
Thomas C. Pantazes
West Chester University of Pennsylvania, tpantazes@wcupa.edu

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Dedication

I dedicate this work to the community of people who made it possible. To JC for the eternal motivation to grow in hope and love. To Sara, the love of my life whose support through countless nights of bath and story time created the space for this writing to come into existence. To Mom and Dad for their unwavering love and support throughout all facets of life. To Bob for showing the way and Kristen for pacing me along the way. To Cohort 3 whose friendship and camaraderie made this a worthwhile and mostly enjoyable journey. Finally, I dedicate this work to Ben and Matt who have sacrificed more than they realize. I wrote the “big paper” to improve this world ever so slightly for both of you. When it was tough, you both were the motivation to keep going. This was always for you two and Daddy can play now.
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Abstract

The growing use of digital video for online learning among US higher education instructors accelerated as a result of the COVID-19 pandemic raising questions about instructors’ knowledge of video creation principles (Bétrancourt & Benetos, 2018; Chorianopoulos, 2018; Kay, 2012; McCormack, 2020; Seaman, et al, 2018). This explanatory sequential mixed methods research describes the extent to which higher education instructors who create digital instructional video for online learning applied 11 multimedia design principles of the Cognitive Theory of Multimedia Learning (CTML). The case study triangulated self-reported survey data from 55 online instructors, interview data from five instructors with the highest implementation of CTML design principles as measured in the survey, and analysis of five video artifacts. Instructors implemented the CTML design principles more often than not, but applied certain principles like redundancy less frequently. Students and personal impacts are factors that informed instructor video design decisions and implementation of CTML design principles is driven more by instructors’ personal experiences and preferences rather than knowledge of the design principles. Given these findings, recommendations for instructors include continuing to be “video stars”, incorporating more signals into their videos, checking on-screen text to ensure it is used as little as possible, accounting for the time needed to create a video, and remembering that it is not the tool, but how they use it that matters.

Keywords: Cognitive Theory of Multimedia Learning, online learning, redundancy principle, video
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Chapter 1: Introduction

In March 2020, humanity abruptly shifted from physical to digital presence in the span of days as the risks of an emerging virus necessitated a world-wide quarantine. Digital video, which had been a medium that served as a means of conveying entertainment and personal, one-to-one communication suddenly became the standard medium for conducting many facets of life including education. Triggered by the COVID-19 pandemic, the transition to remote teaching acted as an accelerant on instructor use of digital video in instruction (McCormack, 2020) while at the same time highlighting questions about instructors’ abilities to create effective instructional videos that utilized research-identified design principles.

Prior to the pandemic, online learning within American higher education institutions had been growing at a steady pace (Seaman et al., 2018). As the number of online courses expanded, so too did the demand for instructors to teach in that environment. Teaching online courses requires instructors to use different combinations of instructional techniques and technologies than those employed with in-person courses (Rapanta et al., 2020). Instructor-created digital video is one such combination that instructors use to convey information to students, and its use has grown in online education as a result of three factors: (1) the advent of YouTube in 2005 and its rise in popularity among the general public (Bétrancourt & Benetos, 2018; Reuters, 2006; Snelson & Perkins, 2009; YouTube, 2019), (2) an increase in the availability of broadband internet access (Kay, 2012; Pew, 2018), and (3) technology improvements that make it easier to record, edit, and share digital video (Bétrancourt & Benetos, 2018; Rudolph, 2017). As I witnessed the increased use of digital video in online courses, I questioned digital video’s benefits to learners and instructors’ utilization of research-supported video design principles.
The benefits of using digital video in online courses extend beyond simple information conveyance. Digital video aids online students by assisting in the facilitation of emotional connections with instructors which is especially beneficial in the isolating online learning environment (Costa, 2020). When instructors used digital video in online courses students reported improved teacher presence and immediacy (Lu, 2017). In one study, online graduate students reported stronger connections with their instructor when the instructor used self-made digital instructional video (Martin et al., 2018). A qualitative case study exploring community building among online doctoral students found video feedback helped students build connections with the instructor (Berry, 2017). Students who reported enhanced emotional connections with their instructors tended to have higher academic achievement (Gehlbach et al., 2016). Thus, instructor created digital video used in online courses has the potential to reduce student isolation by facilitating emotional connections leading to improved student learning outcomes.

In addition to supporting emotional connections, instructors’ use of digital video is an instructional technique which addresses how student populations learn. The Universal Design for Learning (UDL) framework is a research derived collection of teaching concepts that encourage instructors to be proactive, rather than reactive in creating learning experiences that meet the needs of the most diverse student audience as possible (Ok et al., 2017; Rao, 2015). Built upon scientific research exploring how people learn, the UDL framework guides educators to consider the why, what, and how of learning and is a method for designing instruction that considers the neurodiversity of students (Rao & Meo, 2016; Schreffler et al., 2019). The representation strategic network which makes up one third of the UDL framework directs instructors to convey information through multiple means such as visual, auditory, and textual methods which is exactly what digital video is capable of doing (CAST, 2018). According to the UDL framework
digital video is an effective combination of teaching technique and technology for assisting a wide range of students with their learning processes.

The UDL framework addresses the broad impact digital video can have on student learning; however, it does not examine the specific mechanisms or design elements of a video that may impact student learning. Developed by Richard Mayer and others, the Cognitive Theory of Multimedia Learning (CTML) provides a theoretical background that explains why digital video supports learning. CTML states that multimedia, which is the use of words and pictures together, is a more effective way of learning than words alone or pictures alone (Clark & Mayer, 2016). Mayer (2019) identified and situated 11 multimedia design principles inside three types of cognitive load. When the design principles are incorporated into video design, researchers have demonstrated through mostly experimental, laboratory-based studies that they lead to improved learning outcomes for students (Mayer, 2014a; Rudolph, 2017). Since the CTML design principles lead to improved learning, I wanted to know how instructors were choosing to implement them into the digital videos they created for online courses.

Positionality

As an educator, instructional designer, and a creator of over 100 instructional videos, I have a personal and professional interest in exploring how and why higher education instructors use CTML design principles in their instructional videos. Ultimately, I seek to inform future practice and possibly improve the implementation of instructional videos in learning environments. From my first instructional video in eighth grade teaching a scene from the story Shane to my classmates using a VHS recorder, Lincoln Logs, and Playmobil toys to my current use of one-minute instructor update videos filmed with an iPhone, video has been a regular component of my instructional practice. My position towards the subject of instructor-created
instructional video is one of amateur expertise, which is a dangerous position to inhabit as someone with experience, but who is not yet a professional.

According to Herr and Anderson’s (2005) continuum of positionality in action research, I took on the role of insider in collaboration with other insiders because my research participants were instructors who work at the same institution that I do. I support over 150 instructors with online teaching and they look to me for advice regarding teaching techniques, technical tools, and how to combine both to be effective online instructors. As part of my role at the institution, I have conducted at least a half dozen trainings on the use of various video editing software and offered advice to instructors interested in creating their own instructional videos. My position as both an instructional support and an expert comes with certain power dynamics that I will address in Chapter III.

As an instructional designer who has worked with hundreds of instructors at a higher education institution with steadily growing online course offerings, I have firsthand insight into how instructors were choosing to create digital video for use in online courses. I recognized that instructors teach using methods they have experienced and do not typically have training in digital communication and video production skills sets (Dinmore, 2019; Hansch et al., 2015; Schmidt et al., 2013). These findings were evident in the wide variety of instructional digital videos I witnessed while working with instructors. I observed videos instructors created which implemented many of the CTML design principles and other videos that did not. Those observations caused me to question why some instructors were better at incorporating the CTML design principles and how they had learned to incorporate the principles into digital videos they created.
In an effort to answer the questions my observations raised, I sought to investigate instructors of online courses and to identify those who indicated via a survey that they were doing the best at implementing the CTML design principles. This research took on added significance when the COVID-19 pandemic of 2020 caused the entire Higher Education ecosystem in the United States to move to digital instructional models as suddenly all instructors needed to consider the use of instructional video (Hill, 2020). Even though the pandemic forced all instructors to teach in online formats, I intentionally targeted instructors who had chosen to teach online courses prior to the start of the pandemic because I could control for those individuals who had prepared and trained for online teaching and digital video creation. This study was an opportunity to identify the best practitioners in a defined context and attempt to discern what experiences led them to create video that utilized the CTML design principles. If instructors could identify formative experiences that contributed to their implementation of research-based video design principles, it would assist others in higher education in preparing new online instructors to effectively teach online courses.

Rationale for the Study

Since most research on the CTML design principles occurred in experimental laboratory settings using primarily quantitative research methods, there is a need to explore instructors’ practical implementations in online courses (Rudolph, 2017). Educators and educational practitioners would benefit from rich descriptions of local practice in actual instructional settings (Hora & Holden, 2013). Higher education lacks quantitative data about classroom teaching across institutions, has a “weak tradition of studying learning” in the classrooms, and knows little about what happens in classrooms on a broad scale (Bastedo, 2012). There has been little exploration of the origins of instructor teaching knowledge nor the impact of prior experiences...
on the development of instructors’ teaching practices (Lattuca & Pollard, 2016; Oleson & Hora, 2014). Because researchers know little about influences on instructor decision making, exploratory research is needed to identify the space in which the phenomena operate (Hora, 2012).

Problem Statement

Researchers’ investigations of digital instructional video are still at an early stage (Chorianopoulos, 2018). They have focused mostly on Massive Open Online Courses (MOOCs) rather than traditional online instruction (Crook & Schofield, 2017; Guo et al., 2014; Santos-Espino et al., 2016) and on students and not instructors (Kay, 2012; Pan et al., 2012). While it is important to investigate student perceptions of digital video and its impacts on student learning, that research is only addressing half of the digital video learning experience. This approach fails to fully account for the role an instructor plays in the creation of digital video and the subsequent impacts on student learning. There have been no studies solely focused on higher education instructors’ perspectives of digital video use for instruction (Kay, 2012). Published peer-reviewed articles that do discuss instructional video creation tend not to discuss CTML, lack a substantive research backing, and are usually focused on individual or small groups personal reflections (Hughes, 2009; Swarts, 2012; Porter & Tiahrt, 2016; Beheshti et al, 2018). Few researchers have studied how various video editing techniques impact learning (Crooke & Schofield, 2017). More research is needed on how faculty learn to implement technologies like digital video into their instruction (Belt & Lowenthal, 2020). Research describing the extent to which instructors teaching online courses utilize research supported design principle in digital video does not exist.
Purpose of the Study

Given these gaps in the literature, this case study will further illuminate the impact of digital video on online learning through investigating online instructors’ incorporation of the CTML principles on an institutional scale. Thus, the purpose of this explanatory sequential mixed methods study (QUAN → qual) was to develop a case study solely focused on describing instructor implementation of the 11 Cognitive Theory of Multimedia Learning (CTML) design principles in videos created for use in online courses. The case study combined self-reported survey data from an entire institution’s online instructors, interview data from five instructors with the highest self-reported CTML design principles, and CTML design principle analysis data from five video artifacts.

Research Questions

If the purpose of the study is to describe instructor implementation of the 11 CTML design principles, then the key question is to what extent are higher education instructors who create digital instructional video for online learning applying the 11 multimedia design principles of the Cognitive Theory of Multimedia Learning? The following four sub-questions guided this study:

1. Which Cognitive Theory of Multimedia Learning design principles are higher education online instructors incorporating into self-made digital instructional videos? (quantitative)

2. Why do higher education online instructors choose components of digital instructional video production to focus on when creating digital video for use in online courses? (qualitative)
(3) Which CTML design principles appear in higher education online instructors self-selected “best” self-made instructional video? (quantitative and qualitative)

(4) To what extent are CTML design principles an area of focus for higher education online instructors as they create digital instructional video? (quantitative and qualitative)

**Rationale for Methods**

An explanatory sequential mixed method (QUAN → qual) research design combines the strengths of each research method to create “a more complete understanding of the research problem than either approach by itself” (Creswell & Clark, 2017, p. 8). Combining the strengths of both methodologies allowed for a connection or bridge between the quantitative nature of most CTML research with the practical lived experiences and realities of online instructors in higher education. It allowed for the experimental to be linked with the practical. The use of a mixed-methods research design also aligns with my own epistemological orientation. I approached this investigation broadly from a constructivist lens that values multiple perspectives and more specifically with a pragmatic focus (Creswell & Clark, 2017). Coming from this position, research that used quantitative and qualitative methods provided different insights for understanding the problem. Quantitative research methods can provide generalizable, numerically based, and statistically supported insights that apply to populations. On the other hand, qualitative research methods explore individual humans in their natural settings to understand their stories and investigate social phenomena, human interaction, and human behavior (Lichtman, 2013). The combination of considering multiple perspectives, seeking to collect data through multiple methods, and pursuing a question related to real-world practice is a textbook description of a pragmatic worldview (Creswell & Clark, 2017, p. 37).
This explanatory sequential mixed methods study (QUAN --> qual) utilized a survey to measure higher education online instructors’ use of cognitive theory of multimedia learning design principles in self-made digital instructional videos. Five instructors with the highest CTML implementation scores on the survey were selected for semi-structured interviews to gather data for a case study. In addition, those five instructors were each asked to share a single digital video artifact for additional analysis by the researcher for CTML design principle implementation and for themes identified from the interviews. Together the data from the three sources were integrated into a case study to illustrate the instructor incorporation of CTML principles in digital video in a manner that is more robust than if each set of data was investigated independently (Creswell & Clark, 2017). Next, I turn to the justification for the use of survey, case study, and data analysis procedures utilized in this study.

