All individuals in the targeted pool were invited to respond to the survey. The goal was to have approximately 50-90 students participate in this study. In total, there were 55 total participants who completed all parts of the activity. Subjects were selected from two or more sections of COMM 101: Communications Media in American Society and COMM 150: Aesthetics and Theory.

The experiment was primarily designed for use in an introductory communications course. It was important to the research study that some of the participants arrived with some relative knowledge or comfort level with its contents. COMM 101 and COMM 150 students were used as the sample because of two primary assumptions: 1) the students had some knowledge of communications by the time of the testing and 2) there was a more diverse sample of students, particularly in COMM 101, as that class fulfills both a Communications major requirement and a Liberal Studies elective — this allowed potentially deeper insights into the results.

Each group contained a convenience sample of between 17-21 undergraduates, drawn from COMM 101 and COMM 150. In the data analysis phase of the study, the smallest unit of analysis was the individual. However, the researcher looked for differences among the rates of information acquisition between the experimental groups. Basic demographic information was collected, and this resulted in further units of analyses. Possible units of analyses in this context were based on the variables of gender,

class rank, age, college major, and self-reported technical aptitude. In addition, there were no vulnerable subjects used as participants in this study.

Variables

A quasi-experiment with a counterbalanced, repeated measure design, with the post-viewing question accuracy scores as the dependent variable, was utilized (Creswell, 2008; Buddenbaum & Novak, 2002). The independent variables that were examined were video content resolution, video content topic, group membership, age, college major, and self-reported technical aptitude. In addition, interaction effects between video resolution and video content, video resolution and gender, and video resolution and class rank were investigated in order to see if a statistically significant impact on overall score accuracy existed.

The independent variable (consisting of three separate videos) was subdivided into three versions depending on quality. Each group viewed a low quality video, a medium quality video, and a high quality video. A counterbalanced design was reflected in this portion of the experiment, as each group's order of quality was different. Group one's quality order was low, medium and high; group two's quality order was medium, high and low; group three's quality order was high, low, and medium. After the viewing of each video, the participants responded to ten multiple-choice questions pertaining to the content. The responses to the items on the test questions were analyzed to see whether there were significant differences based on the quality of the video excerpts, as well as the other independent variables stated above (Creswell, 2008; Buddenbaum & Novak, 2002; Reinhard, 2006).

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Video Content

The three videos for the learning modules were selected because all featured a cohesive mix of live-action video, corresponding but not distracting graphics, and audio that was supportive of the story being presented and articulated via the video channel. All video content was retrieved from the IUP Communications Media library of productions, and were edited down to an appropriate length for the study, between 4:50 and 5:33. The videos were edited in Final Cut X and were exported in three different conditions, each targeted to closely resemble YouTube streaming conditions of low, medium and high quality. There were three videos, each consisting of low, medium and high quality versions. The content of each video excerpt is detailed below.

When editing the content for the video modules, length was of prime importance. Due to issues arising from cognitive overload, care was taken to edit the videos down to a point that was not overly lengthy. As the playback time of the video content increases, it becomes more difficult for viewers to concentrate and retain information presented via the audio channel. In other words, it is harder to pay attention for longer periods of time. As Wang and Gearhart (2006) observe, "because listening is usually not a conscious effort, it is hard for most people to remain concentrated on a listening task for an extended period of time" (p. 169). The first video was produced for the Indiana University of Pennsylvania Safety Sciences Department as part of the 2012 Fatality Prevention Forum. This video excerpt focuses on Objective 3 of the forum, which investigated ways that workplace fatalities could be prevented by recognizing and acting upon precursors, or events that enable the higher probability of workplace fatalities. This

video excerpt features integrated graphics, expert panelists, a slight amount of

background music and screenshots from presentations given at the forum. The overall

length of the video is 5 minutes, 12 seconds. See Figures 1, 2 and 3 for screenshots that

show differences in detail for the high, medium, and low quality conditions of Video 1,

"The Role of Human Performance Concepts in Preventing Fatalities," respectively.
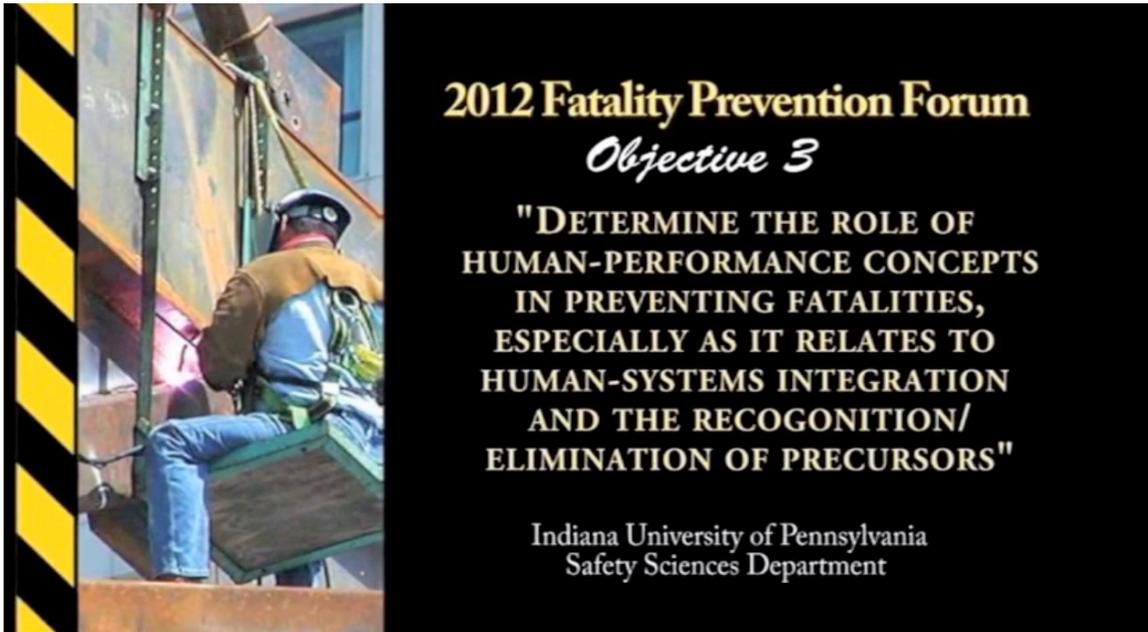
Figure 1. Video 1 in high quality.
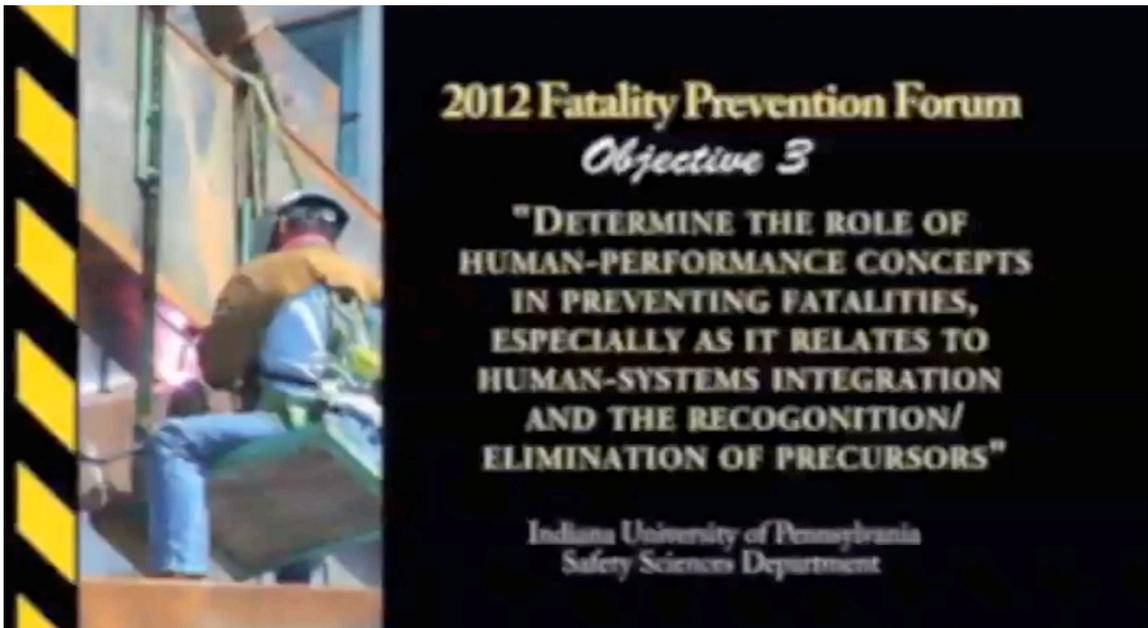
Figure 2. Video 1 in medium quality.
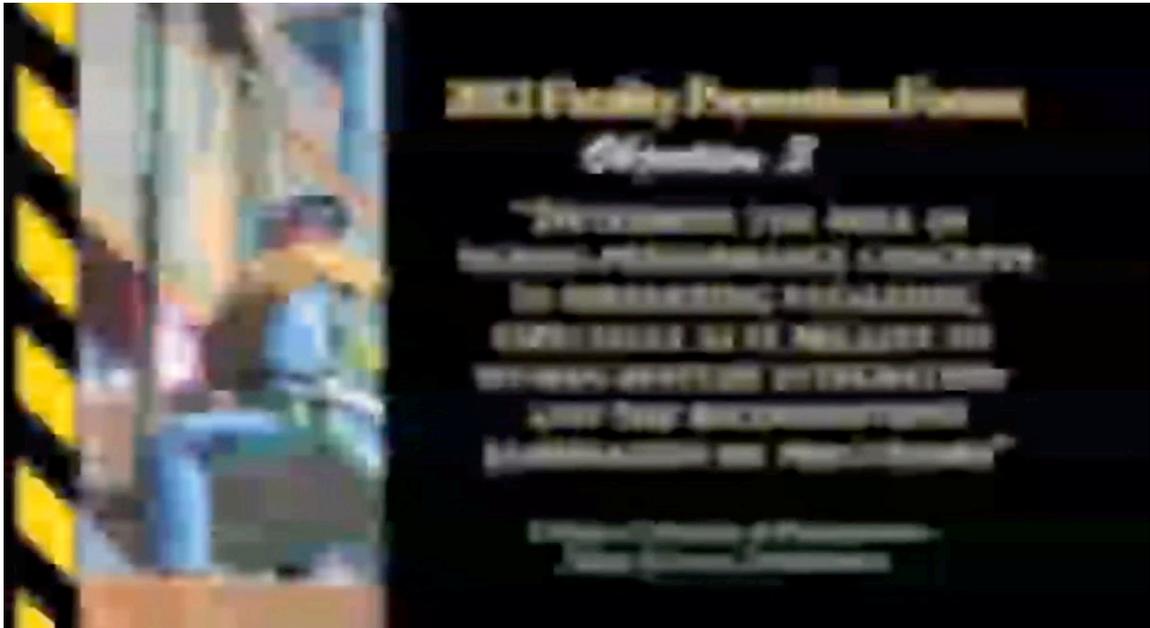
Figure 3. Video 1 in low quality.

Video #2: "Medical Services in Indiana County: A History"

This video content was excerpted from an informational video produced by the

Indiana University of Pennsylvania Communications Media Department, for broadcast on

the local public television channel. The video content chronicles medical care in Indiana

County at the turn of the 20th century, from the late 1800s to the early 1900s. Historical

information is provided concerning how the first hospital in the region, The Greater

Indiana County Memorial Hospital, came about. Similar to video #1, this excerpt features

integrated graphics, audio narration, and background music. Video #2 does not include

video taped interview subjects. However, it contains a large amount of historical still

images and newspaper clippings. The still images are presented in the video, often using

the "Ken Burns" or pan-and-scan effect, which gives the illusion of motion when using

still images. The overall length of the video is 5 minutes, 2 seconds. See Figures 4, 5 and