Survey Design

I selected a survey as the tool for measuring trends of the instructors self-reported use of the eleven multimedia design principles as a means of “learning about a population” (Creswell, 2012, p. 376). The use of surveys is a common tool used in research of digital instructional video in practical settings (Bourdeau et al., 2017; Christ et al., 2017; Danielson et al., 2014; Miner & Stefaniak, 2018; Pan et al., 2012; Seifert, 2019). A survey was constructed using a combination of questions I developed, drawing inspiration from related research that explored the application of CTML design principles in a K-12 setting and the evaluation of CTML principles in courseware (Allison, 2015; Jiang et al., 2017). I developed a survey because there is no specific instrument for measuring higher education instructors’ implementation of the 11 CTML design principles. Four instructional design experts reviewed the survey prior to its use, and I asked them to indicate language clarity, question appropriateness, and question comprehensiveness
using a simple yes/no mark for clear or not clear and useful or not useful for each question on the survey. They also had a comments section to provide additional feedback on each question.

**Case Study Design**

The case study method is particularly adept at addressing how and why questions, which in this case are how instructors engage in the video creation process and why they make certain design decisions regarding CTML design principles in instructional video (Merriam, 1998; Yin, 1994). I selected a case study design because it is an appropriate methodological choice when focusing on practical problems (Merriam, 1998, p. 29). Specifically, the case is about the digital video creative process used by instructors of online courses who had the best self-reported use of CTML design principles on the survey. I selected those instructors with the highest ratings because they represent the uppermost bounds of design principle implementation and will assist me in defining the extent to which instructors have implemented the design principles. I can also assume that other instructors will fall somewhere below the standard set by those with the highest rating.

I used qualitative data in addition to the survey data because it allowed for a better understanding of the context and instructor voices than if only survey data was used (Creswell & Clark, 2017, pg. 12; Yin, 2009). Because the information I sought occurred in the past and may have included behaviors and feelings, I selected interviewing as the data gathering technique for this context (Merriam, 1998, pg. 72). Using the 11 CTML design principles as a starting place, I developed a semi-structured interview protocol to explore the creative processes of instructors. It was further refined based on the data reported from the survey to assist in validating the information. A semi-structured format allows for collection of specific information while still allowing me to respond to the perspectives and worldview of the instructor (Merriam, 1998, p.
Choosing to consolidate the interview data into a case study is an appropriate methodological choice when focusing on practical problems (Merriam, 1998, p. 29). This case study has the potential to provide evidence to future instructors on what to do and not do when preparing to create digital video for online learning. It also provides a means of attempting to illustrate the complex influence of an instructor’s lived experiences in the video creation process. Providing evidence of future use scenarios and illustrating complex situations are two justifications for my use of case study methods (Merriam, 1998).

**Data Analysis**

In an explanatory sequential mixed methods design, data analysis occurs in stages, with data from a previous stage informing the next stage in the research process (Creswell & Clark, 2017). After collecting the survey data, I conducted analysis using descriptive statistics, Chi-square tests of independence or a Fisher’s Exact Test between matched CTML design principle questions, and Spearman’s Rank Order correlations between CTML design principles scores. My use of the Chi-Square test was appropriate for data that consists of dichotomous frequencies, with mutually exclusive levels, and unequal sample sizes (Franke et al., 2012: McHugh, 2013). The Fisher’s Exact Test was an appropriate test because I had expected values of less than 5 for some question pairings, and there was only 1 degree of freedom (Kim, 2017). My use of the Spearman’s Rank Order correlations was appropriate because the data is non-parametric (Creswell, 2012, p. 183). Interview data underwent a double coding process. The first round of coding I conducted used hypothesis coding with the CTML design principles as the codes in order to establish connections between survey results and the interviews (Miles et al., 2014, pg. 78). This is an example of deductive coding because, I already have a set of codes established (Miles et al., 2014). The second round of coding I conducted was *in vivo* coding in order to
further probe the interview data for additional insights (Miles et al., 2014, pg. 74). When I conducted the video artifact analysis, I also used hypothesis coding with the CTML design principles as the codes. Throughout the interview and coding process I engaged in a reflective memo process after each step to aid myself in identifying possible influences that I brought to the analysis. The multi-layered coding approach and data collection processes allowed me to form connections between the data and triangulate my findings from the survey results, the interview analysis, and the video analysis.

**Significance of the Study**

The study will assist in describing design issues facing instructors (Bétrancourt & Benetos, 2018). Given the growing number of students taking online courses and the increasing use of digital instructional video in those courses, an enhanced understanding of the realities instructors face when attempting to integrate the CTML design principles would assist educators in improving their use of the principles and thus their educational delivery. Improved educational delivery via enhanced digital video would then lead to improved educational outcomes for students. Researchers have highlighted a need to investigate a larger population than has traditionally been done when exploring instructor perspectives of digital video creation (O’Callaghan et al., 2017). Few researchers have investigated the costs of production, scalability, and return on investment of video creation and use in online courses (Winslett, 2014). When instructors develop video, the process can be complex and time consuming. If I can identify commonalities among instructors who have a high rate of CTML design principle incorporation in their videos, it may assist in the development of improved training methods, which in turn would lead to more efficient video production for future instructors.
Limitations

While there are a numerous potential positive impacts of this study, there are also some limitations to consider. The study was conducted at only one higher education institution which allows for results to be contextually situated, but also necessitates future replication of the study to further support and validate the results. I was an employee of the institution at which the study was conducted which increases the risk of interviewer bias (Jager et al., 2020). Because the survey involves self-reported data, there is a possibility participants’ responses were impacted by social desirability bias (Jager et al., 2020). Additionally, the study was conducted during the COVID-19 global pandemic which significantly impacted teaching and learning in higher education (Hill, 2020). The additional stresses of this time period may have impacted the results of this study.

Definition of Terms

In this section, I will define the relevant terms from the Cognitive Theory of Multimedia Learning and higher education that are used in this study:

Coherence Principle

Instructors include only those elements needed to meet the learning objective in a multimedia product (Mayer, 2019).

Digital Instructional video

A multimedia product created using computer technologies that teaches conceptual knowledge using visual and verbal components (Expósito et al., 2020; Fiorella & Mayer 2018).

Embodiment Principle

Use natural human gestures in a multimedia product (Mayer, 2019).
**Essential Cognitive Load**

Cognitive processing done by an individual to represent or make meaning of the learning content (Mayer, 2019).

**Extraneous Cognitive Load**

Cognitive processing done by an individual of information that is irrelevant to the learning goal (Mayer, 2019).

**Instructor**

A tenure track or adjunct professor listed as the teacher of record for a course at an institution of higher education.

**Intrinsic Cognitive Load**

Cognitive processing caused by an individual’s efforts to make meaning of the learning content (Mayer, 2019; Sweller, 2020)

**Modality Principle**

Present words as spoken narration in a multimedia product (Mayer, 2019).

**Multimedia**

Presenting words and pictures together (Mayer, 2014a).

**Online Learning**

“Instruction delivered on a digital device that is intended to support learning” (Mayer, 2019, p. 152).

**Personalization Principle**

Narration should use a conversational talking style in a multimedia product (Mayer, 2019).
Pre-training Principle

Provide terms and definitions of key concepts for learners prior to their viewing of a multimedia product (Mayer, 2019).

Redundancy Principle

Do not narrate onscreen text in a multimedia product (Mayer, 2019).

Retention

A learner’s ability to remember information (Mayer, 2014b).

Seductive Details

Additional interesting words or graphics added to multimedia which are unnecessary for meeting the learning goal (Mayer et al., 2020).

Segmenting Principle

Break a multimedia product into user-controlled parts (Mayer, 2019).

Signaling Principle

Highlight important information in a multimedia product (Mayer, 2019).

Spatial Contiguity Principle

On-screen text and related images should appear near each other in a multimedia product (Mayer, 2019).

Temporal Contiguity Principle

Related narration and images are synchronized so they occur at the same time in a multimedia product (Mayer, 2019).

Transfer

A learner’s ability to apply information in new contexts (Butcher, 2014).
**Voice Principle**

Use of natural, friendly human voice in a multimedia product (Mayer, 2019).

**Summary**

The use of digital instructional video in higher education online courses is growing. Digital instructional video addresses the UDL principle of multiple means of representation and can serve as a method for fostering connections between students and instructors. The Cognitive Theory of Multimedia Learning and the 11 design principles that are derived from it explain how students can learn from digital instructional video. Recognizing the diversity of instructor experiences with digital video creation and use, I sought to investigate the individuals who were best incorporating the CTML design principles. After finding significant gaps in the literature on how instructors create video, I designed an explanatory sequential mixed methods study (QUAN → qual) to collect data via a survey, five semi-structured interviews, and video artifact analysis in order to create a case study to connect the experimental elements of CTML with the practical applications of instructors. This study will assist the higher education online learning field with improving video creation and use to the benefit of future students. In the next chapter, I will review the literature of the theoretical framework for my research which combines the Cognitive Theory of Multimedia Learning with Constructivist Learning theory and address the current state of digital instructional video use in online education.
Chapter 2: Literature Review

Educators have used video in education for over 100 years, but the ability for individual instructors to create their own instructional videos is a relatively new phenomenon brought on by technological advances that have reduced the cost and complexity of tools needed for video creation (Bétrancourt & Benetos, 2018; Saettler, 1990). In the nascent field of digital instructional video, researchers have primarily focused investigations on the impact of video on students and have not studied instructors (Kay, 2012; Pan et al., 2012). In this chapter, I review the disparate collection of research that supports this investigation. I begin this literature review with an introduction of the theoretical framework which combines Constructivist Learning Theory and the Cognitive Theory of Multimedia Learning. After explaining the two theories and their compatibility, I will outline the state of research in digital instructional video and efforts to develop an instructional video classification system. Then, I will identify areas for investigating how instructional video improves learning before focusing on the 11 design principles that researchers have derived from the Cognitive Theory of Multimedia Learning before concluding with an overview of three models for investigating instructor decision making.

Theoretical Framework

The research process combined two different theoretical lenses. The first theory, Constructivist Learning Theory, provides a broad and flexible lens for investigating the impact of higher education (HE) instructors’ lived experiences on the process of creating instructional videos and addresses the multitude of inputs instructors incorporate into the video creation process. The second theory, the Cognitive Theory of Multimedia Learning (CTML), provides a lens for analyzing the learning effectiveness of recorded instructional videos. The theory frames
the analysis of the outputs of the creative process. Taken together, the two theories help to illuminate the relationships and interactions between a creator and the video they create.

Figure 1 demonstrates how I applied the two theories to the investigation of the input and output of an instructor’s creation of digital video for online courses. On the left side of Figure 1 are components of Constructivist Learning Theory that could contribute to the video creation process. The exact composition and influence of those elements are as unique as each individual instructor. A dashed circle represents the fluid nature of the video creative process which leads to an output of a digital video. The design principles of the Cognitive Theory of Multimedia Learning (CTML), organized by cognitive load, are the mechanism for analyzing the video. Specifically, students have a greater likelihood of learning effectively from video in which more CTML design principles are present. Both theories taken together allow for the analysis of data on creative processes and outputs.
Note. Elements of Constructivist Learning theory on the left impact the video creation process and appear as Cognitive Theory of Multimedia Learning design principles in the video itself.

**Constructivist Learning Theory**

Each time an instructor creates a digital video, they are literally constructing their own understanding of a topic. The created video is as unique as the set of lived experiences that the instructor draws on when creating it (Tam, 2000). Constructivist learning theory provides the broadest possible lens through which to investigate those influences on that creative process because it encompasses multiple perspectives (Amarain & Gihsan, 2013). Since instructor use of instructional video for online courses is under-researched, utilizing the broadest possible theoretical lens is important for maximizing opportunities to capture possible impactful events, situations, or experiences (Kay, 2012). Whereas adult learning theory is focused on explaining how adults learn, constructivist learning theory encompasses the complete set of life experiences...
making it appropriate to use with both adults and children because it does not distinguish between pedagogy and andragogy (Alfred et al., 2013; Narayan et al., 2013).

In this research, the instructor takes on the role of the learner, which Constructivist theory views as key to the learning process (Tam, 2000). The central tenet of constructivist learning theory is that an individual constructs knowledge by integrating new information and building upon previous learning (Bada & Olusegun, 2015). An instructor develops their own understanding of how to create an instructional video over time, building on their previous knowledge. The knowledge construction process has two primary assumptions: (a) individuals must use their previous knowledge, which includes cultural knowledge and experiences, in the knowledge construction process (Merriam & Caffarella, 1999), and (b) the learning process is active (Bada & Olusegun, 2015). Social interactions with other individuals are a component of the active process (Tam, 2000). Ultimately, the learner or in this case the instructor remains in control of when and how learning about video creation occurred (Hannafin, 1992). Tam (2000) described this constructivist learning process best saying, “Learning is determined by the complex interplay among learners’ existing knowledge, the social context, and the problems to be solved” (p. 52).

While constructivism is applicable to both teaching and learning situations, I focused the study on the elements of the theory that address teaching (Narayan et al., 2013). The theory has two distinct branches, psychological constructivism and social constructivism (Richardson, 2003). This investigation will utilize psychological constructivism which situates the creation of knowledge first in an individual and then in society. This position is in contrast to Vygotsky’s concept of social constructivism which places knowledge construction in society first and then in the individual (Amineh & Asl, 2015; Narayan et al., 2013). Piaget first articulated psychological
constructivism which incorporates three processes experienced by a learner: (1) assimilation, (2) accommodation, and (3) equilibration (Piaget, 1977; Narayan et al., 2013; Tam, 2000). Individuals navigate the process of integration of new knowledge and experiences into their current understandings, adjusting their understanding of the world where necessary for their own individual mental balance (Piaget, 1970). Assimilation, accommodation, and equilibration processes provide three stages to situate instructors’ experiences of learning to create instructional video.

Two other theorists contributed to psychological constructivism, John Dewey and Jerome Bruner. Dewey argued that reflection only occurs in a learner if it ultimately leads to action stating that learners first thought and then articulated their ideas (Narayan et al., 2013; Rodgers, 2002). Applying Dewey’s ideas to this study, an instructor first considers creating a video and then does it. The second theorist was Bruner who expanded on Piaget’s concepts with four additional considerations of (1) willingness to learn, (2) spiral organization, (3) generation, and (4) social contexts (Bruner & Austin, 1986; Amineh & Asl, 2015). The value of constructivism as a theory is its flexibility to potentially explain a wide array of possible experiences that impact an instructor’s video creative processes; however, the theory does not address the outputs of the process. I needed a second theory to explain how design elements of video can impact student learning.

*Cognitive Theory of Multimedia Learning*

Understanding how design elements of digital video impact and support learning assists with evaluating the aspects of video production that instructors consider when creating digital video. The Cognitive Theory of Multimedia Learning (CTML) provides a theoretical background that explains why elements of digital video support learning. The Cognitive Theory of
Multimedia Learning (CTML) states that multimedia, which is the use of words and pictures together, is a more effective way of learning than words alone or pictures alone (Clark & Mayer, 2016; Mayer, 2014a). Mayer along with others developed CTML over the last thirty years with refinement continuing to this day. Baddeley’s (1986) theory of working memory, Paivio’s (1986) dual coding theory, and Paas & Sweller’s (2014) cognitive load theory all contributed to the development of CTML. Each authors’ work contributed to the three assumptions found in CTML about how individuals learn.

The first assumption is the *dual channel assumption* which states that individuals use an auditory channel via their ears and a visual channel via their eyes to process incoming information. The auditory channel processes sounds, music, and spoken words while the visual channel processes images, written words, and moving images or video (Mayer & Moreno, 1998; Swerdloff, 2016). This processing occurs in what Sweller (2005) called sensory memory. Sensory memory holds the incoming auditory or visual representation experienced by the learner for just a brief moment of time before passing information along to working memory (Mayer, 2014b; Schnottz, 2014; Sorden, 2012).

The *active processing assumption* is that individuals are actively working to construct understanding or knowledge through an organizational process of integrating new knowledge coming from the sensory memory with prior knowledge stored in long term memory (van Merriënboer & Kester, 2014). An individual's long-term memory retains information in an organized structure called a schema. (Van Merriënboer & Kester, 2014) An individual can recall information from a schema more easily than new information (Sorden, 2012; Sweller, 2005). The process of adding new information to a schema occurs in working memory where a learner
processes information from sensory memory with information from long term memory (Mayer, 2019; Sorden, 2012).

The limited capacity assumption is that individuals have a limited amount of working memory capacity to engage in the knowledge-making process (Sorden, 2012). Because working memory is where knowledge creation is taking place, an instructor who creates learning scenarios that maximize its efficiency will ease the learning process for students (De Jong, 2009). Cognitive load is the term used to describe the capacity of working memory and it is also made up of three components:

(a) Extraneous cognitive load refers to an individual’s processing of incoming information not related to the learning goal. Thus, video creators should minimize or eliminate elements contributing to extraneous cognitive load.

(b) Intrinsic or essential cognitive load is the processing an individual uses to organize new information. Video elements that assist the learner with organizing information work to enhance essential cognitive load.

(c) Germane cognitive load is the process of making sense of the new information (Mayer, 2019; Paas & Sweller, 2014; Sorden, 2012).

Mayer identified and situated 11 multimedia design principles inside of the 3 areas of cognitive load. The 11 principles are backed by quantitative research conducted primarily in laboratory settings (Rudolph, 2017). When an instructor implements these 11 design principles into multimedia, the principles assist in maximizing an individual’s opportunity to learn (Mayer, 2019). The design principles do have limits called boundary conditions after which their effectiveness at assisting individuals with the learning process may diminish (Mayer, 2019; Sorden, 2012). Boundary conditions describe different learning contexts that may occur such as
novice learners versus experienced learners. For example, one of the design principles states that learners should be introduced to key vocabulary prior to viewing a video. The effect of this principle is greater on learners with low prior knowledge than those with high prior knowledge. Thus, researchers consider prior knowledge a boundary condition for that principle (Mayer, 2014a).

**Theory Compatibility**

Constructivism and the Cognitive Theory of Multimedia Learning (CTML) are compatible with each other and are combined in this study to create a theoretical framework to analyze instructor experiences in the digital video creation process for online courses. Piaget’s constructivist theory has been called cognitive constructivism, a connection that established the compatibility of Constructivism and CTML (Amineh & Asl, 2015; Egbert & Sanden, 2014; Narayan, et al., 2013). There are several neuroscientific studies documenting how people’s brains change in relationship to different experiences, forming a connection between brain development research and the learning experiences articulated in constructivist learning theory (Brooks, 2013). The concepts identified in both theories relating to how information is integrated into schema are similar. Mayer has also argued that the cognitive theory of multimedia learning is congruent with constructivism and has even titled an article, “Maximizing Constructivist Learning from Multimedia Communication by Minimizing Cognitive Load” (Mayer, et al., 1999). Constructivism provides me with a lens for analyzing an instructor’s creative process, editing decision making, and the impacts of their lived experiences on the creation of a digital video, while the cognitive theory of multimedia learning is the theoretical lens I used for evaluating the video’s learning effectiveness for students.

**Areas of Research Focus**
The study of digital instructional video and learning is new (Chorianopoulos, 2018). Currently, there is limited research regarding how individuals learn from digital video in real-world settings (Fyfield et al., 2019; Hansch et al., 2015). Educators have used films for educational purposes going back to at least 1910 (Saettler, 1990). Since that time, even with a burst of research activity on the use of video and learning in the 1970s and 1980s, there have been no studies solely focused on higher education instructors’ perspectives of digital video use for instruction (Bétrancourt & Benetos, 2018; Kay, 2012). Additionally, there is a lack of research on how various video editing techniques impact learning (Crooke & Schofield, 2017). Researchers have not thoroughly investigated instructor decision making on video use for education (Winslett, 2014). The dearth of instructor focused research may be due to the variety of both video types and usage opportunities currently available. Instructors use digital instructional video in higher education for lecture capture (Danielson, et al, 2014; Hadgu, et al, 2016; Bourdeau, et al, 2017; O’Callaghan et al., 2017; Miner & Stefaniak, 2018; Seifert, 2019), massive open online courses (MOOCs) (Guo, et al, 2014; Santos-Espino et al., 2016; Crook & Schofield, 2017), blended or flipped learning (Lo et al., 2017; Lee & Choi, 2018), and online learning (Pan et al., 2012). When there has been research conducted about the use of digital video, the focus has been on students and not instructors (Kay, 2012; Pan et al., 2012). The field of research in digital video is new, fragmented among instructional types, and not currently focused on instructors.

**Digital Instructional Video Classification**

The youthful nature of digital video research has led researchers to focus on classifying digital video. A clear and descriptive classification framework would assist in evaluating the elements or components that instructors consider as they create video. There is considerable
variation in how researchers have attempted to classify digital instructional video accompanying the diffusion of research contexts and approaches. There is disagreement among researchers over differentiating between human presence, media style, and pedagogical technique when creating means of classification. An early attempt divided instructional video into four categories of Engaging, Doing, Saying, and Seeing. The four categories focused around styles and pedagogical techniques (Schwartz & Hartman, 2007). Kay (2012) conducted a literature review on instructional video podcasts which also identified four classifications for instructional video. These classifications were primarily focused on the type of media found in the videos and Kay described them as lecture based, enhanced, supplemental, and worked examples. Kay also broadly defined three pedagogical approaches as (a) students viewing videos, (b) videos that demonstrated how to solve a problem, and (c) students creating their own videos. Winslett (2014) created a conceptual framework organized into thirteen outcomes and eleven production styles; however, the outcomes category mixed pedagogical approaches with justifications for using digital video which diluted the systems organizing power. Two other groups of researchers created classification systems that mixed pedagogical approaches and media styles (Majid et al., 2012; Guo et al., 2014). As the field evolved, the classifications became more nuanced and complex. An investigation of video in MOOC courses identified 18 categories that mixed media, locations, and human presence concepts (Hansch et al., 2015).

A continuum approach evolved out of the earlier classification work. The first was a classification of MOOC video’s primary content delivery mechanism on a spectrum from speaker-centric to board-centric (Santos-Espino, et al, 2016). Expanding on that idea further, Chorianopoulos (2018) created a taxonomy of instructional video that utilizes a two-way axis system with human embodiment on one axis and instructional media on the other. Each axis has
digital as one extreme and physical as the other. This two-way axis system is the closest the field has come to reaching an overarching framework. Chorinaopoulos intentionally chose not to attempt to create a framework that encapsulates pedagogical concepts because the wide variety of approaches made it too difficult. The lack of a pedagogical framework is a concern. Researchers should analyze educational video based on specific identified learning objectives as there are different values for different audiences (Laaser & Toloza, 2017; Bétrancourt and Benetos, 2018). Further exploration of instructor considerations while creating digital video may assist in the creation of a pedagogical taxonomy to accompany the human embodiment and instructional media classification system.