6 for screenshots that show differences in detail for the high, medium, and low quality

conditions of Video 2, "Medical Services in Indiana County: A History," respectively.
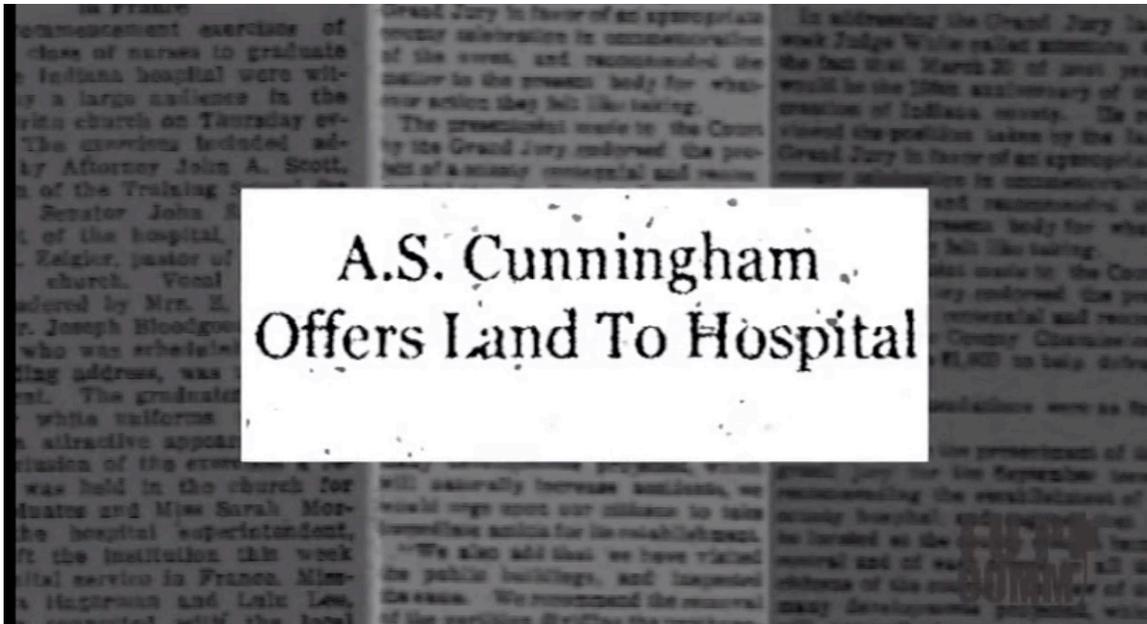
Figure 4. Video 2 in high quality.
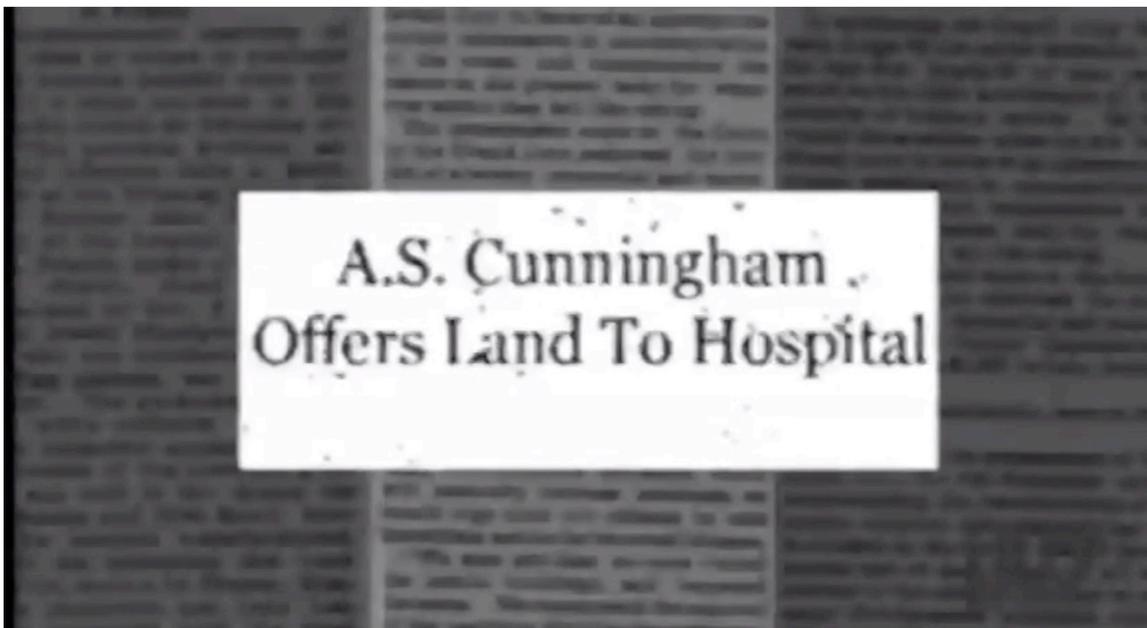
Figure 5. Video 2 in medium quality.
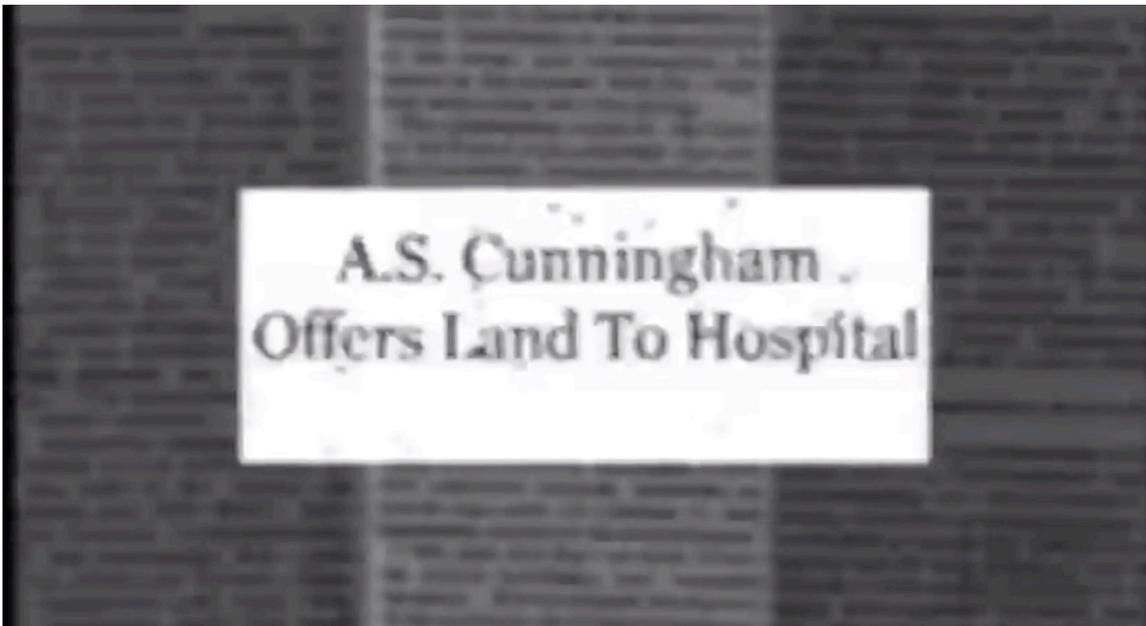
Figure 6. Video 2 in low quality.

Video #3: "The Indiana Hospital School of Nursing: A History"

This video content was excerpted from an informational video produced by the Indiana University of Pennsylvania Communications Media Department, for broadcast on the local public television channel. The video excerpt chronicles the history of the Nursing School at the Indiana Regional Medical Center (IRMC) from 1915—1979. Utilizing live interviews and information gleaned from historical documents, the video examines the growth and contributions to the area of the IRMC Nursing School to the greater Indiana community and beyond. Similar to Video #1, Video #3 features several interviews with Nursing School graduates and administrators, integrated graphics, some instrumental background music, supporting audio narration, and historically accurate still images presented with the "Ken-Burns" or pan-and-scan effect to simulate motion. The overall length of the video is 5 minutes, 33 seconds. See Figures 7, 8, and 9 for screenshots that show differences in detail for the high, medium, and low quality

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conditions of Video 3, "The Indiana Hospital School of Nursing: A History,"

respectively.

Figure 7. Video 3 in high quality.

Figure 8. Video 3 in medium quality.

Figure 9. Video 3 in low quality.

Compensation

There was no direct monetary compensation for participating in the study. To encourage participation, students were offered extra credit at the discretion of the course instructor, and could also request an electronic version of the dissertation. In addition, in order to enhance participation rates, at the conclusion of the study, the top three combined scores on the content questions received $75, $50, and $25 Amazon gift cards, respectively. The Amazon gift cards were provided by the researcher, and were distributed at the conclusion of the study.

Threats to Validity

According to Reinhard (2006), reliability is "the internal consistency of a measure" (p. 121). In accordance with accepted measures of reliability in the Communications Media and Instructional Technology (CMIT) Ph.D. program, expert

panel reliability was used to gauge the reliability of the treatments, the demographic questions, and the post-test questions that were used to measure rates of information acquisition in the study. Additionally, the internal reliability of the research instrument was tested using Kuder-Richardson Formula 20 (K-R 20).

Validity of a measure is "the consistency of a measure with a criterion (the degree to which a measure actually assess what is claimed)" (Reinhard, 2006, p. 137). Face validity was used so that the content of the treatments were confirmed as being related to the concepts being measured. In addition, individuals who were knowledgeable in the field were shown the videos and test questions. Their comments and input was used to further focus and refine numerous aspects of the multimedia materials utilized in the experiment.

CHAPTER 4

RESULTS OF THE STUDY

Introduction

This study was conducted to determine the effects that aesthetic differences have

on undergraduate students' ability to recall information presented in an informational

multimedia video. This chapter investigates and analyzes the post-test results of the

study's research questions and corresponding hypotheses. All data was downloaded from

Qualtrics as .csv files which were then imported into Microsoft Excel for Mac 2011.

From there, the data was coded, entered, and analyzed using IBM SPSS Statistics version

22. This chapter begins by presenting characteristics of the sample population including

demographic information such as gender, age, class rank, college major, and self-reported

technical aptitude. Also, the internal reliability of the research instrument was tested

using Kuder-Richardson Formula 20 (K-R 20).

The chapter will then quantitatively examine the research questions and

hypotheses, all of which were evaluated using one-way and two-way ANOVA where

applicable. One-way ANOVAs were used to look for significant differences in post-test

accuracy by resolution, video, group, age, major, and technical aptitude. Two-way

ANOVAs were employed in order to examine differences in post-test accuracy by video

resolution and video, by video resolution and gender, and by video resolution and class

rank. In the event of statistically significant data, post hoc analysis tests of Tukey's HSD

and the Scheffé post-hoc criterion test for significance were run where applicable. The

Scheffé post-hoc criterion test was used to analyze RQ1 H4 due to its relatively

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conservative characteristics regarding how it reports statistical significance (Reinard, 2006).

Sample Demographics

Participants were recruited from undergraduate communications media courses at IUP. Participants were drawn from courses including COMM 101, Communications Media in American Society, and COMM 150, Aesthetics and Theory of Communications Media. The instructors of the courses sent an email to the students in their classes inviting them to participate in the study. The email contained a link to the pretest in Qualtrics. The pretest contained the demographic information that follows.

Gender

According to Indiana University of Pennsylvania's 2013 Crimson Snapshot, the total college enrollment by gender was 45.15% male and 54.85% female (IUP Enrollment – Crimson Snapshot, 2014). There were 55 total participants in this study, consisting of 34 (61.8%) females and 21 (38.2%) males. Table 2 provides a summary of the participant responses to pretest question 2, which asked participants to indicate their gender. It should be noted that there was no option for participants to identify as transgender.

Table 2

Gender of Participants - Overall

	Frequency (%)
Female	34 (61.8%)
Male	21 (38.2%)

The participants were separated into three groups for the experiment. Group 1 consisted of 17 participants made up of 12 females (70.5%) and 5 males (29.5%). Group

2 also consisted of 17 participants made up of 10 females (59.0%) and 7 males (41.0%).

Group 3 consisted of 21 participants made up of 12 females (57.0%) and 9 males (43%).

Table 3 illustrates the distribution of gender across the three groups in the study.

Table 3

Gender of Participants by Group

	Group			Total
	Group 1	Group 2	Group 3	Total
Female	12 (70.5%)	10 (59.0%)	12 (57.0%)	34 (61.8%)
Male	5 (29.5%)	7 (41.0%)	9 (43.0%)	21 38.2%)
Total	17 (100%)	17 (100%)	21 (100%)	55 (100%)

Age

Question 3 on the pretest asked participants to indicate their age. Table 4 provides an overall summary of the participants' age, while Table 5 shows the age distribution by group.

Table 4

Age of Participants - Overall

Age (years)	Frequency (%)
18	7 (12.7%)
19	16 (29.1%)
20	12 (21.8%)
21	10 (18.2%)
22+	10 (18.2%)

Table 5

Age of Participants - Group

Age (years)	Group 1	Group 2	Group 3	Total (%)
18	2 (12.0%)	2 (12.0%)	3 (14.5%)	7 (12.7%)
19	6 (35.1%)	6 (35.1%)	4 (19.0%)	16 (29.1 %)
20	3 (17.5%)	5 (29.5%)	4 (19.0%)	12 (21.8%)
21	4 (23.4%)	0 (0.0%)	6 (28.5%)	10 (18.2%)
22+	2 (12.0%)	4 (23.4%)	4 (19.0%)	10 (18.2%)
Total	17 (100%)	17 (100%)	21 (100%)	55 (100%)

Class Rank

Question 6 on the pretest asked participants to indicate their class rank. Table 6 provides an overall summary of the participants' class rank, and Table 7 illustrates the class rank distribution within the groups in the study.

Table 6

Class Rank of Participants - Overall

Rank	Frequency (%)
Freshman	10 (18.2%)
Sophomore	23 (41.8%)
Junior	12 (21.8%)
Senior	10 (18.2%)
Total	55 (100.0%)

Table 7

Class Rank of Participants - Group

		Group 1	Group 2	Group 3	Total
Class Rank	Freshman	4	2	4	10
	Sophomore	8	9	6	23
	Junior	4	3	5	12
	Senior	1	3	6	10
Total		17 (31%)	17 (31%)	21 (38%)	55 (100%)

College Major

Question 4 on the pretest was an open-ended inquiry that asked the participant's major. Table 8 provides a breakdown of Communications Media majors viewed against all other majors, presented here as "other." The category of other included the majors of Health / Physical Education, Criminology, Hospitality Management, Music, English, Theatre, Nuclear Medicine Technology, Journalism, Psychology, Respiratory Care, Marketing, English, Dietetics / Nutrition, and Accounting. Table 9 illustrates the class major distribution within the groups in the study, broken down between Communications Media majors and all other majors of the participants.