**Identifying How Digital Video Improves Student Learning**

With the need for research focused on instructors and a description of how to classify digital video addressed, I now turn to the three areas of thought for exploring when and why digital video improves learning. Higher education instructors are not creating digital video in a vacuum. They are working in the context of specific learning situations. If I am going to analyze instructors digital video creation processes, the analysis requires a method for addressing when and why digital video enhances learning. Bétrancourt and Benetos (2018) defined three categories of research emphasis that attempt to address those questions. The first is what they call the representational approach which explores the signs and symbols as well as the communication properties of video in comparison to other formats. This approach is less studied than the other approaches. Since the instructors have already decided to use digital video with their instruction, the assumption is that they recognize video will improve student learning and as such this category is not explored further. The second category is instructional approach which addressed the videos’ settings, purposes, and genres. Video used for educational purposes can be
considered a meta-genre because it encapsulates a broad array of techniques, conventions, and production styles (Winslett, 2014). Bétrancourt and Benetos (2018) identified four instructional techniques including using video as an engagement tool, for tutorials, for observing professionals in complex situations, or having students create their own video. The instructional approach category is closely related to the classification discussion I addressed earlier in the review and does not need further elaboration. The third category of research emphasis, called the cognitive and perceptual approach, is the most researched of the three categories and is best represented by the Cognitive Theory of Multimedia Learning (CTML).

**Cognitive Theory of Multimedia Learning Design Principles**

Before I can evaluate the aspects of video production that higher education instructors consider when creating digital video, I sought to understand how design elements impact and support learning. The Cognitive Theory of Multimedia Learning (CTML) provides a theoretical background that explains why elements of digital video support learning. Richard Mayer is one of the primary theorists articulating the concepts of CTML and has done extensive work both investigating design principles and summarizing their impacts. Mayer identified and situated 11 design principles inside the 3 types of cognitive load that instructors should address as part of effective instruction (Mayer, 2019).

**Extraneous Cognitive Load**

There are five multimedia design principles of the Cognitive Theory of Multimedia Learning which address extraneous cognitive load. The first is the *coherence principle* which states that multimedia should only include those items necessary for meeting the identified learning objective and nothing else (Mayer & Fiorella, 2014). A small meta-analysis of 23 experimental studies addressing the coherence principle had a median effect size of 0.86 (Mayer,
An additional meta-analysis of 58 studies with 7521 participants found that students exposed to seductive details which were irrelevant to the learning focus had lower learning performance on assessments (Sundararajan & Adesope, 2020). Instructors who incorporate music into digital video may or may not be creating a seductive detail depending on their intended purpose and how the music relates to the learning objective associated with the video. Some researchers found that incorporating music negatively impacts cognitive tasks while others reported that music had positive effects (Gunnell, 2017). While music is just one example of how researchers are defining boundary conditions for the coherence principle, other areas include differences between static versus dynamic presentation, language, and subject of the video (Sundararajan & Adesope, 2020).

The second principle is signaling or highlighting important information (Mayer, 2019; van Gog, 2014). A review of 103 peer-reviewed quantitative studies on signaling between 1970 and 2016 found that 117 out of 139 effect sizes were positive in favor of signaling principles (Schneider, et al, 2018). An additional meta-analysis of 29 experimental studies with 2726 individuals found a .38 effect size at the \( p<.01 \) significance level in favor of signaling increasing learning outcomes (Alpizar et al., 2020). Boundary conditions for the signaling principle include content-specific prior knowledge, pacing of the video, static versus moving images, complexity of signaling needs, and the distinctiveness of the signals themselves (Richter et al., 2016).

The redundancy principle says that on-screen text should not duplicate narrated text (Kalyuga & Sweller, 2014; Mayer, 2019). There are mixed results regarding the effectiveness of this principle in the research literature. A meta-analysis of 33 studies found no statistically significant difference between conditions with redundant conditions versus those without (Adesop & Nesbit, 2012). A more recent analysis found a 0.86 effect size across 16 experimental
The mixed results may have more to do with a variety of possible boundary conditions such as learner prior knowledge, spoken text with printed text and no graphics, using just one or two words with graphics, learner age, and on-screen text worded differently than narration (Ari, et al., 2014; Fenesi, 2015; Mayer, 2017). However, one identified exception to this principle is subtitles for those whose primary language is not the language of the video (Mayer et al., 2020).

The final two learning design principles that address extraneous cognitive load are closely related. The spatial contiguity principle states that people learn better when instructors present related words and images near each other in multimedia and the temporal contiguity principle states that people learn better when instructors synchronize spoken words with related visual images (Mayer & Fiorella, 2014; Mayer, 2019). A meta-analysis of 71 studies that built on a previous meta-analysis conducted by Ginns (2006) found an overall statistically significant effect size of .63 in favor of the spatial contiguity principle’s application in multimedia for the improvement of learning outcomes (Schroeder & Cenkci, 2018). Mayer (2019) also reported a large median effect size of 1.10 across a smaller set of 22 experiments investigating applications of the spatial contiguity principle. Nine experimental studies demonstrated temporal contiguity had a median effect size of 1.22 in support of improved learning outcomes for students (Mayer, 2019). A recently completed study reaffirmed the learning benefit of congruent presentation of information in spoken and visual forms (Khacharem et al., 2020).

**Essential Cognitive Load**

The Cognitive Theory of Multimedia includes three multimedia design principles that address essential cognitive processes. The pre-training principle states that individuals will learn more effectively if instructors provide them an opportunity to learn key terms before viewing
multimedia (Mayer & Pilegard, 2014). A median effect size of 0.75 was calculated from an analysis of 16 experiments evaluating the impact of pre-training on learning outcomes (Mayer, 2019). A separate meta-analysis of five different pre-training methods also found positive effects on learning outcomes (Mesmer-Magnus & Viswesvaran, 2010).

The *modality principle* states that text in audio form is better than text as words on a screen. There is a debate about whether this principle is applicable (Low & Sweller, 2014). Mayer reported that 42 out of 51 experiments had a median effect size of 0.72 in favor of the principle (Mayer, 2017) while an earlier meta-analysis that analyzed the results of 57 studies found in 33 articles did not find a significant difference (Adesope & Nesbit, 2012). A recent meta-analysis dissertation that analyzed 41 studies found positive effects for verbal segment length and types of visualizations, but not for pace of narration suggesting possible boundary conditions for future research (Ye, 2018).

The *segmenting principle* says that instructors should divide multimedia content into small segments to assist individuals with their learning (Mayer, 2019; Mayer & Pilegard, 2014). A meta-analysis of 56 investigations evaluating the segmenting principal’s impact on retention, transfer, and cognitive load found statistically significant effect sizes of 0.32, 0.36, and 0.23 respectively in favor of segmenting (Rey, et al, 2019). The segmenting effect appears to have a greater impact with video elements with a higher degree of visual complexity as compared to those with lower visual complexity (Hasler et al., 2007). The effect of segmenting may also diminish as the expertise of the viewer in relation to the video content increases (Khacharem et al., 2013).
**Germane Cognitive Load**

Three multimedia principles from the Cognitive Theory of Multimedia Learning address germane cognitive load. The *personalization principle* requires the use of a conversational style of talking and writing in multimedia (Mayer, 2019). Mayer (2019) reported that 17 experiments have demonstrated a median effect size of 0.79 in support of this principle. A meta-analysis of 30 studies evaluating retention and 25 studies measuring transfer in cases using the personalization principle found positive effects of 0.30 and 0.54 respectively in favor of the principle (Ginns et al., 2013). A study exploring the impacts of human like teachers using conversational and formal talking styles in multimedia instruction among 98 Chinese students found that using a conversational style supported retention, but not transfer. The research team suggested that learners’ emotional state may be negatively impacting transfer, which suggests emotional state as a boundary condition (Lin et al., 2020).

The next principle is *embodiment* which is the use of human gestures in multimedia recording. Eleven studies demonstrated a median effect size of 0.36 presenting moderate evidence in support of this principle (Mayer, 2019). One study found significant differences in learning performance on a delayed posttest among a group of 17 college students who had received instruction from a video containing visual embodied social cues as compared to a group of 14 students who received no embodied social cues (Wang & Crooks, 2015). Another experimental study investigated the learning differences between multimedia in which an instructor gazed at information versus directly pointing at information. The results indicated that directly pointing at information led to a statistically significant different in retention and transfer over multimedia with no social cues (Pi et al., 2019). The embodiment effect also appears to diminish if the voice principle is not applied in conjunction with it (Mayer, 2014c).
Voice is the final multimedia principle which says that a friendly human voice is better than computerized ones. Six experiments with a median effect size of 0.74 support this finding (Mayer, 2019). A qualitative analysis of instructional videos used in flipped mathematical courses affirmed these three principles. Instructor-created videos where the instructor talked while using fluid human handwriting were more engaging for students in the study than sterile computer fonts or other computerized elements (Lo, et al, 2017). As computerized voices have become more lifelike, the impact of this principle may be diminishing (Craig & Schroeder, 2019).

**Instructor Instructional Decision Making**

As evidenced by the research I addressed above, most of the exploration into CTML has been conducted in experimental laboratory settings using primarily quantitative methods (Rudolph, 2017). Because there is no research exploring how the design principles are translated into actual instruction, we now shift focus to the literature addressing instructor decision making as a means of connecting the experimental with the practical. We start with a model that explains why instructors adopt certain technologies for instructional use, turn to case study methods that have attempted to articulate the complexity of instructor decision making, and end with a holistic model that tries to capture the breadth of impacts on instructor decision making.

**Technology Adoption Model**

Instructor decisions to utilize technology may be closely related to instructor decisions to incorporate instructional video design principles. One model which explains instructor technological decision making is the Technology Adoption Model (TAM). According to TAM instructors consider the perceived usefulness and the perceived ease of use of a new technology
when deciding whether to use a technological tool (Davis, 1989). Researchers combined TAM with additional related models to create the Unified Theory of Acceptance and Use of Technology (UTAUT) which includes four determinants that predict technology use (Venkatesh et al., 2003). The first determinant is performance expectancy or the extent to which an individual believes that using a technology will assist them in their job performance. In the context of this study, that idea is represented in an instructor’s belief that a design principle will help them be an effective educator. The second determinant is effort expectancy or the ease of using a technology. For instructors creating video this could be the relative difficulty of incorporating a design principle. The third determinant is social influence which is “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al., 2003, p. 451). For instructors using video this would be the influence of other individuals who use CTML design principles. The fourth determinant is facilitating conditions or the organizational and technical infrastructure that supports the use of the technology. With instructors this would address the technologies available at their institution as well as the support structures in place. The UTAUT model is focused on initial decision making and is not as adept at addressing ongoing instructor decision making as would occur with digital video creation.

**Complexity of Instructor Decision Making**

The research literature addressing ongoing instructor decision making reveals considerable complexity in potential influences. Planning for instruction involves complicated cognitive processes such as mental representations, routines, and decision-making rules (Borko, et al., 2008; Shelton, 2018). Individuals internalize information and experiences, eventually converting them into schema through repetition, reinforcement, and attachment to key life experiences or emotions (Hora, 2012). These developed schemata are then called upon when
instructors encounter new situations to assist in the decision-making process (Klein, 2008). This is a theoretical explanation for the process of transfer that is related to the one described in CTML. In a review of the literature Kane, Sandretto & Heath (2002) reported that instructors have beliefs from their previous schooling experiences which act as filters of new incoming information about teaching. These beliefs contain both general concepts of teaching and specific ideas about their instruction in their specific contexts. Instructors rely on those previous experiences because they typically have little or no formal teaching training. Instructors also react to different contextual situations deploying different decision-making strategies to fit different contexts. The constraints of the operating environment, task requirements, and the target group characteristics all influence an instructor’s media decision making (van Merriënboer & Kester, 2014).

Instructors acquire the experiences that make up their schemata through a series of different contexts. Two related case studies attempted to delineate the complicated contexts and cognitive processes that influence instructor decision making. The authors of the first case study collected data from 40 math and science instructors of undergraduate courses. They found four factors influenced instructors’ decision-making and contributed to a likelihood of utilizing a technology in their instructional practice: (1) strong alignment between an instructors pre-existing beliefs and their goals, (2) ability to relate prior experiences to a current scenario, (3) identification of the perceived affordances of a tool, and (4) supportive cultural conventions of the instructor’s discipline (Hora & Holden, 2013). The authors of a second case study of 53 math and science instructors of undergraduate courses at three large, public research universities found seven concepts influenced instructor decision making: (1) instructors relied on previous related experiences as an instructor to inform decisions, (2) prior classroom experiences where they used
trial and error techniques, attended to how students responded, and adjusted accordingly to settle into a preferred teaching method, (3) professional development experiences that expanded their teaching knowledge, (4) reflections on feedback from peers and particularly from students, (5) interactions with other instructors from whom they borrowed ideas they identified as “good”, (6) their own student experiences including how they best learned as a student and the pedagogies they experienced, and (7) experiences from research including research they were exposed to and research they conducted (Oleson & Hora, 2014). Both case studies highlight the diverse array of instructor-connected contexts that could be possible influences on instructor decision-making processes during video creation.

**Ecological Model**

Both TAM and the identified influences rely on an individual focus of analysis which fails to completely capture the broader contexts in which an instructor operates. Woolfolk-Hoy, Davis, and Pape (2006) articulated an ecological model that conceptualized influences on primary and secondary teacher decision making as a series of “nested ecosystems” or rings emanating out from the individual. The model started with the instructor and their identify or sense of self. Around the self is the immediate instructional context which included students, content, and the instructional spaces. The next ring surrounding the self and instructional context is the state and national context and the outer most ring encompassed cultural norms and values. Shelton (2014) expanded and refined the ecological model for use in higher education drawing on semi-structured interview data collected in a multisite case study. Shelton divided the immediate instructional ring into a departmental context ring and an institutional context ring separating the influences of an instructor’s specific department and institution. Shelton also converted the state and national context ring into a ring for influences from the field of higher
education. Two other contexts were added which crossed through multiple rings of influence acting like a second axis for the model. The first cross ring context is Subject and Discipline which spans from self through the higher education sector context and attempts to capture the influences of an instructor’s discipline throughout those spaces. The second cross context element was professional context which also started in the self ring and spanned out to the furthest society and culture ring. Further research would assist in clarifying whether the two cross-context concepts should be incorporated into the furthest contexts they touch or remain as cross contextual elements. The value of this model is its ability to situate influences at different depths from the instructor while still capturing a broad array of possible influences.

Summary

Instructors create digital videos for use in online courses in specific contexts drawing on their own unique experiences. To investigate instructors’ creation of digital video, I am using a theoretical framework which combines the broad lens of constructivist learning theory with the cognitive theory of multimedia learning to explore the inputs and outputs of the process. CTML assumes learners manage three types of cognitive load as they learn, and instructors should employ eleven multimedia design principles to address the different types of cognitive load. The study of digital instructional video is new and there are many elements such as editing techniques and instructional decision making that have not been studied. Frameworks for classifying digital instructional video are slowly improving which will assist in the evaluation of digital instructional video. Researchers have thoroughly researched the eleven design principles in experimental settings and most design principles have a meta-analysis demonstrating significant positive effect sizes on learning. Research into the design principles continues with efforts underway to identify boundary conditions where the effects dissipate or stop being
effective at improving learning. While there is no specific research addressing instructor
decision-making with instructional video, there are numerous models addressing different
components of instructor decision-making such as the technology adoption model and the
ecological model.
Chapter 3: Methodology

The purpose of this explanatory sequential mixed methods study (QUAN qual) was to develop a case study solely focused on describing instructor implementation of the 11 Cognitive Theory of Multimedia Learning (CTML) design principles in videos the instructors created for use in online courses. In this chapter, I will discuss why I selected a mixed methods approach before stating the sub-research questions and justifying the study design. Next, I will overview the study setting, my own bias, and the generalizability of the study. Then, I will describe the three instruments I used to collect data; (a) survey, (b) semi-structured interview protocol, and (c) video artifact analysis protocol, before discussing how I addressed validity and reliability concerns. After a detailed examination of the research procedures which occurred in three phases, I will end this chapter with a brief discussion of five potential limitations and the steps I used to protect the study participants.

Pragmatic Approach to Mixed Methods

My choice to utilize a mixed methods approach had its roots in my own epistemological and theoretical orientations. I am a pragmatist who subscribes to a rejection of the post-positivist view, that there is no such thing as a value-free, neutral, unbiased researcher. Thus, I view knowledge as always provisional in that it remains true until someone else is able to refute, revise, or redefine that knowledge (Holmes, 2020). For example, humanity once believed that the sun revolved around the earth until Copernicus proved otherwise and humanity’s views shifted. My position on evolving knowledge lets me maintain an understanding that there are truths in the natural world, which remains in alignment with my faith; however, our human understanding of them is fallible and open to reinterpretation as new knowledge is discovered. As a pragmatist I view “reality as both singular (e.g., there may be a theory that operates to explain the
phenomenon of study) and multiple (e.g., it is important to assess varied individual input into the
nature of the phenomenon as well)” (Creswell & Clark, 2017, p. 37). This pragmatic perspective
allows for the use of both deductive and inductive reasoning through the course of a research study and it requires that I combine multiple sets of data to adequately answer the identified questions.

Extending from this epistemological orientation, I naturally selected a constructivist approach for a theoretical framework. Each individual human assigns their own meaning to the facts they encounter, which in turn becomes knowledge (Hinchey, 2010, p. 41). For example, two people can view the exact same experience and arrive at vastly different interpretations because they draw on unique and different lived experiences. As Takas (2003) wrote, "Our views may be constrained by the limits of our own experiences" (p. 29). This position of an experience drive, knowledge creation process orients value to multiple perspectives derived from unique individuals.

Finally, my personal experiences as an instructional designer led me to the research questions in this study and those questions are the driver of the study, not the methods. I have a desire to figure out what CTML design principle implementations are ideal for online instructors in real-world practice and not in experimental laboratory settings. If I believe in the use of both deductive and inductive reasoning, the value of multiple perspectives, and the need to seek answers to practical, real-world questions then I have a pragmatic world view, which is one of the “best” worldviews for creating a foundation for a mixed methods study (Tashakkori & Teddlie, 2003).
Mixed Methods

Creswell and Clark (2017) defined mixed methods as the actions of a researcher who rigorously collects and analyzes both quantitative and qualitative data and then integrates that data and the subsequent results via organized and logical procedures grounded in theory and philosophy. The 1959 work of Campbell and Fiske is the earliest instance of mixed methods ideas, but the foundations of the methodological approach took shape during the 1980s and 1990s (Creswell & Clark, 2017; Howard, 2019). In essence, the methodology formed as a means of combining data collected from quantitative and qualitative methods to analyze problems too complex for either method on its own (Creswell & Clark, 2017). A mixed methods approach allows researchers to contextualize numerical data with context and texts from their participants. Since most of the CTML research is based in quantitative methods and I was interested in exploring qualitatively how instructors came to know and apply the CTML design principles, a mixed methods approach was the practical choice (Rudolph, 2017).

Research Questions

As stated in Chapter I, the purpose of this study is to describe instructor implementation of the 11 CTML design principles through the research question: To what extent are higher education instructors who create digital instructional video for online learning applying the 11 multimedia design principles of the Cognitive Theory of Multimedia Learning? The following four sub-questions guided this study:

1. Which Cognitive Theory of Multimedia Learning (CTML) design principles are higher education online instructors incorporating into self-made digital instructional videos? (quantitative)
Why do higher education online instructors choose components of digital instructional video production to focus on when creating digital video for use in online courses? \textit{(qualitative)}

Which CTML design principles appear in higher education online instructors self-selected “best” self-made instructional video? \textit{(quantitative and qualitative)}

To what extent are CTML design principles an area of focus for higher education online instructors as they create digital instructional video? \textit{(quantitative and qualitative)}

\textbf{Explanatory Sequential Design}

Specifically, I chose an explanatory sequential mixed method design (QUAN \rightarrow qual) which is comprised of two distinct segments. As evidenced in Figure 2, the first phase of the design is the collection of quantitative data, which in the case of this study will be derived from the survey of instructor implementation of CTML design principles. The second phase of the study is informed by the results of Phase 1 and is collection of qualitative data, which in this situation will be via a case study of instructors who had the highest levels of CTML design principle implementation as measured by the survey (Creswell & Clark, 2017). The final portion of the design involves interpreting the data collectively via triangulation. This design is an appropriate choice for investigating “positive-performing exemplars” such as the instructors with the highest levels of CTML design principle implementation and for explaining why certain results from the survey data occurred (Creswell & Clark, 2017, p. 109).
Figure 2

Explanatory Sequential Design

Survey Methodology

This study uses survey methodology to help answer the quantitative research questions and to assist in identifying candidates for the case study portion of the research design. Surveys are a common method that researchers use to investigate digital instructional video in practical settings (Bourdeau et al., 2017; Christ et al., 2017; Danielson et al., 2014; Miner & Stefaniak, 2018; Pan et al., 2012; Seifert, 2019). Specifically, I used a cross-sectional survey design or the collection of data at a single time point (Creswell, 2012, p. 377). The survey provided data on characteristics of the population as it related to video use and creation as well as assisted me with identifying individuals for in-depth study during the case study portion of the research project. A survey tool also provided data to measure trends of the instructors self-reported use of the 11 CTML design principles as a means of “learning about a population” (Creswell, 2012, p. 376).

Case Study Methodology

Creswell (2012) defined case study broadly as “an in-depth exploration of a bounded system” and situated the methodology as being part of qualitative inquiry (p. 465). In this study I am utilizing a combination of case study approaches using Merriam’s process and supplementing it with elements of Yin’s sequence that enhance areas of validity and reliability. My decision to emphasize Merriam’s process first and Yin’s second is based on how my epistemological
orientation aligns with both authors. While Yin does not explicitly state a preference, many researchers have identified positivism as his epistemological orientation because of the methodical approach he articulates and the language with which he writes which is in tension with my own perspectives (Bhatta, 2018; Brown, 2008; Harrison et al., 2017; Hyett, 2014; Yazan, 2015). Merriam utilized a constructivist orientation, but one that others have described as more pragmatic because of her suggestion that researchers use procedures which is in alignment with my own orientations (Bhatta, 2018; Harrison et al., 2017). Thus, I seek to complete a case study design that is appropriate, doable, rigorous, and credible (Merriam, 1998).

Among the competing detailed definitions of case study, Merriam (1998) defined case study as “an intensive, holistic description and analysis of a single instance, phenomenon, or social unit” (p. 27). According to Merriam (1998) the key characteristics of a case study are the ability to clearly identify the boundaries of a case based upon an “end product” (p. 27). The case study definitions from Yin (2009) and Stake (1995) focus on process and the unit of study respectively. Since I can clearly denote the boundaries of this case as instructors who have incorporated the most CTML design principles into a video they created for use in an online course and the video is a form of end-product, Merriam’s definition of a case study is most appropriate for this study.

**Approach**

Merriam articulated an approach to case study methodology that incorporated the flexibility of the qualitative research tradition while also providing a structured approach. The method Merriam (1998) described included engaging in a literature review, building a theoretical framework, crafting a research problem with research questions, and selecting a sample with purpose, which are the steps I undertook for this study. Merriam (1998) briefly mentioned
identifying units of analysis as part selecting a sample but did not provide procedural details for that process (p. 60). In addition, the acknowledgment of a need for some flexibility in a case study design fits with my intent to modify interview questions in response to incoming data. My concern with Merriam’s approach arises in the lack of guidance on addressing issues of validity and reliability during the construction of the methodological process and so I turned to the procedures described by Yin (2009) to supplement Merriam’s method.

Yin has a detailed, comprehensive, and scrupulous articulation of case study methodology that follows a rigid structure (Yazan, 2015). According to Yin (2009), a researcher completes the design work of a study at the beginning of the research process and then deviates from it as little as possible through the course of the study. There is a heavy emphasis on logical connection of all components of the research process. The methodological process described by Yin consists of five parts: (1) questions, (2) propositions, (3) unit(s) of analysis, (4) logic connecting data to propositions, and (5) criteria for interpreting the findings (Yin, 2009).

Because I have already utilized Merriam’s approach for identification of questions and propositions, I incorporated Yin’s approach to identify units of analysis and logic connecting data to propositions.

According to Yin, the unit of analysis should evolve from the research questions of the study and so the unit of analysis in this study are instructors who teach at least one online course at a regional comprehensive university and have the highest self-reported use of CTML design principles in an instructional video (p. 30). Within the case I have subcases or subunits of analysis that consist of the five individual instructors which means I am conducting an embedded single case study design (Yin, 2009). A single case study design is appropriate when the rationale is one of an extreme case which is occurring with my investigation of instructors who
have the highest self-reported CTML design principle implementation scores (Yin, 2009, p. 47). The embedded portion is necessary because I am collecting and analyzing data from the five distinct individuals or subunits of the single case. I rejected the multi-case design described by Yin (2009) because I consider the investigated instructors to be operating in the same general context of the case and not in separate contexts, I do not have a framework to explain why certain conditions lead to the occurrence of particular phenomenon, and I am not intending to revisit the theoretical underpinnings of the case.