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Table 8

Class Major of Participants - Overall

Major	Frequency (%)
Comm. Media	36 (65.5%)
Other	19 (34.5%)
Total	55 (100.0%)

Table 9

College Major of Participants – Group

Group	Comm. Media	Other	Total
Group 1	11 (64.7%)	6 (35.3%)	17 (100.0%)
Group 2	10 (58.8%)	7 (41.2%)	17 (100.0%)
Group 3	15 (71.4%)	6 (28.6%)	21 (100.0%)
Total	36 (65.5%)	19 (34.5%)	55 (100%)

Technical Aptitude

Pretest question 13 asked each participant to describe his/her technical aptitude/ability with digital technology including computers, tablets, and smart phones. The choices were "excellent," "good," "average," "fair," and "poor." The responses were then grouped into three categories, presented below. The categories were 1 (excellent), 2 (good), and 3 (average, fair, and poor). Tables 10 and 11 show the overall technical aptitude of the participants and the technical aptitude of the groups in the experiment, respectively.

Table 10

Technical Aptitude of Participants - Overall

Aptitude	Frequency (%)
1 (excellent)	21 (38.2%)
2 (good)	24 (43.6%)
3+ (average, fair, poor)	10 (18.2%)
Total	55 (100.0%)

Table 11

Technical Aptitude of Participants – Group

Aptitude	1	2	3+	Frequency (%)
Group 1	6 (35.3%)	8 (47.1%)	3 (17.6%)	17 (100.0%)
Group 2	7 (41.2%)	6 (35.3%)	4 (23.5%)	17 (100.0%)
Group 3	8 (38.1%)	10 (47.6%)	3 (14.3%)	21 (100.0%)
Total	21 (38%)	24 (44 %)	10 (18%)	55 (100%)

Instrument Reliability

The internal reliability of the research instrument was tested using Kuder-Richardson Formula 20 (K-R 20). The first step in the process was to transform the multiple-choice data into dichotomous choices; the responses for each question were coded as either correct or incorrect. Then, K-R 20 was calculated for all videos viewed by the groups in the study. K-R 20 values range from 0 to 1. High K-R 20 values indicate high reliability; 0.70 and higher is generally recognized as a benchmark for acceptable reliability in the social sciences (Reinard, 2006; Buddenbaum & Novak, 2001). Group 1 had 17 participants. K- R 20 for the high quality video for group 1 was 0.6745; K-R 20 for the medium quality video for group 1 was 0.5015; K-R 20 for the low quality video of

group 1 was 0.5537. Group 2 consisted of 17 participants. The K-R 20 value for the high

quality video in this group was 0.4537; the K-R 20 value for Group 2's medium quality

video was 0.456, and the K-R 20 value for the low quality video for Group 2 was 0.657.

Group 3 had 21 participants. The K-R 20 value for the high quality video for Group 3

was 0.4538; the K-R 20 value for the medium video for Group 3 was 0.3662, and the K-R

20 value for the low quality video of group 3 was .7503. Table 12 lists a summary of all

K-R 20 values for the three groups of participants in the study detailed above. It is

important to note that the participant responses to the test items may have been

influenced by the quality of the video, which was an integral part of the research design.

K-R 20 values were also calculated for scores for all of the high, medium, and low

quality conditions regardless of video content. This data is presented in Table 13.

Table 12

Kuder-Richardson 20 (K-R 20) values for Participant Video Scores

Group	Video Quality		
	High	Medium	Low
1	0.6745	0.5015	0.5537
2	0.4537	0.456	0.657
3	0.4538	0.3662	0.7503

Table 13

Kuder-Richardson 20 (K-R 20) values for All Conditions

Video Quality	K-R 20 Value
High	0.4807
Medium	0.4171
Low	0.6798

As the K-R 20 value would be unavoidably low due to the influence and difficulty induced by lower quality audio and video in the multimedia stream, the K-R 20 value was calculated using the participant responses to the high-quality videos.

<div align="center">**Research Questions and Hypotheses**</div>

Research Question One

RQ1*:* What are the effects of digital audio-video (AV) data compression and encoding utilized in an instructional video on information acquisition among undergraduate students?

Multimedia content, specifically the aural and visual channels, place specific cognitive demands on the learner. These aural and visual channels align well to Dual Coding Theory (DCT), which contends that learners categorize and process incoming aural and visual stimuli differently, and in distinct parts of the brain. Based upon previous research on DCT, and associated cognitive factors that enhance or inhibit learning from a multi-medial learning module (Paivio, 2013; Plass, 2010; Mayer, 1999), the following hypothesis is presented:

H1: It is predicted that the resolution of the video content (low, medium, or high) will have an impact on the overall accuracy scores (% correct) of the participants.

Video excerpt #1, "The Role of Human Performance Concepts in Preventing Fatalities," was shown to all three groups, and was the first video shown in all cases. Group 1 viewed the content in low quality, Group 2 viewed the content in medium quality, and Group 3 viewed the content in high quality. Video excerpt #2, "Medical Services in Indiana

County: A History," was the second video shown in each group. Group 1 viewed this video in medium quality, Group 2 viewed the video in high quality, and Group 3 viewed the video in low quality. Finally, video excerpt # 3, "The Indiana Hospital School of Nursing: A History," was the third video shown in each group's viewing sequence. Group 1 viewed this video in high quality, Group 2 viewed this video in low quality, and Group 3 viewed this video in medium quality.

Levene's test of homogeneity of variance was employed and confirmed that the variances among the levels of the independent variable (low, medium and high video resolutions) were significantly different (F=4.04, p = .019). Since this violates one of the assumptions of ANOVA, the Welch's One-Way ANOVA was used. Since the result of Welch's ANOVA was not statistically significant, post-hoc tests were not utilized.

After viewing each video learning activity, participants were asked a series of ten questions that pertained to the content that was just viewed. The questions were presented in the same order across the groups, and were not randomized in any way. An analysis of variance using Welch's ANOVA showed that the difference in video resolution among all participants (N=55) was not a sufficient predictor of accuracy scores on the post-test questions and was not statistically significant, F(2, 107) = 1.37, p = .259 (see Table 14).

Table 14

Welch's One-Way ANOVA: Difference in Accuracy by Video Resolution

| | | N | Mean | S.D. | 95% Confidence Interval for Mean | | F | p |
					Lower Bound	Upper Bound		
Video Resolution	Low	55	62.00	24.30	55.43	68.57		
	Medium	55	64.73	19.04	59.58	69.87	1.37	0.259
	High	55	58.55	20.04	53.13	63.96		

H2: It is predicted that the specific topic of the video content will have an impact on the overall accuracy scores (% correct) of the participants.

Video excerpt #1, "*The Role of Human Performance Concepts in Preventing Fatalities,*" is an informational video that was produced for the Indiana University of Pennsylvania Safety Sciences Department as part of the 2012 Fatality Prevention Forum. The content of this excerpt explored ways that workplace fatalities could be prevented by recognizing and acting upon events that enable the higher probability of workplace fatalities. Video excerpt #2, *"Medical Services in Indiana County: A History,"* is an informational video that was produced by the Indiana University of Pennsylvania Communications Media Department for broadcast on the local public television channel. The video excerpt chronicles medical care in Indiana County at the turn of the 20th century, from the late 1800s to the early 1900s. In addition, historical information is provided concerning how the first hospital in the region, The Greater Indiana County Memorial Hospital, came

about. Video excerpt # 3, *"The Indiana Hospital School of Nursing: A History,"* is an informational video that was produced by the Center for Media Production and Research at Indiana University of Pennsylvania for broadcast on the local public television channel in Indiana County. In this excerpt, the history of the Nursing School at the Indiana Regional Medical Center (IRMC), from 1915—1979, is explored by incorporating interviews of graduates of the program with information gleaned from historical documents. The video also examines the growth, contributions to the area, and wider impact of the IRMC Nursing School to the greater Indiana community.

Levene's test of homogeneity of variance was employed and confirmed that the variances in video content among the three videos were statistically equivalent ($F = .911$, $p = .404$). Because of this value, according to Reinard (2006), Tukey's HSD (referred to in the post-hoc panel of SPSS as "tukey") is an acceptable post-hoc test to employ in this situation, as equal variances may be assumed.

An analysis of variance (ANOVA) showed that the accuracy scores of all participants (N=55) did vary in a statistically significant manner based on the video content $F (2,162) = 7.67$, $p = .001$ (see Table 15). Tukey's HSD showed a difference at the $p = .000$ level between Video excerpt # 3, "The Indiana Hospital School of Nursing: A History," and Video excerpt #1, "The Role of Human Performance Concepts in Preventing Fatalities" (see Table 16).

Table 15

One-Way ANOVA: Difference in Accuracy by Video Content

| | | N | Mean | S.D. | 95% Confidence Interval for Mean | | F | p |
					Lower Bound	Upper Bound		
Video	1	55	54.18	19.02	49.04	59.32		
	2	55	61.64	21.67	55.78	67.49	7.668	0.001
	3	55	69.45	20.59	63.89	75.02		

Table 16

Results of Tukey's HSD

Video (I)	Video (J)	Mean Difference (I-J)	Std. Error	Sig.
1	2	-7.455	3.900	.139
	3	-15.273[*]	3.900	.000
2	1	7.455	3.900	.139
	3	-7.818	3.900	.114
3	1	15.273[*]	3.900	.000
	2	7.818	3.900	.114

H3**:** It is predicted the overall accuracy scores (% correct) of the

participants will vary among the groups.

Hypothesis 3 explores whether or not a statistically significant difference in

comprehension level, represented by the overall accuracy scores of each group, exists

among the three groups in the experiment. Group 1 was comprised of twelve females and

five males (N=17); the breakdown of class rank was four freshmen, eight sophomores,

four juniors and one senior. Group 2 was comprised of ten females and seven males

(N=17). In this group, there were two freshmen, nine sophomores, three juniors, and three

seniors. Group 3 was made up of twelve females and nine males, represented in class

rank by four freshman, six sophomores, five juniors, and six seniors (N=21).

Levene's test of homogeneity of variance was employed and confirmed that the

variances among the groups 1,2 and 3 were statistically equivalent (F=1.259, p = .287),

thus indicating that equal variances may be assumed.

An analysis of variance (ANOVA) showed that the differences in scores between

the three groups in the study were not statistically significant $F(2,162) = 2.90$, p = .058

(see Table 17).

Table 17

One-Way ANOVA: Difference in Accuracy by Group

| | | N | Mean | S.D. | 95% Confidence Interval for Mean | | F | p |
					Lower Bound	Upper Bound		
	1	17	59.02	21.47	52.98	65.06		
Group	2	17	67.65	19.55	62.15	73.15	2.896	0.058
	3	21	59.21	21.80	53.72	64.70		

H4**:** It is predicted that the interaction between video resolution and video content will affect overall post-test accuracy scores among the participants.

Levene's test of homogeneity of variance was employed and confirmed that the variances among video resolution and video content were statistically equivalent (F=1.796, $p = .082$), thus indicating that equal variances may be assumed, and the assumptions of a two-way ANOVA are met.

In order to test the relationship between differences in accuracy scores, video resolution, and specific video (1, 2, or 3), a two-way analysis of variance was employed. The two-way ANOVA yielded a main effect for the video content, $F(2, 156) = 7.25$, $p = .001$. The main effect of video resolution was non-significant, $F(2, 156) = .84$, $p = .433$. The interaction effect was also non-significant, $F(4, 156) = 1.61$, $p = .175$ (see Table 18). Post hoc analyses using the Scheffé post-hoc criterion for significance indicated that there was a difference at the $p = .001$ level between Video excerpt # 3, "The Indiana Hospital School of Nursing: A History," and Video excerpt #1, "The Role of Human Performance Concepts in Preventing Fatalities."

Table 18

Two-Way ANOVA: Differences in Accuracy by Video Resolution and Video

| | | Marginal Mean | Std. Error | 95% Confidence Interval | | F | p |
				Lower Bound	Upper Bound		
Video Resolution	Low	62.27	2.75	56.83	67.71		
	Med	64.31	2.75	58.88	69.75	0.842	0.433
	High	59.29	2.75	53.85	64.73		
Video	1	54.59	2.75	49.15	60.02		
	2	61.88	2.75	56.44	67.32	7.251	0.001
	3	69.41	2.75	63.97	74.85		
Interaction	Low, 1	52.94	4.93	43.21	62.68		
	Low, 2	58.57	4.43	49.81	67.33		
	Low, 3	75.29	4.93	65.56	85.03		
	Med, 1	61.77	4.93	52.03	71.50		
	Med, 2	61.18	4.93	51.44	70.91	1.608	0.175
	Med, 3	70.00	4.43	61.24	78.76		
	High, 1	49.05	4.43	40.29	57.81		
	High, 2	65.88	4.93	56.15	75.62		
	High, 3	62.94	4.93	53.21	72.68		

To summarize the results of RQ1, the actual video presented affected the overall accuracy scores, but video resolution and group membership did not. The accuracy scores for Video 3 had a statistically significantly higher mean score than either Video 1 or Video 2. Also, there were no significant interaction effects between video resolution and specific video content. From these results, H1 is not supported by the data results; video resolution does not appear to be a statistically significant predictor on test scores within and among the groups in this study. It is feasible, based on the prior research of Mayer (2009, 2006, 2003), Miller (1994), Paas, Ayres, & Pachman, (2008), that other factors including prior participant experience, unintended environmental distractors, and time

constraints, were unaccounted for in the experiment and may have affected accuracy scores in a greater manner than resolution alone.

While RQ1 considers the broad effects of aesthetic quality on recall of information presented in a multimedia context, RQ2 considers further variables that may contribute to overall scores.

Research Question Two

RQ2*:* Is the degree or amount of information acquisition among students influenced by demographic factors and video resolution?

Based on the research of Page (2002), Passig (2000), Sanders (2005), and Gunn (2003) in which gender and education level, represented in this study as class rank, may have a statistically significant effect on learning within a multimedia environment, the following hypotheses result from RQ2:

H2a: It is predicted that video resolution, combined with gender, will not have a statistically significant impact on overall score accuracy.