**Data Collection**

Emphasizing the importance of collecting quality data, Merriam described the data collection process as recursive as the researcher moves through various data collection methods and holistic in attempting to capture the full scope of the phenomenon (Merriam, 1998 p. 134). This study is holistic because it is capturing data through multiple methods across different sources, and it is recursive in that data collected at earlier stages are informing the data collection of later stages. In addition, Merriam advocated for the use of an interview guide comprising the questions to ask participants as a tool for collecting data from interviews, which is a process I followed for this study as evidenced in Appendix D (Merriam, 1998, p. 81). My concern with Merriam’s approach to data collection is its entire reliance on qualitative measures; whereas Yin is an advocate for mixed method approaches that combine quantitative and qualitative data (Yazan, 2015). For example, Yin (2009) described a triangulation style of data collection and an expectation that a previously articulated theoretical framework guides the data collection which are two steps I took in this study. Neither author explicitly stated video as a method for collecting data; however, both did speak to the importance of collecting documentary evidence because of
its stability and ability to corroborate data from other sources (Merriam, 1998, p. 126; Yin, 2009, p. 103).

**Data Analysis**

Data collection in a case study design typically yields troves of information which I would need to distill into a narrative that conveys the essence of the investigated case. According to Merriam (1998) a researcher must go beyond the narrative to also generate conclusions which through categorized connections demonstrate patterns which assist in explaining the investigated case. Thus, I seek to identify patterns across the three sets of data using the 11 CTML design principles, which are variables defined prior to the investigation. Using pre-identified codes is in contrast to the constant comparative process Merriam (1998) advocated for in order to generate naturally emerging categories, but in alignment with the data analysis procedures Yin described which said that a researcher needs to have clear reasons for the initial codes used to analyze collected data which include an obvious connection to the research design (Yin, 2009, p. 128). I have anchored my initial codes in the theoretical framework of the study and created opportunities for their use across all three data sets. The concept of connecting ideas from the three areas of data collection is a form of triangulation which is a concept that both authors articulated as a means of strengthening the reliability and validity of the study (Merriam, 1998; Yin, 2009). I am engaging in two types of triangulation, the aforementioned triangulation of data sources, but also in methods as I am using a mixed methods approach that combines quantitative and qualitative data collection and analysis (Yin, 2009, p. 116). There are three other elements of a high-quality case study that I incorporated in the analysis portion of this study. I addressed all of the collected evidence including rival hypotheses or interpretations, remained focused on the
key theoretical concepts, and utilized my own prior, expert knowledge of the topic throughout the analysis portion of the study (Yin, 2009, p. 160-161).

### Setting

The setting of this study was a large, regional, public university in the mid-Atlantic region of the United States of America that has more than 900 full and part time instructional faculty. This institution is classified as a Master’s Colleges and universities: Larger programs under the Carnegie Classification System meaning it has more than 10,000 full-time equivalent students (Indiana University Center for Postsecondary Research, n.d.). The institution has been engaged in online learning since 2010 and has seen steady growth in its online courses and programs (U.S. Department of Education, 2012-2018). The University has an office charged with supporting online instruction as well as a separate office for supporting the learning management system through which instructors deliver online courses. Based on these details, the setting and its population meet the necessary criteria for this study.

### Sample

Using the university’s publicly available *Online and Blended Course Search Tool* located on its website, I compiled a list of the 140 instructors that taught at least one 100% online course during the Fall 2020 semester along with their department and the catalog numbers and titles for their specific online courses. The University classifies courses into five categories based on percentage of a course taught through digital means and two of those categories are considered online courses. In pre-COVID-19 operating conditions, any course classified as an online course had to be approved by the University governing body and instructors at the University had to complete an online teaching training program prior to teaching an approved online course. During the fall 2020 semester, courses listed as 100% online were considered traditional online
courses and would have been offered in the online format if the University were operating under pre-pandemic conditions. Thus, individuals listed as teaching 100% online courses during the fall 2020 semester had already completed training to teach online and likely had already taught online courses prior to the remote teaching requirements brought on by the COVID-19 pandemic. Instructors of those courses would likely be the most experienced online instructors at the institution and were most likely to have created digital video for online courses in the past.

As a result of the COVID-19 pandemic, most courses in the fall 2020 semester were required to utilize digital means of instruction. In addition to the 100% online course designation, the University temporarily added two additional course classifications called Remote Asynchronous and Remote Synchronous which were used to denote which courses would have been taught via face-to-face means but were now required to use digital methods as a result of the pandemic. I intentionally excluded instructors of the remote asynchronous and remote synchronous course types because they were not required to take the online teaching training program and were unlikely to have previous online teaching experience. In situations where an instructor was teaching both a remote asynchronous or synchronous course and a traditional 100% online course, they were left in the sample. This population and sample are appropriate for this study because the instructors teach online courses, are likely to create online videos, and are all operating in the same institutional environment.

**Survey Participants**

I removed two instructors from the initial list because of their roles on my dissertation committee, which resulted in a total of 138 instructors who were initially solicited to participate in this study. These individuals were available, convenient, and represent the characteristics of online higher education instructors making it a nonprobability sampling (Creswell, 2012, pg.
145). More specifically the group of instructors is a convenience sample because participants were available and willing to participate (Creswell, 2012, p. 146). I emailed sample members a request to participate, and the email included a link to the Instructional Review Board (IRB) approved consent form (Appendix B). If an instructor agreed to participate and completed the consent form, they were immediately directed to a 17-question survey administered via the Qualtrics survey platform (Appendix C). Instructors received three email reminders to participate with no more than one email sent per week. The participant solicitation and survey data collection process took three weeks and occurred during October 2020.

**Case Study Participants**

Using data collected from the survey, I identified the five instructors with the highest self-reported CTML design principle implementation scores for follow up interviews per Creswell’s (2013) recommendation that a case study should have no more than five cases. To identify the instructors, I used survey questions 6 through 11, which addressed CTML design principle implementation to create what I called a Simple CTML Scale Score and question 16 which asked about an instructor’s willingness to share a video for analysis. In the event of a tie in simple CTML scale scores, I used data from question 12 to create a Complex CTML Scale Score as a tie breaker. Questions 7c and 7f along with 12a, 12c, and 12e were intentionally inverted so that the responses indicating CTML design principle use were negative as opposed to positive as a means of preventing the identification of false high scores by an instructor marking items as all positive without careful reading of the options. Selecting the instructors with the highest incorporation of CTML design principles allowed me to investigate the upper bounds of CTML design principle implementation in this population of instructors.
Researcher’s Bias

As I mentioned earlier in the chapter, I reject the concept of value-free, unbiased and neutral research because I believe that each individual incorporates a unique set of personal experiences in the decision-making process utilized in the creation of knowledge. I think it is more important for researchers to be transparent in their decision-making processes and to utilize multiple data points to triangulate findings than to seek an unbiased and neutral research design. One element of transparency in the research process is for the researcher to identify their own perspectives and position towards the research questions and discovered data.

My perspectives towards this research center around a sense of instructional decision making as correct or incorrect and a desire to create conditions supportive of student learning both of which pervade the undertones of my writing and research design. The nature of this study aligns to the organizational and structurally driven ways in which my own mind operates and how it seeks to use patterns to discern information. The CTML design principles operate like a formula in that if an instructor incorporates a design principle, they should expect students to demonstrate improved learning outcomes. The challenge in this thinking is that it explores the principles on an individual level and not in a way that explores how the principles might interact with each other, creating possible blinds spots to interactions that don’t follow the prescribed flow. I also appreciate the implied efficiency the use of CTML principles bring to the video creation process. There is an assumption that utilizing the principles in video will assist instructors in being more efficient teachers of content and information. Finally, I bring my own video creation experiences into the research process having created and edited over 100 different instructional videos. I am keenly aware of what is and is not possible in the video creation process with the tools available to the study participants. These perspectives on the research
topic may not be similar to those of the instructors investigated in this study and I intend to utilize reflective memoing to help capture and interrogate the impacts of these perspectives during the qualitative portion of the study.

**Generalizability**

This study is generalizable to instructors teaching online courses at the University because 39.86% (55) of the population completed the survey which is an average response rate for a web-based survey (Shih & Fan, 2008). Given the high survey response rate it is possible to generalize the survey findings to additional audiences made up of higher education instructors, who teach online courses, received some training on how to teach online prior to teaching an online course, and who work at a teaching-oriented institution. Case study data should not be generalized beyond its ability to demonstrate replication of the overall study theory. Collectively the data guides what may be possible, and findings should be further tested in additional contexts. Ultimately these results should be viewed as a means of defining potential boundaries within which additional explorations of CTML design principles should occur.

**Instrumentation**

Within this explanatory sequential design, I used three instruments for data collection: (a) a survey, (b) a semi-structured interview protocol, and (c) a video artifact analysis protocol. Survey instruments have a long history of use in educational research going back to at least 1817 (Creswell, 2012, p. 382). Interview and artifact analysis protocols are both instruments other researchers have utilized to access the thinking and previous decision making of instructors (Kane et al, 2002). Each instrument has an identified role in the data collection process for this study and corresponding connections to the specific research questions. Table 1 highlights the strategy, sample, research questions, and analysis procedures I utilized with this design.
Table 1

Strategy, Sample, and Analysis

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Sample</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey</td>
<td>Nonprobability convenience sample of higher education instructors teaching online courses</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chi-square test of independence and Fisher’s Exact Test between matched CTML questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spearman’s Rho correlations between CTML scores and demographic measures</td>
</tr>
<tr>
<td>Semi-structured interviews</td>
<td>Five instructors with the highest CTML design principle implementation scores from the survey</td>
<td>Hypothesis coding and In vivo coding</td>
</tr>
<tr>
<td>Video Artifact analysis</td>
<td>Instructional videos from the five selected instructors</td>
<td>Hypothesis coding</td>
</tr>
</tbody>
</table>

Survey

There is no developed instrument for measuring higher education instructors’ implementation of the 11 CTML design principles so I constructed a survey using a combination of questions I developed, drawing inspiration from related research that explored the application of CTML design principles in a K-12 setting and the evaluation of CTML principles in courseware (Allison, 2015; Jiang et al., 2017). Four instructional design experts tested the survey for content validity prior to use in this study. They were asked to indicate language clarity and question appropriateness using a simple yes/no mark and use a comment space to explain decisions or provide additional feedback. If at least three reviewers identified a concern with a question I revised it based on their feedback. Revisions consisted of clarifying the specific semester, punctuation, and text-based formatting.

The survey has 17 questions, is divided into four sections, and is available in Appendix C. The first section contained questions related to the instructor’s initial interest to teach online,
online teaching experience, current online course load, and use of video. I used data collected from these questions to provide context of the instructor setting. The fluid and controversial nature of demographic questions specific to gender and race led me to intentionally exclude them from the survey. The second section of the survey contained questions that asked instructors to rate their implementation of CTML design principles in an instructional video they consider to be their “best” and were using during the semester. I measured instructor implementation of 9 of the 11 CTML design principles using a set of paired questions listed in Table 2. One question was a dichotomous yes or no question while the other type of question was either a five-point Likert scale using a point scale consisting of “None of the time (0%)”, “Some of the time”, “Half the time (45 to 55%)”, “Most of the Time”, and “All of the time” or a scaled rating from “0” to “100%”. In addition to the questions listed in Table 2, this section included two questions which do not have a corresponding matching question. Question 6 which asked instructors to provide the length of the video in minutes and seconds, addresses the segmenting principle and provided data on average length of self-made instructor videos. The other question without a pair was question 10 which addressed the voice principle and asked what type of voice was used in the video.
### Table 2

**CTML Design Principle and Corresponding Survey Questions**

<table>
<thead>
<tr>
<th>CTML Design Principle</th>
<th>Yes / No Question</th>
<th>Likert Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherence Principle (music)</td>
<td>7c. Does the video include music?</td>
<td>12a. The video contains music.</td>
</tr>
<tr>
<td>Coherence Principle (visuals)</td>
<td>7f. Does the video contain decorative visuals or video that are not essential for learning?</td>
<td>12c. Visual or auditory elements that are not essential to the learning are included in the video to add interest.</td>
</tr>
<tr>
<td>Signaling Principle</td>
<td>7d. Does your video include cues (highlighting, arrows, etc.) to draw attention to important information in the video?</td>
<td>12d. Cues (such as changes in voice, highlighting, arrows, etc.) are used in the video to draw attention to important information.</td>
</tr>
<tr>
<td>Redundancy Principle</td>
<td>8. Approximately what percentage of the video contains text appearing on the screen that is read by the video narrator?</td>
<td>12e. Text is included on the screen at the same time that a narrator is speaking it.</td>
</tr>
<tr>
<td>Spatial Contiguity Principle</td>
<td>7e. Are related words and images presented near each other in the video?</td>
<td>12f. Text is included on the same screen as the picture or footage for which it applies.</td>
</tr>
<tr>
<td>Temporal Contiguity Principle</td>
<td>9. Approximately what percentage of the video contains audio narration spoken at the same time as related images are appearing on the screen?</td>
<td>12g. The video narration occurs at the same time as related images or video footage.</td>
</tr>
<tr>
<td>Pretraining Principle</td>
<td>7g. Were students taught general concepts or key vocabulary found in the video prior to viewing the video?</td>
<td>12h. General concepts and / or key vocabulary are taught prior to students viewing the video.</td>
</tr>
<tr>
<td>Personalization Principle</td>
<td>11. Is the narration personalized (i.e. uses terms like “you” and “I”) as opposed to third-person narration?</td>
<td>12j. The voice of the narrator is personalized, such as using terms like “you” and “I” as opposed to third-person narration.</td>
</tr>
<tr>
<td>Embodiment Principle</td>
<td>7b. Can you be seen in the video at any time?</td>
<td>12i. A human narrator was at least partially present (visible) in the video.</td>
</tr>
</tbody>
</table>

*Note. Likert-scale options were “None of the time (0%)”, “Some of the time”, “Half the time (45 to 55%)”, “Most of the Time”, and “All of the time.”*
The third section of the survey contained three questions to gather data on an instructor’s video creation process in order to guide the interview process and create an opportunity for triangulation between survey and interview data. The questions asked the instructors to estimate the amount of time it took them to create the video, to indicate which tools they used to create the video and describe what instructional techniques they used in the video. The fourth and final section of the survey asked two questions about willingness of the instructor to share their video for analysis and likelihood of the instructor creating a video during the semester. I used data from both questions to assist with the identification of instructors for interviews in the next segment of the research process.

**Survey Reliability**

Using data I collected during the study, I checked the reliability of the survey instrument by calculating a Pearson Correlation between the two CTML design principle scales and conducting tests of independence for eight CTML design principle question pairs. First, I conducted a Pearson Correlation between the two CTML design principle scales. The skewness of the simple CTML scale scores was -.279 and -.235 for the complex CTML scale scores, which were both in the range for approximately symmetrical. I calculated a Pearson Correlation Coefficient which resulted in a strong correlation of .728, which was statistically significant at the 0.01 level. Then I calculated and reported Chi-Square tests of independence or Fisher’s Exact Tests for the matched questions which I identified in Table 2. I converted the five-point Likert-scale responses to a dichotomous yes or no response since four points of Likert-scale were measuring the degree of presence and one was measuring absence. As noted in Table 3, if a question pair had no expected counts of less than five in any of the four quadrants of the crosstabulation, I used the Chi-square; otherwise, I used the results of the Fisher’s Exact Test to
evaluate the null hypothesis. A Chi-Square test was appropriate because the data consisted of
dichotomous frequencies, with mutually exclusive levels, and unequal sample sizes (Franke et
al., 2012; McHugh, 2013). The Fisher’s Exact Test was appropriate because there were expected
values of less than five for each question pairing, and there was only one degree of freedom
(Kim, 2017). The null hypothesis for each question pairing was that the two sets of responses
were not related. As seen in Table 3, seven of the eight question pairs were able to reject the null
hypothesis and thus can be considered related, which is expected given that both questions were
attempting to ascertain the implementation of the same CTML design principle. I could not reject
the null hypothesis for the modality principle.

To test the correlation for the CTML design principles of redundancy and temporal
contiguity, I used a Spearman’s rho correlation calculation because both sets of collected data
were ordinal and the relationship was monotonic (Creswell, 2012). For the redundancy principle,
the correlation coefficient was .565 and was significant at 0.01 level (2-tailed). There was a .573
correlation for the temporal contiguity principle and it was also significant at the 0.01 level (2-
tailed). Given the results of the correlation tests at the scale level and among the individual
question pairs, the individual instructor responses have a strong reliability.
Table 3

Reliability Calculations for Paired CTML Design Principle Survey Questions

<table>
<thead>
<tr>
<th>CTML Principle</th>
<th>Pearson Chi-Square</th>
<th>Asymptotic Significance (2-sided)</th>
<th>Fisher’s Exact Test Sig. (2-sided)</th>
<th>n value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherence (No Music)</td>
<td>49.000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.000</td>
<td>0.000***</td>
<td>49</td>
</tr>
<tr>
<td>Coherence (No Extras)</td>
<td>4.235&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.040*</td>
<td>0.054</td>
<td>49</td>
</tr>
<tr>
<td>Signaling</td>
<td>17.391&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.000***</td>
<td>0.000</td>
<td>48</td>
</tr>
<tr>
<td>Spatial Contiguity</td>
<td>13.088&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.000</td>
<td>0.002**</td>
<td>49</td>
</tr>
<tr>
<td>Pretraining</td>
<td>25.167&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.000</td>
<td>0.000***</td>
<td>49</td>
</tr>
<tr>
<td>Modality</td>
<td>0.022&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.883</td>
<td>1.000</td>
<td>48</td>
</tr>
<tr>
<td>Personalization</td>
<td>30.637&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.000</td>
<td>0.003**</td>
<td>47</td>
</tr>
<tr>
<td>Embodiment</td>
<td>37.802&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.000***</td>
<td>0.000</td>
<td>49</td>
</tr>
</tbody>
</table>

<sup>a</sup> 3 cells (75.0%) have expected count less than 5. Used Fisher’s Exact Test.
<sup>b</sup> 0 cells (00.0%) have expected count less than 5. Used Chi-Square Test.
<sup>c</sup> 1 cells (25.0%) have expected count less than 5. Used Fisher’s Exact Test.

*S* < .05. **S* < .01. ***S* < .001

**Semi-Structured Interviews**

Interviewing is a common method for collecting data in a case study as a means of finding out what is occurring in an individual’s mind (Merriam, 1998). I selected a semi-structured one-time interview protocol to maintain some consistency among the five interviews, while also allowing for some variation in questions based on the circumstances and incoming survey data (Lichtman, 2013). Available in Appendix D, I developed an initial interview protocol or guide which was made up of 13 questions written to address a wide array of considerations such as: (a) identifying CTML design principles in use, (b) creating opportunities for data linkage between the survey and interview data, and (c) approaching the video creation process from multiple perspectives (Merriam, 1998 p. 81).

After the initial consent questions, I started the protocol with a “grand tour question” asking the instructor to take me through their creative process in a making a video because this type of question is good for starting an interview (Lichtman, 2013, p. 198). While all the
questions have the possibility of capturing data on CTML design principles, I specifically wrote questions 2 and 3, 5, 7, and 8 to create opportunity to collect data related to the principles. For example, question 3 is directly related to the embodiment principle. I specifically wrote interview questions 6 and 9 to explicitly connect survey data and interview data as a means of strengthening the reliability of the data collection instruments and to support pattern matching for internal validity (Yin, 2009). The interview questions conclude with a closing question which provides the instructor a chance to add information not yet discussed (Lichtman, 2013, p. 200).

I modified and adapted interview questions from the initial creation after receiving survey data. First, data regarding the overall implementation of CTML design principles among the entire sample led to question adjustment. I added notes in all capitals to questions 3, 4, and 5 of the interview guide to ask about CTML design principles that had lagging survey scores in comparison to the other design principles. Second, I reviewed the specific data from the individual instructor and made sure to include questions that addressed CTML design principle use that deviated from the overall sample data. Question adjustment was done to address internal validity concerns by collecting data that could assist with pattern matching, explanation building, and addressing rival explanations as part of the data analysis stage of the study (Yin, 2009, p. 41).

**Tool for Analyzing Video**

Analysis of video is a popular method that researchers use to investigate instructional digital video (Chorianopoulos, 2018; Crook & Schofield, 2017; Kruse & Veblen, 2012; Wijnker et al., 2018). Because individuals can sometimes engage in social response bias where they provide answers they think a researcher wants to hear rather than what actually happened, I am also collecting a sample video artifact from each of the five interview participants to assist with
corroborating and augmenting the evidence collected from the survey and interviews (Jager et al., 2020; Yin, 2009, p. 105). Video artifact data is “nonreactive or stable in that it was not originally generated in the presence of influence from the researcher (Merriam, 1998, p. 126).

Table 4 is the hypothesis coding procedure I will follow to collect data on the use of CTML design principles in the collected video artifacts. A final component of the artifact analysis is to assess its characteristics in terms of length and construction using the physical to digital spectrum on the human embodiment and instructional media axis (Chorianopoulos, 2018).
Table 4

CTML Design Principles Code Descriptions and Process

<table>
<thead>
<tr>
<th>Principle</th>
<th>Hypothesis Coding Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coherence:</strong></td>
<td>1. Identify the video learning goal by watching the video and/or utilizing interview data.</td>
</tr>
<tr>
<td></td>
<td>2. Watch the video and note instances of elements not supporting learning goal.</td>
</tr>
<tr>
<td><strong>Signaling:</strong></td>
<td>3. Watch the video and note instances of verbal indications of important information.</td>
</tr>
<tr>
<td></td>
<td>4. Watch the video and note instances of visual indications of important information.</td>
</tr>
<tr>
<td><strong>Redundancy:</strong></td>
<td>5. Watch the video and note instances where on-screen text was read aloud by the narrator.</td>
</tr>
<tr>
<td><strong>Spatial Contiguity:</strong></td>
<td>6. Watch the video and note instances were related words and images appear together.</td>
</tr>
<tr>
<td><strong>Temporal Contiguity:</strong></td>
<td>7. Watch the video and note instances were images appeared as they were discussed by the narrator.</td>
</tr>
<tr>
<td><strong>Modality:</strong></td>
<td>8. Watch the video and note instances where information was presented on the screen, but not as narration.</td>
</tr>
<tr>
<td><strong>Personalization:</strong></td>
<td>9. Watch the video and note instances were a formal talking style was used.</td>
</tr>
<tr>
<td><strong>Embodiment:</strong></td>
<td>10. Watch the video and note instances where unnatural human gestures were used</td>
</tr>
<tr>
<td><strong>Voice:</strong></td>
<td>11. Watch the video and note where a computerized voice was used.</td>
</tr>
</tbody>
</table>

Note: Instances will be noted using timestamps.

**Threats to Validity and Reliability**

Because mixed methods research incorporates both quantitative and qualitative methods it is necessary to address the validity and reliability of both phases of the research (Creswell & Clark, 2017). Validity and reliability are more challenging to address in qualitative research because there are many types and terms a researcher can choose to utilize in a study, thus I begin...
each section discussing the case study portion of the research design first (Creswell & Poth, 2017).

**Internal Validity**

Internal validity assesses or addresses questions regarding how well the findings of this study match up with the real-world reality and more specifically if I have correctly inferred that a concept or relationship does in fact lead to or relate to another concept (Merriam, 1998; Yin, 2009). This is a particular challenge in a case study research design because some inferences may not have been directly observed. I am using pattern matching and addressing rival hypothesis during data analysis to assist in controlling threats to internal validity (Yin, 2009, p. 43). Additionally, I am improving the internal validity through the use of triangulation which I have done by collecting different sets of data through different methods, member checking the interviews, and a clear articulation of my biases (Merriam, 1998, p. 204). The validity of the survey instrument was confirmed via a content validity check from four instructional design experts which is an example of evidence based on test content (Creswell, 2012, p. 163).

**External Validity**

Again, the use of a case study method exposes the study to concerns about the ability to generalize the findings beyond the specific sample I investigated (Creswell, 2012). The use of a mixed methods design that incorporates survey methodology, a method that allows for greater generalizability of results along with the aforementioned triangulation, member checking, and reporting of disconfirming evidence assists in controlling for threats to external validity (Lincoln & Guba, 1985). The impacts of the ongoing COVID-19 pandemic are a considerable threat to the external validity of this study in that I don’t have the ability to measure the impact a sudden shift to online instruction has had on the population. There is a risk that I am capturing data pertinent
to the specific situation and context of this site within the greater pandemic impacts that is
distinct from that other locations and time periods.