Levene's test of homogeneity of variance was employed and confirmed that the variances among video resolution and gender were statistically equivalent (F=1.74, p = .128), thus indicating that equal variances may be assumed. A two-way analysis of variance yielded no significant main effects for video resolution, $F(2, 159) = .80$, p = .453, or gender, $F(1, 159) = 1.10$, p = .296. The interaction effect was also non-significant, $F(2, 159) = .53$, p = .592 (see Table 19). Finally, since the result of the two-way ANOVA was not statistically significant and no significant main effects or interactions were found, post-hoc tests were not employed.

Table 19

Two-Way ANOVA: Differences in Accuracy by Video Resolution and Gender

| | | Marginal Mean | Std. Error | 95% Confidence Interval | | F | p |
				Lower Bound	Upper Bound		
Video Resolution	Low	62.16	2.96	56.33	68.00		
	Med	64.83	2.96	58.99	70.66	0.795	0.453
	High	59.55	2.96	53.71	65.39		
Gender	Male	63.97	2.68	58.67	69.27	1.097	0.296
	Female	60.39	2.11	56.23	64.56		
Interaction	Low, Male	62.86	4.65	53.68	72.04		
	Low, Female	61.47	3.65	54.26	68.69		
	Med, Male	65.24	4.65	56.06	74.42	0.526	0.592
	Med, Female	64.41	3.65	57.20	71.63		
	High, Male	63.81	4.65	54.63	72.99		
	High, Female	55.29	3.63	48.08	62.51		

H2b: It is predicted that video resolution, combined with class rank, will not have a statistically significant impact on overall score accuracy.

Levene's test of homogeneity of variance was employed and confirmed that the variances among video resolution and class rank were statistically equivalent (F=1.93, *p* = .040), thus indicating that equal variances may be assumed. A two-way analysis of variance yielded no significant main effects for video resolution, $F(2, 153) = 1.21$, *p* = .303, or class rank, $F(3, 153) = .14$, *p* = .937. The interaction effect was also non-significant, $F(6, 153) = .29$, *p* = .941 (see Table 20). However, since the result of the two-way ANOVA was not statistically significant and no significant main effects or interactions were found, post-hoc tests were not utilized.

Table 20

Two-Way ANOVA: Differences in Accuracy by Video Resolution and Class Rank

| | | Marginal Mean | Std. Error | 95% Confidence Interval | | F | p |
				Lower Bound	Upper Bound		
Video Resolution	Low	61.75	3.10	55.61	67.88		
	Med	65.12	3.10	58.99	71.25	1.205	0.303
	High	58.31	3.10	52.18	64.44		
Class Rank	Freshman	62.33	3.96	54.50	70.16		
	Sophomore	62.17	2.61	57.01	67.34		
	Junior	59.72	3.62	52.57	66.87	0.138	0.937
	Senior	62.67	3.96	54.84	70.50		
Interaction	Low, FR	65.00	6.87	51.44	78.56		
	Low, SO	63.48	4.53	54.54	72.42		
	Low, JR	57.50	6.27	45.12	69.88		
	Low, SR	61.00	6.87	47.44	74.56		
	Med, FR	68.00	6.87	54.44	81.56		
	Med, SO	63.48	4.53	54.54	72.42		
	Med, JR	65.00	6.27	52.62	77.38	0.289	0.941
	Med, SR	64.00	6.87	50.44	77.56		
	High, FR	54.00	6.87	40.44	67.56		
	High, SO	59.57	4.53	50.62	68.51		
	High, JR	56.67	6.27	44.29	69.05		
	High, SR	63.00	6.87	49.44	76.56		

To summarize the results of RQ2, there was no statistically significant interaction effects found between gender and video resolution on overall participant post-test accuracy scores. In other words, gender had no bearing as a predictor of accuracy when combined with video resolution of low, medium, or high. Also, there were no statistically significant effects found between video resolution and class rank. As with gender, class

rank, when analyzed as an interaction effect with video resolution, was not a statistically significant predictor on overall participant post-test accuracy scores.

The third and final research question examines other variables that may contribute to higher scores on less than optimal multimedia content, as represented by the medium and low-quality conditions. This research question has been included in an effort to examine and understand other variables that may impact and affect student learning in a multimedia environment and that may reinforce or transcend limitations imposed by the aesthetic quality of the multimedia content.

Research Question Three

RQ3: Will other variables of age, college major, and self-reported technical aptitude affect the degree or amount of information acquisition among students, regardless of how the digital audio-visual content is compressed or encoded?

The following hypotheses will also be tested based on the variables articulated in RQ3:

H3a: There will not be a significant difference in overall test scores (% accuracy) by age.

Hypothesis H3a considers whether or not age affects the overall mean scores of all videos and resolutions combined. Participants were grouped into five categories based on age: 18, 19, 20, 21, and 22+. There were 55 total participants in the study. Of those 55, 7 (12.7%) were 18 years of age, 16 (29.1%) were 19 years of age, and 12 (22.0%) were 20 years of age. There were 10 participants (18.1%) aged 21, and 10 participants (18.1%) aged 21 or over.

Levene's test of homogeneity of variance was employed and confirmed that the variances in age among the age groups were statistically equivalent ($F = .424, p = .79$). A one-way analysis of variance showed no significant differences in accuracy based on age, $F(4, 50) = .92, p = .463$ (see Table 21).

Table 21

Differences in Accuracy by Age

		Mean	S.D.	95% Confidence Interval		F	p
				Lower Bound	Upper Bound		
	18	66.67	14.14	53.59	79.75		
	19	62.50	14.88	54.57	70.43		
Age	20	60.00	16.02	49.82	70.18	0.915	0.463
	21	55.33	11.99	46.76	63.91		
	22+	65.67	14.99	54.94	76.39		

H3b: There will not be a significant difference in overall test scores (accuracy) between Communications Media Majors and non-Communications media majors.

Hypothesis H3b examines whether or not college major affects the overall mean scores of all videos and resolutions combined. In the pretest questions, participants were asked to give their major. In Qualtrics, the response field was a text box, and students were free to self-report their major rather than having to pick one from a predefined set of choices. As a result, extremely varied majors were reported, as not all participants were Communications Media majors. For ease of data analysis, the participants' majors were

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grouped into two categories: Communications Media majors and non-Communications Media majors (other).

Levene's test of homogeneity of variance was employed and confirmed that the variances between the categories of Communication Major or non-Communication Major (other), were statistically equivalent $(F = 2.592, p = .113)$. A one-way analysis of variance showed that differences in accuracy between students who were Communications Media majors versus those who were non-Communications Media majors were not significant $F(1, 53) = 2.09, p = .155$ (see Table 22).

Table 22

Differences in Accuracy by Major (COMM vs. non-COMM)

| | | Mean | S.D. | 95% Confidence Interval | | F | p |
				Lower Bound	Upper Bound		
COMM. Major	Yes	63.80	13.27	59.31	68.28	2.085	0.155
	No	57.89	16.41	49.98	65.81		

H3c: It is predicted that participants who have a high technological aptitude will have higher overall accuracy than those who report having a low technological aptitude.

Hypothesis H3c explores whether or not differences in self-reported technical aptitude affects the overall mean scores of all videos and resolutions combined. The technical

aptitude question in the pretest asked participants to describe your technical

aptitude/ability with digital technology including computers, tablets, and smart phones.

The response choices were arranged in a Likert-scale array, ranging from excellent, good,

average, fair, to poor. For ease of data analysis, the responses were grouped into three

final categories, representing the responses to excellent (1), and good (2). The responses

of average, fair and poor were grouped together for the third category (3).

    Levene's test of homogeneity of variance was employed and confirmed that the

variances between the levels of self-reported technical aptitude were statistically

equivalent $(F = 1.214, p = .305)$.

    A one-way analysis of variance showed that accuracy scores did not vary

significantly based on technical aptitude as self-reported by the participants $F(2, 52) =$

$.12, p = .885$ (see Table 23).

Table 23

Differences in Accuracy by Technical Aptitude

| | | Mean | S.D. | 95% Confidence Interval | | F | p |
				Lower Bound	Upper Bound		
	1	62.22	15.36	55.23	69.21		
Technical Aptitude	2	62.22	13.10	56.69	67.75	0.122	0.885
	3+	59.67	17.39	47.23	72.11		

    To summarize the results of RQ3, no significant differences in post-test accuracy

scores based on age were found. Additionally, differences in accuracy between students

who were Communications Media majors versus those who were non-Communications

Media majors were not significant. Finally, accuracy scores did not vary significantly based on self-reported technical aptitude with digital devices including computers, tablets, or smartphones. As a result, since no statistically significant findings were evident, RQ3 was refuted.

Summary

RQ1 suggested that the effects of audio-visual (AV) data compression and encoding would affect information acquisition (as assessed through post-test accuracy scores) among undergraduate college students. The data supported evidence that illustrated the statistically significant effect video content had on accuracy scores across all participants. In contrast, the difference in video resolution was found to be a statistically insignificant predictor of post-test accuracy scores. In addition, differences in post-test scores among the three groups in the study were also not statistically significant. Finally, when looking at differences in post-accuracy scores by video resolution and video, although there was a statistically significant main effect for video content, the interaction effect between video resolution and video content was also non-significant.

RQ2 considered the variables of gender and class rank as being potentially significant predictors of post-test accuracy scores, which would indicate increased information acquisition based on content and resolution. The interaction effects between gender and video resolution and class rank and resolution were also explored as being possible predictors of post-test accuracy scores. According to the data for RQ2, differences in accuracy between video resolution and gender produced no statistically significant interaction effects. In addition, there were no significant main effects for video

resolution or gender. Similarly, there were no statistically significant main effects for video resolution or class rank, and the interaction effect between the two was also found to be non-significant.

The data from RQ3 supported the hypotheses that predicted that other variables of age and self-reported technical aptitude would not affect post-test accuracy scores in a statistically significant manner. Indeed, there were no statistically significant differences in accuracy based on age, and there were no statistically significant differences in accuracy between different levels of self-reported technical aptitude. Finally, although the data showed that students who were Communications Media majors versus those who were non-Communications Media majors did not affect accuracy scores in a significant way, the results, although above the accepted alpha level, were strong enough to warrant further investigation. A summary table of all findings is provided below (see Table 24).

Table 24

Summary of Findings

Hypothesis	Description	Statistically significant result (Yes/No)
H1	Video content resolution impacts overall accuracy scores	N
H2	Video content topic (subject matter) impacts accuracy scores	Y
H3	Overall accuracy scores vary among groups	N
H4	The interaction between video resolution and video content will affect accuracy scores.	N
H2a	Video resolution combined with gender will not impact overall accuracy scores	N
H2b	Video resolution combined with class rank will not impact overall accuracy scores	N
H3a	Age does not impact overall test scores	N
H3b	College major does not affect overall test scores	N
H3c	Participants who have a high technological aptitude will score higher on the tests	N

CHAPTER 5

DISCUSSION OF THE RESULTS

Introduction

This purpose of this study was to determine the effects of aesthetic differences related to video encoding on undergraduate students' acquisition and retention of information presented in a primarily bi-modal multimedia presentation, i.e. a heavy reliance and the visual and aural aspects, with minimal graphical (text) support. Although abundant research has been conducted in the past three decades regarding multimedia, cognition and learning (Berk, 2009; Brünken, Plass & Leutner, 2004; Chambers, Cheung, Madden, Slavin & Gifford, 2009; Clark & Paivio, 1991; Doolittle, 2002; Mayer, 2009; Mayer & Moreno, 2001a; Mayer, Heiser & Lonn, 2001b), little, if any, research has investigated the effects of data compression – the aesthetic differences – caused by differing rates of audio and video compression in a multimedia learning environment, particularly among college students.

An important theme that permeated this research study was the idea of how the look and sound of streaming digital media may affect cognition and recall, particularly in a learning environment; this is another area of research that is novel and has received little attention in the field up to this point. The findings in the previous chapter have broad implications for both current applications of multimedia-based delivery, such as using YouTube in the classroom, for example, and for future research into how the aesthetic quality of a multimedia presentation may or may not affect learner cognition and recall.

The following sections will elaborate upon and elucidate the findings of the study, and will attempt to understand the implications of the findings, particularly the statistically significant results. The results of the study will be interpreted and explicated upon with an understanding of how ubiquitous multimedia technology is becoming in our educational environments, especially in higher education. This chapter will conclude with a discussion of the limitations of the study, ideas, concepts and recommendations for future studies and research possibilities, and a summative conclusion.

Interpretation of the Results and Discussion

Research Question One

The purpose of RQ1 was to investigate the effects of audio-visual (AV) compression and encoding schemes commonly utilized in streaming multimedia on information acquisition among undergraduate college students. In other words, did the aesthetic quality of the audio-visual content affect accuracy scores on post-viewing questions that asked about content in the videos? The research of Wang & Gearhart (2006) supports the notion, finding that video scores may vary in a significant way due to content due to several variables including subject matter, user familiarity, and user interest.

Contrary to the research of Mayer (2009) and Paivio (2010, 2013), the findings support the notion that video resolution is not a significant predictor of post-test accuracy scores. Degraded video did not always result in lower content-based test accuracy scores. Conversely, high-quality video did not always predict high post-test accuracy scores. These findings concur with the research of Hannafin, Hannafin, Hooper, Rieber & Kini

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(1996) as they observe, "well-documented research on cognitive resource allocation has established conclusively that more is not necessarily better when presenting stimuli" (p. 382). This assertion seems counterintuitive at first; it seems logical to think that if streaming multimedia content is presented in high quality, then it will be easier to recall information from it. However, this assumption is not realized in the findings of this study.

Regarding differences in accuracy by group, the data showed that there was a strong ($p = .058$), yet not statistically significant result at the accepted alpha level of $p = .05$. This could have been due to the notion that the participants who were members of group 2 were simply better at recalling the information presented in this type of environment. The participants of group 2 may have been more adept at processing multimedia information presented in a manner similar to the way the information was presented in the experiment.

The differences in accuracy by video resolution and video supported the view that the content in Video 3 was a statistically significant predictor of higher post-test scores among the participants. Although there was a non-significant main effect of video resolution and the interaction effect between the two variables was also non-significant, indicating that the change was not more or less pronounced due to resolution, there was a main effect for video content. This main effect is consistent and aligns well with participant responses to one of the exit questions that asked "what did you find most enjoyable about this exercise?" Participants responses included "I enjoyed the last video," "they graduated 900 hundred nurse [sic] a year in such a small building," "learning about the Nursing school's history," "I liked the video about the beginning of the nurses in

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Indiana," and "I found the video regarding Indiana's nursing programs to be the most enjoyable." Participant responses were overwhelmingly positive regarding unsolicited comments about Video 3. Perhaps there was something that resonated with the participants regarding the third video; the interviewees, the narrator's voice, possibly even the background music, which may have tapped into something intangible among the participants and caused that particular video excerpt to be better received than the others. Similarly, these responses could also indicate that the participants found the subject matter in Video 3 more relatable and less impenetrable and boring than information regarding workplace safety regulations.

Research Question Two

The purpose of RQ2 was to examine if the degree or amount of information acquisition as represented with post-test accuracy scores among the participants is influenced by gender and class rank. In addition, interaction effects between video resolution and gender as well as video resolution and class rank was investigated. There were non-significant interaction effects found between gender and video resolution and between class rank and resolution. There were also no main effects for class rank or gender. Class rank was taken into account when the groups were assembled; care was taken to ensure an equal dispersion from freshman to senior in each group. As a result, each group was comprised of a sample that closely resembled the demographic composition regarding gender at IUP. Although that was the way the groups were initially set up, the actual groups were not as even as initially planned due to scheduling conflicts and other reasons for non-participation.

Any difference of post-viewing accuracy scores due to low, medium or high quality of the videos did not vary based on gender, and this concurs with the research of Chang and Yang (2010) who observe "that the efficiency of a web-based curriculum depends not only on the instructional design, but also on how students approach and process the curriculum materials" (p. 679). In contrast, this finding does not agree with the research of Gunn (2003), as she observes there are not only differences in how males and females access and learn with technology, but "gender-based differences in performance and interaction style in computer supported learning (CSL) environments are recognized as an important focus for research" (p. 15). However, in the context of the findings of this experiment, gender is not considered to be an influential predictor of learning capacity with multimedia elements, particularly as a variable with video resolution.

Research Question Three

Results of RQ3 considered whether or not the variables of age, college major, and self-reported technical aptitude affected the degree or amount of information acquisition among students, regardless of how the digital audio-visual content was compressed or encoded. When the mean scores were compiled, the one-way ANOVA showed that there were no statistically significant differences in accuracy based on age or technical aptitude. However, the differences in accuracy by major, categorized as "Communications" major or "Other" major, revealed a strong (p = 0.155), but not statistically significant, result at the accepted alpha level of $p = .05$. Future research in this area may investigate this relationship in greater detail. Also, more data, in the form of

more participants, could help to make the *p* value smaller, and further reveal the possibility of a statistically significant result in this area of the study.

Although self-reported technical aptitude was not a statistically significant predictor of post-test accuracy ($p = .885$), the mean scores of the participants who reported that they were "excellent" or "good" with digital technology including computers, tablet, and smart phones were slightly higher than those participants in the third category of "average, fair, or poor:" 62.22 versus 59.67. The results here, although not significant at accepted levels, warrant further research as the basic premise aligns well with the research of Dobrian, Sekar, Awan, Stoica, Ganjam, and Zhang, (2011) and Berk (2009), which identifies existing student technical proficiency with comfort, curiosity, and success when utilizing digital devices and multimedia content to learn subject matter or a particular concept.

Limitations

According to Reinard (2006), "researchers who use unreliable measures may miss identifying relationships that really are there because of the effects of the cloud of unreliability" (p. 135). However, the reliability of the test instrument was hampered because of the low number of post-test questions, which resulted in sub-standard KR-20 values. After each video, ten questions were asked. The lengths of the video excerpts and the decision to include ten questions in each post-test content assessment was guided by the research of Clark & Paivio (1991), Chang & Yang (2010), and Mayer, Heiser, and Lonn (2001b), which investigated cognitive overload in the context of not only Dual Coding Theory (DCT), but also in the context of length and depth of content. However,

the decision to ask ten questions after each excerpt may well have been too conservative. The reliability of the test instrument could have been heightened by the action of adding more test questions to each post-test assessment. According to the Spearman-Brown values, increasing each post-test assessment from ten to twenty questions would boost the KR-20 values into a more acceptable range and further increasing the reliability of the test instrument into a more acceptable level for social sciences research.

A second limitation concerns the difficulty and amount of the post-video questions. It is quite possible that the questions were too easy and the possible multiple-choice responses too obvious, as there were examples of perfect scores in the results. This limitation may have been avoided if the raw number and the difficulty level of the assessment questions asked after each video excerpt were increased. Just as no student can score a true zero and know absolutely nothing about the content, no student can earn a perfect score and know everything about the material being assessed. In other words, if a student participant earns a perfect score on a test, then she is not being tested, because they already knew the answer to each question. There were also examples of participants missing every question, and this is another problematic aspect of the post-test questions. Participants who scored a zero on the post-test assessments were not observed to simply click through the questions in order to get to the end and finish; their elapsed time of completion of the learning activity was in line and comparable to participants who scored much better. Finally, it is important to note that there were perfect scores no matter the resolution, which illustrates the next limitation of the study.

Although the study sought to replicate streaming video conditions that closely

resemble poor resolution, medium resolution, and high resolution, the actual real-time

conditions of YouTube, particularly in the sense of how the site streams multimedia

content, is difficult if not impossible to duplicate, due in part of the active-sensing nature

of the streaming servers. Because YouTube servers are ceaselessly attempting to stream

the highest quality content possible, downstream conditions including ISP speed,

available user bandwidth, and the kind of device being used are always going to affect the

digital stream, and therefore, the quality of the multimedia content on the client side.

Consequently, the resolutions chosen for the study represent three conditions out of a

myriad of possibilities; it was not possible to know if the resolution rates chosen for this

study are truly representative of what is being streamed from YouTube and other

multimedia-centric websites on the World Wide Web. It was only possible to put forth

similar conditions regarding aesthetic quality and digital resolution that were supported

by existing research, theory and observations of multimedia streaming and client-side

capabilities, including the work of Wiske & Breit (2010), Hoogeveen (1997), Follansbee

(2004), and Mayer (2006).

The video content chosen for the multimedia excerpts in the study was intended to

be material that would be unfamiliar to most undergraduate majors, particularly if they

did not grow up in Indiana County, Pennsylvania. Question 15 on the pretest asked

"Where did you grow up?" in an effort to sort and disperse those students who may have

a familiarity with the content, due to their pre-existing knowledge of historical aspects of

Indiana County, into different groups. The participant responses to this question indicated

that very few participants were actually from Indiana County; of the 55 participants who participated in the study, only 3 were from Indiana County.

Subsequently, one unintended result due to the participants' unfamiliarity with the material was boredom. Several participants noted that boredom with the content, particularly the way it was presented or narrated, made it difficult to concentrate. This also is underscored by the responses to pre-test Question 13, which asked each participant to indicate their interest in history, which was essentially the primary focus of each of the video excerpts. Of the 55 participants in the survey, 12 indicated that they were either "somewhat non-interested" or "very non-interested" in history. Open-ended participant observations in the exit questions also illuminate the aspect of boredom included comments such as "the videos were of low quality and slightly dry," "the voices were a little boring," "the pictures and speakers on the video were dull," "the content of the videos was boring," and "I found the videos to be dull and very monotone; I was having trouble focusing the whole time."

Another limitation of the study concerned the actual order of video presentation. Although the research design scrambled the resolution among the groups, the actual order of the videos was constant across groups. In other words, each group saw the same first video dealing with fatality prevention in the workplace, but each group viewed it at a different resolution. Interestingly, video content was statistically significant, and of the three videos in the study, video three scored the highest. The participants might simply have gotten better at watching the videos and anticipating eventual content-based questions, causing the mean scores on the third video to be significantly higher.

The final limitations of the study concern the mechanics and logistics of the experiment. Prior to the actual experiment, a small pilot study was conducted to assess the difficulty of the questions as well as the effectiveness and accuracy of the chosen videos and resolutions. The pilot study consisted of five participants, none of whom were of college age. Improved pretesting in the pilot study may have revealed issues that could have been addressed prior to the experiment that may have resulted in better reliability of the test instrument as well as more possibilities and opportunities for statistically significant results.

Moreover, significantly deeper and more intensive pilot testing, particularly of the video content, may have revealed that the issue of boredom was affecting concentration and participant focus on the content in the video excerpts. If more extensive pilot testing of the video content occurred, then content boredom would have been mitigated, by altering the actual video excerpts, by adding background music, by incorporating additional narration, or by altering the content video entirely. Another option would have been to introduce or incorporate different content that would have been intended to be more appealing for the demographic of the participants in the actual experiment.

The data results from Chapter 4 indicated that Group 2 outperformed Group 1 and Group 3. This may have been due to random effects, or simple bad luck. In any case, better pretesting may have helped to spread the higher performing participants more evenly across the groups. The pretest questions in this study did not probe deep enough and did not ask the proper questions to allow this stratified dispersion to occur. A more intensive pilot study would have also aided in this regard. Furthermore, the video content

could have been designed in such a way that could have maintained a higher interest level in the participants throughout the entire duration of the activity; more insightful questions in the pilot and final versions of the study could have been included. Finally, the study could have incorporated a more representative, larger sample of the student population.

Finally, the number of participants in this study, while acceptable and aligned with the committee's recommendations, was somewhat low. Although there were some statistically significant findings as result of this research study, there were several other findings, while not statistically significant at acceptable levels, certainly do warrant consideration. The inclusion of more participants into each group may have brought to bear more data points, and as a result, stronger and more statistically significant results.

Future Research

The basis of this study was streaming video resolution and its effect on student learning acquisition and recall. Because of the difficulties of accurately portraying the true video resolution encountered in streaming media environments and accurately gauging learner interest in the content, along with several other considerations as a result of this experiment, many possibilities exist for future research.

Although there was a difference in overall post-test accuracy scores between Communications Media majors and non-Communications Media majors, the p value was strong (0.155) but not significant at the $p = .05$ alpha level. Although the difference is not statistically significant at an acceptable level, it is very close to that and may warrant additional study. Future research may expand upon this idea by including more majors

from across more disciplines or by comparing only two groups of majors: Communications Media majors and Music majors, for example.

Additionally, future research may benefit from a more expansive pilot study that would incorporate sample test questions of varying difficulty, from relatively easy to exceedingly difficult. Also, increasing the amount of questions to provide more data points could aid in teasing out factors in play that could ultimately result in statistically significant findings. This could be accomplished in conjunction with deliberate and intensive screening of potential videos that pique the interest of the target demographic and population represented by the sample. Additionally, future studies in this field may benefit by increasing the amount of video content, both in length and in number, while still remaining sensitive to the issues of cognitive overload, particularly as applied to the principles articulated in Dual Coding Theory (Mayer, 2006; Paivio, 2010).

As the World Wide Web continues its maturation and as more users are equipped with access to high-bandwidth connections to it, streaming multimedia content will increase its importance as a learning tool in educational environments. Multimedia designers and teachers may continue to leverage the powerful advantages of multimedia media streaming technologies by understanding the difficulties and limitations involved with streaming high-bandwidth multimedia content. Future research could delve deeper into actual broadcasted codecs and more accurately portray and simulate real-world streaming conditions under load. This will provide designers and instructors alike with concrete data on minimum acceptable multimedia file resolution and aesthetic qualities that will aid in successful attainment of educational goals.

Conclusion

Previous research has shown multimedia content has been a powerful, compelling instructional tool for decades, as it offers the possibilities of deeper, richer, and more authentic engagement with learning content, topics, and concepts. This experimental study attempted to draw a connection between the aesthetic quality of multimedia content and its effect on learning acquisition and cognition. Specifically, it sought to investigate whether or not streaming quality, as represented in the study as low, medium, and high quality, had a statistically significant effect on accuracy scores among college undergraduates.

Access to vivid, compelling multimedia content has become second nature to current college undergraduates. The World Wide Web, because of its powerful capabilities to deliver multimedia content, has become a ubiquitous provider of multimedia learning content in educational institutions, and in the workplace. Indeed, research illustrates the staggering amount of content being repurposed for web delivery or designed with distribution on the World Wide Web as its primary delivery medium (Chapman and Chapman, 2000; Mullen & Wedwick, 2008; Jones & Cuthrell, 2011). Although resolution did not appear to be a significant factor in learning acquisition and recall, it was shown that video content, and the resultant learner interest, is an important determinant in information recall. This study has contributed to the field by examining a heretofore largely unexplored concept of how streaming video resolution in a multimedia, streaming environment affects learner cognition. In the future, as streaming multimedia content becomes ever more useful and further integrated into the educational paradigm,

research into how aesthetic resolution, when combined with bi-modal multimedia

delivery will be even more in demand, relevant and useful, especially when viewed with

the educational needs of college students in mind.

References

Agazio, J., & Buckley, K. (2009). An untapped resource: Using YouTube in nursing education. *Nurse educator, 34*(1), 23-28.

Alessi, S. M., & Trollip, S. R. (2001) *Multimedia for learning: Methods and development* (3rd ed.). Boston, MA: Allyn & Bacon.

Askov, E., & Bixler, B. (1998). Transforming adult literary instruction through computer-assisted instruction. In D. Reinking, L. McKenna, L. Labbo, & R. Kieffer (Eds.), *Handbook of literacy and technology: Transformations in a post-typographic world* (pp. 184-203). New York, NY: Routledge Press.

Azevedo, R., Moos, D., Johnson, A., & Chauncey, A. (2010). Measuring cognitive and metacognitive regulatory processes during hypermedia learning: Issues and challenges. *Educational Psychologist, 45*(4), 210-223.

Bandura, A. (1969). Social-learning theory of identificatory processes. *Handbook of socialization theory and research, 213*, 262.

Berk, R. (2009). Multimedia teaching with video clips: TV, movies, YouTube, and mtvU in the college classroom. *International Journal of Technology in Teaching and Learning, 5*(1), 1-21.

Bringuier, J. (1980). Conversations with Jean Piaget. *Society, 17*(3), 56-61.

Bruner, J., Olver, R., & Greenfield, P. (1966). *Studies in cognitive growth*. Oxford, England: John Wiley & Sons.

Brünken, R., Plass, J., & Leutner, D. (2004). Assessment of cognitive load in multimedia learning with dual-task methodology: Auditory load and modality effects. *Instructional Science*, *32*(1-2), 115-132.

Brunyé, T., Ditman, T., Augustyn, J., & Mahoney, C. (2009). Spatial and non-spatial integration in learning and training with multimedia systems. In R. Zheng, & I. Global. (Eds.). *Cognitive effects of multimedia learning* (pp. 108-133). Hershey, PA: IGI Global.

Buddenbaum, J., & Novak, K. (2002). *Applied communication research*. Ames, IA: Wiley-Blackwell.

Burke, S., Snyder, S., & Rager, R. C. (2009). An assessment of faculty usage of YouTube as a teaching resource. *The Internet Journal of Allied Health Sciences and Practice, 7*(1), 1-8.

Caladine, R. (2008). *Enhancing e-learning with media-rich content and interactions*. New York, NY: Information Science.

Cater, D., & Adler, R. (1975). *Television as a social force: New approaches to TV criticism*. New York, NY: Praeger.

Chambers, B., Cheung, A., Madden, N., Slavin, R., & Gifford, R. (2009). Embedded multimedia: Using video to enhance reading outcomes in success for all. In A. Bus & S. Neuman (Eds.), *Multimedia and literacy development* (pp. 213-223). New York, NY: Routledge Press.

Chambers, J., & Sprecher, J. (1983). *Computer-assisted instruction: Its use in the classroom*. Englewood Cliffs, NJ: Prentice-Hall.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and instruction, 8*(4), 293-332.

Chang, C.-C., & Yang, F.-Y. (2010). Exploring the cognitive loads of high-school students as they learn concepts in web-based environments. *Computers & Education, 55*(2), 673-680.

Chapman, N. & Chapman, J. (2000). *Digital multimedia* (Vol. 4): Hoboken, NJ: Wiley.

Chenail, R. J. (2011). YouTube as a Qualitative Research Asset: Reviewing User Generated Videos as Learning Resources. *Qualitative Report, 16*(1), 229-235.

Childers, T., Houston, M., & Heckler, S. (1985). Measurement of individual differences in visual versus verbal information processing. *Journal of Consumer Research*, 125-134.

Chumley-Jones, H., Dobbie, A., & Alford, C. (2002). Web-based learning: sound educational method or hype? A review of the evaluation literature. *Academic Medicine, 77*(10), S86-S93.

Clark, J., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review, 3*(3), 149-210.

Cleveland, M. (2011). 13 A practical guide to using YouTube in the classroom. In D. Dunn, J. Wilson, J. Freeman, & J. Stowell (Eds.). *Best practices for technology-enhanced teaching and learning: Connecting to psychology and the social sciences* (pp. 197-206). New York, NY: Oxford University Press.

Cohen, A. J. (2005). How music influences the interpretation of film and video: Approaches from experimental psychology. *Selected reports in ethnomusicology: perspectives in systematic musicology, 12*, 15-36.

Collis, B. (1991). Anticipating the impact of multimedia in education: Lessons from literature. *International Journal of Computers in Adult Education and Training, 2*(2), 136-149.

Cook, E. (2009). Measurement of cognitive load during multimedia learning activities. In R. Zheng & I. Global (Eds.), *Cognitive effects of multimedia learning* (pp. 34-50). Hershey, PA: IGI Global.

Creswell, J. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research (3rd).* Upper Saddle River, NJ: Prentice Hall.

Crigler, A., & Just, M. (1994). Interpreting visual versus audio messages in television news. *Journal of Communication, 44*(4), 132.

DeSchryver, M. (2009) New forms of deep learning on the web: Meeting the challenge of cognitive load in conditions of unfettered exploration in online multimedia environments. In R. Zheng & I. Global (Eds.), *Cognitive effects of multimedia learning* (pp. 134-152). Hershey, PA: IGI Global.

DeVries, R. (1997). Piaget's social theory. *Educational researcher, 26*(2), 4-17.

Dobrian, F., Sekar, V., Awan, A., Stoica, I., Joseph, D., Ganjam, A., Zhang, H. (2011). Understanding the impact of video quality on user engagement. *ACM SIGCOMM Computer Communication Review, 41*(4), 362-373.

Doolittle, P. E. (2002). Multimedia learning: Empirical results and practical applications. *Extrait le, 18*.

Duffy, P. (2007). *Engaging the YouTube Google-Eyed Generation: Strategies for Using Web 2.0 in Teaching and Learning.* Paper presented at the European Conference on ELearning, ECEL.

Fan, J., & Macredie, R. (2006). Gender differences and hypermedia navigation: Principles for adaptive hypermedia learning systems. In G. Magoulas & S. Chen (Eds.), *Advances in web-based education: personalized learning environments* (pp. 1-20). Hershey, PA: IGI Global.

Fang, R.-J., Chang, Y.-S., Lee, C.-J., & Tsai, H.-L. (2010). *The model of multimedia and cognitive learning theory.* Paper presented at the 9th WSEAS International Conference on Software Engineering, Parallel and Distributed Systems (SEPADS'10).

Fee, K. (2009). *Delivering E-Learning: A complete strategy for design application and assessment*. Philadelphia, PA: Kogan Page.

Finkelstein, J. (2009). *Learning in real time: Synchronous teaching and learning online* (Vol. 22). Hoboken, NJ: John Wiley & Sons.

Follansbee, J. (2004). *Get Streaming!: Quick Steps to Delivering Audio and Video Online*. New York, NY: Taylor & Francis.

Fraenkel, J., Wallen, N., & Hyun, H. (1993). *How to design and evaluate research in education* (Vol. 7). New York, NY: McGraw-Hill.

Girvan, C., & Savage, T. (2010). Identifying an appropriate pedagogy for virtual worlds: A communal constructivism case study. *Computers & Education, 55*(1), 342-349.

Goh, W., Dexter, B., & Murphy, W. (2007, March). Promoting critical thinking with computer mediated communication technology. In *Proceedings of the sixth conference on IASTED International Conference Web-Based Education-Volume 2* (pp. 580-585). ACTA Press.

Google. (2014). Advanced encoding settings – YouTube help. Retrieved from https://support.google.com/youtube/answer/1722171?hl=en

Gosselin, P., & Gagné, J. (2011). Older adults expend more listening effort than young adults recognizing audiovisual speech in noise. *International Journal of Audiology*, *50*(11), 786-792.

Gunn, C. (2003). Dominant or different? Gender issues in computer supported learning. *Journal of Asynchronous Learning Networks, 7*(1), 14-30.

Hannafin, M., Hannafin, K., Hooper, S., Rieber, L., & Kini, A. (1996). Research on and research with emerging technologies. *Handbook of research for educational communications and technology*, 378-402.

Harasim, L. (1987). Teaching and learning on-line: Issues in computer-mediated graduate courses. *Canadian Journal of Educational Communication, 16*(2), 117-135.

Haug, P. (2009). Learning in the network society as an ideal for learning in school. In R. Krumsvik (Ed.), *Learning in the network society and the digitized school* (pp. 195-208). Hauppauge, NY: Nova Science.

Hede, A. (2002). Integrated model of multimedia effects on learning. *Journal of educational multimedia and hypermedia, 11*(2), 177-191.

Holzinger, A., Kickmeier-Rust, M., Wassertheurer, S., & Hessinger, M. (2009). Learning performance with interactive simulations in medical education: Lessons learned from results of learning complex physiological models with the HAEMOdynamics SIMulator. *Computers & Education, 52*(2), 292-301.

Hoogeveen, M. (1997). Toward a theory of the effectiveness of multimedia systems. *International Journal of Human-Computer Interaction, 9*(2), 151-168.

Hunt, E. (1980). Intelligence as an information-processing concept. *British Journal of Psychology, 71(*4), 449-474.

IUP Enrollment – Crimson Snapshot (2014, December 30) in *Crimson Snapshot Enrollment,* Retrieved from http://www.iup.edu/page.aspx?id=120990

Jereb, E., & Šmitek, B. (2006). Applying multimedia instruction in e-learning. *Innovations in Education and Teaching International, 43*(1), 15-27.

Jonassen, D. (Ed.). (2004). *Handbook of research on educational communications and technology*. New York, NY: Taylor & Francis.

Jonassen, D., & Reeves, T. (1996). Learning with technology: Using computers as cognitive tools. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 706-707). New York, NY: Simon & Schuster Macmillan.

Jones, T., & Cuthrell, K. (2011). YouTube: Educational potentials and pitfalls. *Computers in the Schools, 28*(1), 75-85.

Juluri, P., Plissonneau, L., & Medhi, D. (2011). *Pytomo: a tool for analyzing playback quality of YouTube videos.* Paper presented at the Proceedings of the 23rd International Teletraffic Congress.

Kounios, J., & Holcomb, P. (1994). Concreteness effects in semantic processing: ERP evidence supporting dual-coding theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(4), 804.

Lan, Y.-F., & Sie, Y.-S. (2010). Using RSS to support mobile learning based on media richness theory. *Computers & Education, 55*(2), 723-732.

Lane, D. M. (2004). *Carry-over effects*. Retrieved from http://davidmlane.com/hyperstat/A134100.html

Lillejord, S., & Dysthe, O. (2009). Productive horizontal learning and digital tools. In R. Krumsvik (Ed.), *Learning in the network society and the digitized school* (pp. 311-315). Hauppauge, NY: Nova Science.

Liu, J., Rao, S. G., Li, B., & Zhang, H. (2008). Opportunities and challenges of peer-to-peer internet video broadcast. *Proceedings of the IEEE*, *96*(1), 11-24.

Liu, S., Liao, H., & Pratt, J. (2009). Impact of media richness and flow on e-learning technology acceptance. *Computers & Education, 52*(3), 599-607.

MacInnis, D. J., & Jaworski, B. J. (1989). Information processing from advertisements: Toward an integrative framework. *The Journal of Marketing*, 1-23.

Marshall, D. (2001). *What is compression?* Retrieved from http://www.cs.cf.ac.uk/Dave/Multimedia/node202.html - SECTION04211000000000000000

Mayer, R. E. (2009). *Multimedia learning*. New York, NY: Cambridge University Press.

Mayer, R. E. (1999). Multimedia aids to problem-solving transfer. *International Journal of Educational Research, 31*(7), 611-623.

Mayer, R. E. (2005). Cognitive theory of multimedia learning. *The Cambridge handbook of multimedia learning*, 31-48.

Mayer, R. E. (2006). Ten research-based principles of multimedia learning. *Web-based learning: Theory, research, and practice*, 371-390.

Mayer, R., & Moreno, R. (2001a). *A cognitive theory of multimedia learning: Implications for design principles.* Paper presented at the annual meeting of the ACM SIGCHI Conference on Human Factors in Computing Systems, Los Angeles, CA.

Mayer, R. E., Heiser, J., & Lonn, S. (2001b). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal of Educational Psychology, 93*(1), 187.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 43-52.

Mayer, R. E., & Sims, V. K. (1994). For whom is a picture worth a thousand words? Extensions of a dual-coding theory of multimedia learning. *Journal of Educational Psychology, 86*(3), 389.

McIsaac, M., & Gunawardena, C. (1996). Distance education. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 403-437). New York, NY: Simon & Schuster Macmillan.

McKinney Jr, E. H., Charles, J., & Yoos, I. (2010). Information about information: A taxonomy of views. *MIS quarterly, 34*(2), 329-344.

McLuhan, M. (1964). *Understanding media: The extensions of man*. New York, NY: McGraw-Hill.

McLuhan, M., & Powers, B. (1989). *The global village: Transformations in world life and media in the 21st century*. New York, NY: Oxford University Press.

Meehan, S., Holmes, B., & Tangney, B. (2001). Who wants to be a teacher? An exploration of the theory of communal constructivism at the chalk face. *Teacher Development, 5*(2), 177-190.

Miller, G. A. (1994). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 101*(2), 343.

Miller, G. A. (2003). The cognitive revolution: a historical perspective. *Trends in Cognitive Sciences, 7*(3), 141-144.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological review, 63*(2), 81.

Mohler, J. L. (2001). *Using interactive multimedia technologies to improve student understanding of spatially-dependent engineering concepts*. Paper presented at the Proceedings of the GraphiCon.

Molholm, S., Ritter, W., Murray, M., Javitt, D., Schroeder, C., & Foxe, J. (2002). Multisensory auditory–visual interactions during early sensory processing in humans: a high-density electrical mapping study. *Cognitive Brain Research, 14*(1), 115-128.

Moore, D., Burton, J., & Myers, R. (1996). Multiple-channel communication: The

    theoretical and research foundations of multimedia. *Handbook of research for*

    educational communications and technology, 851-875.

Moreno, R., & Mayer, R. E. (2000). A learner-centered approach to multimedia

    explanations: Deriving instructional design principles from cognitive theory.

    Interactive Multimedia Electronic Journal of Computer-Enhanced Learning, 2(2),

    12-20.

Moreno, R., & Mayer, R. E. (2000). A learner-centered approach to multimedia

    explanations: Deriving instructional design principles from cognitive theory.

    Interactive Multimedia Electronic Journal of Computer-Enhanced Learning, 2(2),

    12-20.

Mullen, R., & Wedwick, L. (2008). Avoiding the digital abyss: Getting started in the

    classroom with YouTube, digital stories, and blogs. *The Clearing House: A*

    Journal of Educational Strategies, Issues and Ideas, 82(2), 66-69.

Najjar, L. (1998). Principles of educational multimedia user interface design. *Human*

    Factors, 40(2), 311.

Narey, M. (2003). Technology in the fine arts classroom. In L. Tomei (Ed.), *Challenges*

    of teaching with technology across the curriculum: Issues and solutions (pp. 211-

    239). Hershey, PA: Information Science.

Neumann, M., Hyde, M., Neumann, D., Hood, M., & Ford, R. (2012). Multisensory

    methods for early literacy learning. In G. Andrews, & D. Neumann (Eds.),

Beyond the lab: Applications of cognitive research in memory and learning (pp.
197-216). Hauppauge, NY: Nova Science.

Paas, F., van Gog, T., & Sweller, J. (2010). Cognitive load theory: New
conceptualizations, specifications, and integrated research perspectives.
Educational Psychology Review, 22(2), 115-121.

Paas, F., Ayres, P., & Pachman, M. (2008). Assessment of cognitive load in multimedia
learning: Theory, methods and applications. In D. Robinson, & G. Schraw (Eds.).
Recent innovations in educational technology that facilitate student learning (pp.
11-36). Charlotte, NC: Information Age.

Page, M. S. (2002). Technology-enriched classrooms: Effects on students of low
socioeconomic status. *Journal of Research on Technology in Education, 34*(4),
389-409.

Paivio, A. (2013). *Imagery and verbal processes*. New York, NY: Psychology Press.

Paivio, A. (2010). Dual coding theory and the mental lexicon. *The Mental Lexicon, 5*(2),
205-230.

Passig, D., & Levin, H. (2000). Gender preferences for multimedia interfaces. *Journal of
Computer-Assisted Learning, 16*(1), 64-71.

Pastore, R. (2012). The effects of time-compressed instruction and redundancy on
learning and learners' perceptions of cognitive load. *Computers & Education,
58*(1), 641-651.

Pea, R. (1994). Seeing what we build together: Distributed multimedia learning

environments for transformative communications. *The Journal of the Learning

Sciences, 3*(3), 285-299.

Piaget, J. (1964). Part I: Cognitive development in children: development and learning.

Journal of research in science teaching, 2(3), 176-186.

Pilling, M., & Thomas, S. (2011). Audiovisual cues and perceptual learning of spectrally

distorted speech. *Language & Speech, 54*(4), 487-497.

Plass, J., Moreno, R., & Brünken, R. (Eds.). (2010). *Cognitive load theory*. Cambridge

University Press.

Playback. (n.d.). In *YouTube.* Retrieved from

https://www.youtube.com/account_playback

Reiber, L. (2009). Supporting discovery-based learning within simulations. In R. Zheng

& I. Global (Eds.), *Cognitive effects of multimedia learning* (pp. 217-236).

Hershey, PA: IGI Global.

Reinard, J. C. (2006). *Communication research statistics*. Thousand Oaks, CA: SAGE

Publications, Incorporated.

Rockwell, S. C., & Singleton, L. A. (2007). The effect of the modality of presentation of

streaming multimedia on information acquisition. *Media Psychology, 9*(1), 179-

191.

Rodrigues, S. (2000). The interpretive zone between software designers and a science

educator: Grounding instructional multimedia design in learning theory. *Journal

of Research on Computing in Education, 33*(1), 1-15.

Ruey, S. (2010). A case study of constructivist instructional strategies for adult online

    learning. *British Journal of Educational Technology, 41*(5), 706-720.

Sadoski, M., & Paivio, A. (2012). *Imagery and text: A dual coding theory of reading and*

    writing. New York, NY: Routledge Press.

Sadoski, M., Goetz, E. T., & Fritz, J. B. (1993). Impact of concreteness on

    comprehensibility, interest, and memory for text: Implications for dual coding

    theory and text design. *Journal of Educational Psychology, 85*(2), 291.

Salomon, G. (1994). *Interaction of media, cognition, and learning*. New York, NY:

    Psychology Press.

Salomon, G. (1984). Television is" easy" and print is" tough": The differential investment

    of mental effort in learning as a function of perceptions and attributions. *Journal*

    of Educational Psychology, 76(4), 647.

Sanders, J. (2005). Gender and technology in education: A research review. *Seattle:*

    Center for Gender Equity. Bibliography retrieved March, 20, 2006.

Savenye, W. (2007). Interaction: The power and promise of active online learning. In J.

    Spector (Ed.), *Finding your online voice: Stories told by experienced online*

    educators (pp. 163 – 194). New York, NY: Routledge.

Schmoyer, T. (2011). *What's the optimal bitrate for encoding YouTube uploads?*

    Retrieved from http://www.reelseo.com/best-bitrate-encode-youtube/

Simkins, M. (2002). *Increasing student learning through multimedia projects*.

    Alexandria, VA: Association for Supervision and Curriculum Development.

Simon, H. A., & Feigenbaum, E. A. (1964). An information-processing theory of some

    effects of similarity, familiarization, and meaningfulness in verbal learning.

    Journal of Verbal Learning and Verbal Behavior, 3(5), 385-396.

Skinner, B. (1959). Teaching machines. *IRE transactions on Education, 2*(1), 14-22.

Snelson, C. (2011). YouTube across the disciplines: A review of the literature. *MERLOT*

    Journal of Online Learning and Teaching.

Snelson, C. (2008). *Web-based video in education: Possibilities and pitfalls.* Paper

    presented at the TCC-Teaching Colleges and Community Worldwide Online

    Conference.

Sorden, S. (2005). A cognitive approach to instructional design for multimedia learning.

    Informing Science, 8.

Souto, M., & Verdin, R. (2006). Modeling learner's cognitive abilities in the context of a

    web-based learning environment. In G. Magoulas & S. Chen (Eds.), *Advances in*

    web-based education: personalized learning environments (pp. 21-45). Hershey,

    PA: IGI Global.

Spector, J. M. (Ed.). (2007). *Finding your online voice: Stories told by experienced*

    online educators. New York, NY: Psychology Press.

Sun, P.C., & Cheng, H. (2007). The design of instructional multimedia in e-Learning: A

    Media Richness Theory-based approach. *Computers & Education, 49*(3), 662-

    676.

Sundar, S. S. (2000). Multimedia effects on processing and perception of online news: A

    study of picture, audio, and video downloads. *Journalism & Mass*

    Communication Quarterly, 77(3), 480-499.

Tavassoli, N. T., & Lee, Y. H. (2003). The differential interaction of auditory and visual

    advertising elements with chinese and english. *Journal of Marketing Research*

    (JMR), 40(4), 468-480.

Wadsworth, B. (1996). *Piaget's theory of cognitive and affective development:*

    Foundations of constructivism. New York, NY: Longman.

Wang, H., & Gearhart, D. (2006). *Designing and developing web-based instruction*.

    Upper Saddle River, NJ: Prentice Hall.

Ward, M., & Robertson, S. (2013, May 18). Google I/O 2013: Adaptive streaming for

    you and YouTube [Video file]. Retrieved from

    www.youtube.com/watch?V=UklDSMG9ffu

Wilk, M. (1976). *The golden age of television: Notes from the survivors*. New York, NY:

    Delacorte Press.

Wiske, M., & Breit, L. (2010). *Teaching for understanding with technology*. Hoboken,

    NJ: John Wiley & Sons.

Yadav, A., Phillips, M. M., Lundeberg, M. A., Koehler, M. J., Hilden, K., & Dirkin, K.

    H. (2011). If a picture is worth a thousand words is video worth a million?

    Differences in affective and cognitive processing of video and text cases. *Journal*

    of Computing in Higher Education, 23(1), 15-37.

Yildirim, Z., Ozden, M., & Aksu, M. (2001). Comparison of hypermedia learning and

traditional instruction on knowledge acquisition and retention. *The Journal of*

Educational Research, 94(4), 207-214.

Youtube.com Site Overview. (2014, July 8). In *Alexa's Actionable Analytics for the Web.*

Retrieved from http://www.alexa.com/siteinfo/youtube.com

YouTube API v2.0 – Revision History (2014, March 21) In *YouTube API v2.0 – Revision*

History – YouTube – Google Developers. Retrieved from

https://developers.google.com/youtube/2.0/developers_guide_protocol_release_n

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IUP Indiana University of Pennsylvania
www.iup.edu

Institutional Review Board for the
Protection of Human Subjects
School of Graduate Studies and Research
Stright Hall, Room 113
210 South Tenth Street
Indiana, Pennsylvania 15705-1048

P 724-357-7730
F 724-357-2715
irb-research@iup.edu
www.iup.edu/irb

October 10, 2014

Todd Campbell
129 Deer Run Rd.
Orangeville, PA

Dear Mr. Campbell:

Your proposed research project, "The Effects of Audio and Video Encoding on
Information Acquisition Among Undergraduates," (Log No. 14-271) has been
reviewed by the IRB and is approved. In accordance with 45CFR46.101 and IUP
Policy, your project is exempt from continuing review.

<u>You should read all of this letter, as it contains important information about
conducting your study.</u>

Now that your project has been approved by the IRB, there are elements of the
Federal Regulations to which you must attend. IUP adheres to these regulations
strictly:

1. You must conduct your study <u>exactly as it was approved</u> by the IRB.

2. <u>Any additions or changes</u> in procedures <u>must</u> be approved by the IRB
   <u>before</u> they are implemented.

3. You must notify the IRB promptly of <u>any</u> events that affect the safety or
   well-being of subjects.

4. You must notify the IRB promptly of any modifications of your study or
   other responses that are necessitated by any events reported in items
   2 or 3.

The IRB may review or audit your project at random or for cause. In accordance
with IUP Policy and Federal Regulation (45CFR46.113), the Board may suspend
or terminate your project if your project has not been conducted as approved or if
other difficulties are detected

Although your human subjects review process is complete, the School of
Graduate Studies and Research requires submission and approval of a Research
Topic Approval Form (RTAF) before you can begin your research. If you have not
yet submitted your RTAF, the form can be found at
http://www.iup.edu/page.aspx?id=91683 .

It is strongly recommended that all researchers and their advisors complete CITI on-line protection of human subjects and responsible conduct of research training. The training is available at http://www.iup.edu/page.aspx?id=93408 and there is no charge to you.

While not under the purview of the IRB, researchers are responsible for adhering to US copyright law when using existing scales, survey items, or other works in the conduct of research. Information regarding copyright law and compliance at IUP, including links to sample permission request letters, can be found at http://www.iup.edu/page.aspx?id=165526.

I wish you success as you pursue this important endeavor.

Sincerely,

Jen Roberts

Jennifer Roberts, Ph.D.
Chairperson, Institutional Review Board for the Protection of Human Subjects
Professor of Criminology

JLR:js

xc: Dr. Zachary Stiegler, Dissertation Advisor
        Ms. Brenda Boal, Secretary

Appendix B
Preliminary Survey Questions

As announced in your COMM 101/150 class, you are invited to participate in a learning activity consisting of preliminary questions and an activity in the computer lab. This preliminary exercise consists of 18 questions, and should take 5-7 minutes to complete. After you complete this preliminary activity, you will receive a follow-up email from Mr. Campbell that will include the location of the second part of the study and available times for you to complete the activity.

After you complete BOTH activities: the preliminary questions **and** the learning activity in the computer lab, you will be entered into a drawing to win one of three Amazon gift cards, valued at $75, $50, and $25.

The data you provide will be recorded anonymously. Your participation in this project is voluntary and you may refuse or discontinue participation at any time by closing your browser window without consequence. If you choose to discontinue participation, all information you generated will be deleted and not stored. Students participating in the project will receive extra credit in their COMM 101/150 class after completion of **both** components of the study: the initial online questionnaire and the learning activity in the computer lab. If you do not wish to participate, please see your instructor for other extra credit options. Your instructor is not a member of the research team; your participation in the study is equivalent to the alternate activity in the eyes of the instructor. This study is for academic research and only summary results will be shared through professional conferences and journals. Since we have no identifying information and are only using aggregate data and not individual responses, there can be nothing that links you to your responses. No data will be reported this way.

Questions or concerns about this study, including your role as a participant, may be directed to Dr. Zachary Stiegler, dissertation chairperson, or Todd Campbell, Ph.D. Candidate, 121A Stouffer Hall, Indiana University of Pennsylvania, 1011 South Drive, Indiana, PA 15705. Contact phone number: 724-357-3219.

Do you wish to participate in this project?

> <u>Yes</u> – proceeds to first survey question
>
> **<u>No</u>** – survey ends with Thank You

This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (Phone: 724-357-7730).

Pretest Questions

1. How would you describe the grades you earned in the last two years (in high school and/or college)?
a. Very Good – mostly As
b. Good – mix of mostly As and Bs
c. Average – mix of mostly Bs and Cs with some higher or lower grades
d. Weak – mostly Cs or lower
e. Poor – mostly Ds or Fs – some better grades

2. What is your gender?
a. male
b. female

3. What is your age?

4. What is your major? _____

5. What is your marital status?
a. single
b. married
c. divorced
d. widowed

6. What is your class rank?
a. Freshman
b. Sophomore
c. Junior
d. Senior

7. When you are studying, how often do you have music playing in the background?
a. always
b. almost always
c. sometimes
d. almost never
e. never

8. If music plays in the background while you study, what is the primary genre?
a. Country
b. Jazz
c. Heavy Metal
d. Easy Listening
e. Top 40
f. Classic Rock
g. Hip-Hop
h. other
i. not applicable

9. How many hours a day do you spend doing homework?
a. 0 - 1 hour
b. 2 – 3 hours
c. 4 – 5 hours
d. more than 5 hours

10. Which of the following best describes your preferred learning style when learning new material?
a. I learn best when the material is presented using visuals.
b. I learn best when the material is presented using audio.
c. I learn best through a combination of audio and visual presentation.
d. I have no preference concerning audio or visuals when learning new material.

11. Please indicate your interest in history:
a. very interested
b. somewhat interested
c. neither interested nor non-interested
d. somewhat non-interested
e. very non-interested

12. On average, how much time each day do you spend listening to music?
a. 0 - 1 hour
b. 2 – 3 hours
c. 4 – 5 hours
d. more than 5 hours

13. How would you describe your technical aptitude/ability with digital technology including computers, tablets, and smart phones?
a. Excellent
b. Good
c. Average
d. Fair
e. Poor

14. How long is your commute time to school?
a. 0-30 minutes
b. 31 minutes – 60 minutes
c. 61 minutes – 90 minutes
d. 91 minutes – 120 minutes
e. more than 120 minutes

15. Where did you grow up?
a. Indiana County
b. Eastern Pennsylvania
c. Western Pennsylvania
d. Outside of the state

16. How well can you see?
a. Very good
b. Good
c. Barely acceptable
d. Poor
e. Very Poor

17. How well can you hear?
a. Very good
b. Good
c. Barely acceptable
d. Poor
e. Very Poor

18. What is your **IUP** email address?

Appendix C
Informed Consent Form in Email: The Effects of Audio and Video Encoding on
Information Acquisition Among Undergraduates

As announced in your COMM 101/150 class, you are invited to participate in a learning exercise in the computer lab where you will answer questions before, during and after the viewing of 3 short videos on preventing fatalities in the workplace, the history of medical services in Indiana County, and the history of the Indiana Hospital School of Nursing. The total time involved, including viewing the videos, is about 25-30 minutes. If you have not completed the preliminary questions, please do so before completing the learning activity.

You will complete this activity in the computer lab located at **LOCATION**, between the hours of **TIME**, on **DATE**. After you complete BOTH activities: the preliminary questions **and** the learning activity in the computer lab, you will be entered into a drawing to win one of three Amazon gift cards, valued at $75, $50, and $25.

The data you provide will be recorded anonymously. Your participation in this project is voluntary and you may refuse or discontinue participation at any time by closing your browser window without consequence. If you choose to discontinue participation, all information you generated will be deleted and not stored. Students participating in the project will receive extra credit in their COMM 101/150 class after completion of **both** components of the study: the initial online questionnaire and the learning activity in the computer lab. If you do not wish to participate, please see your instructor for other extra credit options. Your instructor is not a member of the research team; your participation in the study is equivalent to the alternate activity in the eyes of the instructor.

This study is for academic research and only summary results will be shared through professional conferences and journals. Since we have no identifying information and are only using aggregate data and not individual responses, there can be nothing that links you to your responses. No data will be reported this way.

Questions or concerns about this study, including your role as a participant, may be directed to Dr. Zachary Stiegler, dissertation chairperson, or Todd Campbell, Ph.D Candidate, 121A Stouffer Hall, Indiana University of Pennsylvania, 1011 South Drive, Indiana, PA 15705. Contact phone number: 724-357-3219.

This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (Phone: 724-357-7730).

Appendix D
Consent and Content Questions for Videos 1-3

As announced in your COMM 101/150 class, you are invited to participate in an online learning exercise where you will answer questions before, during and after the viewing of 3 short videos on preventing fatalities in the workplace, the history of medical services in Indiana county, and the history of the Indiana Hospital School of Nursing. The total time involved, including viewing the videos, is about 25-30 minutes. After you complete the initial questionnaire and the learning activity in the computer lab, you will be entered into a drawing for an opportunity to win one of three Amazon gift cards, valued at $75, $50, and $25.

The data you provide will be recorded anonymously. Your participation in this project is voluntary and you may refuse or discontinue participation at any time by closing your browser window without consequence. If you choose to discontinue participation, all information you generated will be deleted and not stored. Students participating in the project will receive extra credit in their COMM 101/150 class after completion of **both** components of the study: the initial online questionnaire and the learning activity in the computer lab. If you do not wish to participate, please see your instructor for other extra credit options. Your instructor is not a member of the research team; your participation in the study is equivalent to the alternate activity in the eyes of the instructor.

This study is for academic research and only summary results will be shared through professional conferences and journals. Since we have no identifying information and are only using aggregate data and not individual responses, there can be nothing that links you to your responses. No data will be reported this way.

Questions or concerns about this study, including your role as a participant, may be directed to Dr. Zachary Stiegler, dissertation chairperson, or Todd Campbell, PhD. Candidate, 121A Stouffer Hall, Indiana University of Pennsylvania, 1011 South Drive, Indiana, PA 15705. Contact phone number: 724-357-3219.

Do you wish to participate in this project?

       <u>Yes</u> – proceeds to first survey question

       <u>**No**</u> – survey ends with Thank You

This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (Phone: 724-357-7730).

VIDEO 1

Q1: According to Rob Fisher, the goal of traditional safety instruction was to:

a. give employees the freedom to react however they want to when faced with danger.

b. give employees options when faced with an on-the-job hazard.

c. get people to think in a common way, with common sense.

d. allow supervisors and middle-management plausible deniability in the wake of a fatality.

e. none of the above

Q2: According to David Jacobi, the first step in preventing job-related fatalities is:

a. collecting data on employee perceptions of on-the-job hazards.

b. recognizing how frequently the potential for hazards that lead to fatalities actually are.

c. examining the safety reports over the past five years in order to find trends.

d. contact the local hospitals to gain a better understanding of what constitutes a fatality.

e. none of the above.

Q3: Who should be asked about potential hazards before a task is performed?

a. the workforce

b. the supervisors

c. middle and upper management

d. the shareholders and other invested parties

e. both b and c

Q4: Which of the following are related to and may influence fatality prevention in the workplace?

a. individual perception of risk

b. required mental and physical aspects of the task

c. latent (existing) conditions

d. performance modes

e. all of the above

Q5: Many companies inadvertently put employees in very high-risk, severe exposure situations.

a. true

b. false

Q6: According to Mike Wright, the only way to really make progress in safety is to:
a. adopt a hands-off approach and hope that the problem takes care of itself.
b. implement a ten-year safety plan.
c. reduce the number of employees and increase each employee's job duties and responsibilities.
d. aggressively look for hazards and/or things that will get people hurt.
e. only hire employees with previous safety experience.

Q7: Precursors are:
a. unavoidable and inevitable
b. dangerous and avoidable
c. predictable and preventable
d. unpredictable and unavoidable
e. none of the above

Q8: What is the first step in fatality prevention?
a. situational and employee awareness.
b. renovate the workplace to reduce hazards.
c. require online employee safety training and certification.
d. analyze the metrics and efforts to see if there are any reductions associated with what is currently being done.
e. none of the above.

Q9: According to Pam Walaski, why do contracted services pose a greater risk of job-related fatalities?
a. contractors are in a rush to finish the job in order to maximize profits.
b. contractors are not familiar with the site's established safety protocols and procedures.
c. contractors typically do not possess the proper tools for the the job.
d. contractors are usually unqualified and/or facing obstacles that promote dangerous or careless behavior.
e. none of the above

Q10: Human systems integration and the recognition/elimination of precursors is related to:
a. the number of employees in the company.
b. the role of human performance concepts in preventing fatalities.
c. available budget.
d. the number of monthly safety meetings.
e. both c and d

VIDEO 2

Q1: According to the narrator, what event was the hospital's first "critical test"?
a. World War I
b. the 1918 Flu Pandemic
c. the 1889 Johnstown Flood
d. the 1916 Ernest mine explosion

Q2: Pennsylvania had the second-highest mortality rate in the nation during the 1918 flu pandemic.
a. true
b. false

Q3: What year did the hospital acquire its first motor ambulance and X-Ray machine?
a. 1912
b. 1913
c. 1914
d. 1915
e. 1916

Q4: Formed in 1902, the group that was established to help plan Indiana County's Centennial celebration was called:
a. the Centennial Committee
b. the New Century Committee
c. the Indiana Century Committee
d. the Centennial Project Committee
e. none of the above

Q5: Medical services in Indiana County began with:
a. Dr. Samuel L. Mack
b. Dr. Tillie Merman
c. Dr. P.L. Springer
d. Dr. Jonathan French
e. Dr. Geert Simblin

Q6: By October 1918, Indiana County had recorded over _____ deaths from the Spanish Influenza pandemic.
a. 50
b. 100
c. 150
d. 200
e. 250

Q7: Dr. French is buried in:
a. Memorial Park
b. Wrigley Field
c. Antietam Cemetery
d. Memorial Cemetery
e. Pleasant View Park

Q8: In 1903, the businessman who offered three acres of land for the proposed hospital was:
a. T.A. Bosley
b. H.B. Winkler
c. A.N. Mount
d. R.J. French
e. A.S. Cunningham

Q9: The fifty-four acre tract of land, which is the site of the current hospital, was acquired from the estate of:
a. George C. Dickey
b. Sam Marshall
c. William T. Morrison
d. Michael Summers
e. Floyd L. Merriweather

Q10: In the early 1900s, what helped to fuel a new round of economic expansion in the Indiana area?
a. coal mining
b. railroads
c. textile goods
d. steel production
e. a and b
f. c and d

VIDEO 3

Q1: The "Mack" wing was completed in:
a. 1939
b. 1940
c. 1941
d. 1942
e. 1943

Q2: The Indiana Hospital School of Nursing, over the course of over 60 years, graduated approximately _____ nurses.
a. 900
b. 1000
c. 1100
d. 2000
e. none of the above

Q3: The nursing home expansion in 1947 was partially funded by donations from:
a. Errol Flynn
b. Jimmy Stewart
c. Elizabeth Taylor
d. Jonathan French
e. Ernest Hemingway

Q4: What color was the bib in the uniform the students wore throughout the 60s?
a. purple
b. blue
c. gray
d. white
e. pink

Q5: In the early days of the school, a high-school diploma was not required.
a. true
b. false

Q6: The nursing program consisted of _____ years of study.
a. 2
b. 3
c. 4
d. 5
e. 6

Q7: During WWI, _____ nurses from the Indiana Hospital Nurses Unit trained at Camp Lee before being assigned to Walter Reed Medical Center in Washington, D.C.
a. 7
b. 17
c. 27
d. 37
e. 47

Q8: When was the first building erected to house the nursing students?
a. 1916
b. 1917
c. 1918
d. 1919
e. 1920

Q9: The nursing uniform was not complete until which of the following were added?
a. pen
b. notebook
c. scissors
d. all of the above
e. none of the above

Q10: The school graduated its last class in:
a. 1975
b. 1976
c. 1977
d. 1978
e. 1979

Appendix E
Exit Questions

1. What did you find most enjoyable about this exercise?

2. What did you find least enjoyable about this exercise?

3. Which video excerpt was the most appealing to you? Why?

4. Do you feel like you guessed at any of the questions? If so, why?

5. As you were viewing the video excerpts, were you aware that there was a difference in audio and video quality among them?
a. yes
b. no

Appendix F
Qualtrics Thank You / Email Follow-up to Participants

Thank you for participating in this project. While we were testing your knowledge of fatality prevention in the workplace, the history of medical services in Indiana County, and the history of the Indiana Hospital School of Nursing, we were also trying to determine if the aesthetic quality of the video impacted your learning and retention of information. In addition, your completion of the initial questionnaire and this learning activity automatically enters you in a random drawing for one of three Amazon gift cards, valued at $75, $50, and $25.

Please note that only your participation, not your test score, will be reported to your instructor in COMM 101/150. Your score on the test does not impact your extra credit award and test scores cannot be matched to individual participants. You must have completed both the initial questionnaire and the learning activity in the computer lab for extra credit to be awarded by your instructor.

We appreciate your participation and thank you for volunteering your time and contributing to our research. You may request a copy of the dissertation by sending an email to Todd Campbell at xtzr@iup.edu.

Thank you!