**Reliability**

Reliability in the traditional or positivist sense expects that another researcher could
follow the procedures of this study and get identical results; however, applying that concept to
the case study portion of this study is impossible because no two human beings are alike
(Merriam, 1998, p. 206). The experiences of the study participants and the researcher and their
individualized impact on the research findings cannot be replicated in an exactly identical form.
Instead Merriam (1998) suggested considering the “dependability” and “consistency” of findings
derived from the data (p. 206). The use of triangulation is a safeguard against issues of researcher
inauthenticity and a step I have taken in this study (Creswell, 2015). I described in as much detail
as possible the procedural steps taken throughout the conduct of the study as another means of
demonstrating the reliability of the findings (Yin, 2009, p. 45). The primary means of testing the
reliability of the survey was through the use of internal consistency reliability by correlating the
results of the dichotomous yes and no CTML questions with the five-point Likert scale questions
using a Chi-square test for independence or a Fisher’s Exact Test (Creswell, 2012, p. 160).

**Procedures**

The first step I undertook in the research process was receiving Institutional Review
Board approval for the study. Once secured, I used the *Online and Blended Course Search Tool*
to identify the instructors who fit the criteria outlined in the Sample section of this chapter. I then
emailed the full list of instructors the request to participate and the link to the combined consent
form and survey. I sent a reminder email once per week during the three weeks the survey was
available during October 2020.
Survey Analysis

Once the survey data collection process was complete, I immediately began analyzing the data using a number of different procedures. First, I calculated a response rate to ensure an appropriate number of responses from which to generalize findings (Creswell, 2012, p. 390). Then I generated descriptive statistics including mean, mode, and median for questions 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 14. To prepare for the interview stage of the study, I noted which design CTML principles had the highest and lowest scores. Next, I calculated Chi square tests for independence or Fisher’s Exact Tests for the matched CTML design principle questions listed in Table 2. After that I began the process of generating CTML design principle implementation scores using both a simple and complex score process.
I calculated a simple CTML design principle score by assigning 1 point for each response to questions 6, 7, 8, 9, 10, and 11 that indicated the presence of a CTML design principle as I noted in Table 5 and then adding an instructors points together to create a single score ranging from 0 to 12. Analysis of question 6 was based on a time interval for the video of less than or equal to 15 minutes and was derived from the instructional video literature and my own experience. Two of the questions were written with the negative response indicating the presence of CTML design principles to confirm that individuals provided consistent answers.
Table 5

*CTML Design Principle Simple Scoring Chart*

<table>
<thead>
<tr>
<th>Question</th>
<th>Indicator of CTML Design Principle Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. How long is the video?</td>
<td>&lt;= 15 minutes</td>
</tr>
<tr>
<td>7a. Does the video contain audio narration?</td>
<td>Yes</td>
</tr>
<tr>
<td>7b. Can you be seen in the video at any time?</td>
<td>Yes</td>
</tr>
<tr>
<td>7c. Does the video include music?</td>
<td>No</td>
</tr>
<tr>
<td>7d. Does your video include cues (highlighting, arrows, etc.) to draw attention to important information in the video?</td>
<td>Yes</td>
</tr>
<tr>
<td>7e. Are related words and images presented near each other in the video?</td>
<td>Yes</td>
</tr>
<tr>
<td>7f. Does the video contain decorative visuals or video that are not essential for learning?</td>
<td>No</td>
</tr>
<tr>
<td>7g. Were students taught general concepts or key vocabulary found in the video prior to viewing the video?</td>
<td>Yes</td>
</tr>
<tr>
<td>8. Approximately what percentage of the video contains text appearing on the screen that is read by the video narrator?</td>
<td>0%</td>
</tr>
<tr>
<td>9. Approximately what percentage of the video contains audio narration spoken at the same time as related images are appearing on the screen?</td>
<td>100%</td>
</tr>
<tr>
<td>10. Does the video narrator have a human voice, a computerized voice, or both voice types?</td>
<td>Human</td>
</tr>
<tr>
<td>11 Is the narration personalized (i.e. uses terms like “you” and “I”) as opposed to third-person narration?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

After generating the simple CTML design principle implementation score, I calculated a complex CTML design principle score using questions 6 and 12 following a similar method. An instructor score was generated by assigning a point value between 1 and 5 to each Likert scale.
response with the response indicating maximum CTML design principle implementation as I noted in Table 6 earning 5 points. Point values reduced by 1 for each response moving away from maximum value so an instructor’s complex CTML score could range from a low of 11 points to a maximum of 55 points. The response to question 6 was categorized based on time intervals of less than a minute, one minute to three minutes, three minutes to six minutes, six minutes to fifteen minutes and greater than 15 minutes. I derived these time intervals from the instructional video literature and my own experience.
Table 6

Complex CTML Design Principle Implementation Score

<table>
<thead>
<tr>
<th>Question</th>
<th>Value of Maximum CTML Design Principle Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. How long is the video?</td>
<td>Less than a minute</td>
</tr>
<tr>
<td>12a. The video contains music.</td>
<td>None of the Time</td>
</tr>
<tr>
<td>12b. The video contains audio narration.</td>
<td>All of the Time</td>
</tr>
<tr>
<td>12c. Visual or auditory elements that are not essential to the learning are included in the video to add interest.</td>
<td>None of the Time</td>
</tr>
<tr>
<td>12d. Cues (such as changes in voice, highlighting, arrows, etc.) are used in the video to draw attention to important information.</td>
<td>All of the Time</td>
</tr>
<tr>
<td>12e Text is included on the screen at the same time that a narrator is speaking it.</td>
<td>None of the Time</td>
</tr>
<tr>
<td>12f Text is included on the same screen as the picture or footage for which it applies.</td>
<td>All of the Time</td>
</tr>
<tr>
<td>12g. The video narration occurs at the same time as related images or video footage.</td>
<td>All of the Time</td>
</tr>
<tr>
<td>12h. General concepts and/or key vocabulary are taught prior to students viewing the video.</td>
<td>All of the Time</td>
</tr>
<tr>
<td>12i. A human narrator was at least partially present (visible) in the video.</td>
<td>All of the Time</td>
</tr>
<tr>
<td>12j. The voice of the narrator is personalized, such as using terms like “you” and “I” as opposed to third-person narration.</td>
<td>All of the Time</td>
</tr>
</tbody>
</table>

Note. The Likert-scale used a five-point scale consisting of “None of the time (0%)”, “Some of the time”, “Half the time (45 to 55%)”, “Most of the Time”, and “All of the time.”

Once I generated the CTML design principle implementation scores, I calculated descriptive statistics for the scores. Finally, I identified the individuals with the highest scores simple CTML scale scores in order to identify the five interview candidates. To break a tie score
among the instructors, I used the complex scale score in combination with the instructor response to question 17 indicating their willingness to share a video artifact. Once I identified the highest scoring individuals, I reached out to my dissertation advisor for the names of those individuals to begin the interview scheduling process. Only the five names were revealed for the purposes of requesting and scheduling interviews so as to protect the identity of the remaining study participants.

**Interview Procedures**

I emailed each instructor with a request to schedule an interview of 30 to 60 minutes using the Zoom video conference meeting tool. I utilized a semi-structured one-time interview protocol listed in Appendix D for the one-on-one interviews (Lichtman, 2013). Prior to each interview, I reviewed the instructor’s responses to the survey questions, making notes of where the instructor deviated from the average CTML design principle usage and how they responded to the video creation questions 14 and 15.

Upon completion of each interview, I created a verbatim transcription of the conversation into a digital document which I then sent to the interviewee for member checking as a means of confirming data validity (Creswell, 2012). The email also contained a request for the interviewee to provide me with access to the digital video if it was not shared during the interview (See Appendix F). While the member check process was taking place, I engaged in a reflective memo as a means of documenting my own perceptions, biases, and experiences from the interview (Birks et al., 2008).

**Interview Data Analysis**

I began analysis of the interview data as soon as each transcript was affirmed by the interviewee through member checking using a hypothesis coding process with codes based on
the 11 CTML design principles as defined in Chapter I and outlined in Appendix E (Carlson, 2010; Miles et al., 2014, p. 78). Because I already had a set of codes in mind, this process is considered deductive coding (Miles et al., 2014). I reviewed each transcript a minimum of three times looking for examples that demonstrated the presence or absence of each CTML principle. After completing the hypothesis coding, I conducted a second round of analysis using in vivo coding to explore instructor experiences that influenced the video creation process (Miles et al, 2014, p. 74). I selected in vivo coding because it generates data to provide thick and rich descriptions for a case study and it is an inductive coding process because themes emerge from the data (Miles et al, 2014).

**Video Artifact Analysis**

I conducted hypothesis coding on the videos collected from the five interview participants with codes based on the eleven CTML design principles (Lichtman, 2013; Mayer, 2019). I reviewed each video a minimum of three times and recorded time stamps of examples demonstrating the presence or absence of CTML design principles. Timestamps allowed me to measure the length of specific CTML design principle applications or violations which could then be used to compute percentages of the total video length for principle application. Then I compared the video data with the interviewees survey data as a means of triangulating the study findings. Conducting the analysis with this layered approach allowed me to use a process of corroborating evidence from multiple sources, which is a means of validating the data (Creswell & Poth, 2016).

**Limitation of Methods**

To begin, I am making an assumption that the population I am sampling is representative of the broader higher education population in terms of gender and racial make-up without having
specific data to back up that assertion. I intentionally refrained from collecting data in those areas primarily because of the fluid and controversial nature of those descriptors and at this time I don’t perceive they are germane to the research questions of the study. A second limitation is the use of a cross-sectional survey may have caused me to miss instructors who had the best implementation of CTML design principles within the population if those instructors were not teaching online during the fall semester. Conclusions drawn from the data collected then would not be completely representative of the best cases (Coughlan et al., 2009). A third limitation is the use of self-reported data and recollections may be impacted by recall bias (Jager et al., 2020). Data on number of videos used in courses is particularly vulnerable to this bias, especially if instructors have large numbers of video. I attempted to address this concern with the CTML design principle reporting by prompting instructors to call up their best video as they completed the survey; however, I have no way to confirm that this was in fact done. The need for further testing of the validity of the survey instrument is a fourth limitation. My own sensitivity to the intricacies of the study topic, instructional video is a potential fifth limitation since I take on the role of instrument in the case study portion of the research project (Queirós et al., 2017).

**Informed Consent and Protection of Human Subjects**

The university Institutional Review Board approved this research study. Instructors provided consent to participate prior to gaining access to the survey. Because I was an employee of the institution and may have worked with some of the instructors prior to the study, steps were taken to protect the identity of survey participants. My dissertation committee chair was the only one with access to the survey results that included instructor names. The same concern also existed for my dissertation committee chair, so I was the only one who knew the names of instructors originally contacted to participate. This design allowed each of us to remain unaware
of who chose not to participate in the study and freed instructors to make a choice not to participate in the study without impacting their relationships with either of us. When the survey data collection process finished, my advisor sent me the data with names removed and replaced with pseudonyms. After I identified the top five instructors based on CTML design principle implementation scores, I requested the actual names of those individuals from my dissertation committee chair one by one until the survey data collection process was complete. Instructors were made aware of the potential to be identified for an interview as part of the consent process. When not in use, all data pertaining to the study remained in the web-based survey tool or a password-protected, folder in a university issued cloud storage system. Interview recordings were created using video conference recording system and a mobile phone voice memo tool. Once transcripts were generated, I only retained the audio files for the purpose of the study. Interview transcripts used a pseudonym for instructor names. I took representative images from the video analysis in a manner that ensured no identifying information of the instructor was included. Three years after the completion of the project, I will delete the original data sets.

Summary

As I have outlined in this chapter, my pragmatic approach led me to select an explanatory sequential mixed methods research design to answer the question to what extent are higher education instructors who create digital instructional video for online learning applying the 11 multimedia design principles of the Cognitive Theory of Multimedia Learning? I utilized a combination of survey and case study methodologies to collect data from a sample of 138 instructors as a large, regional public university. Using data from the initial survey, I identified five instructors who had the highest CTML design principle implementation scores for follow up interviews and collected one video from each interviewee for analysis. I constructed the survey
instrument, interview protocol, and video analysis tool based on previous research methods and
techniques in a way that attempted to address concerns about validity and reliability. The
research procedures I employed occurred in three phases starting with the quantitative survey
data collection and analysis, followed by the qualitative interview and video artifact data
collection and analysis, and ending with an integration phase that used pattern matching across
the three data sets. In concluded this chapter with a brief discussion of five potential limitations
of the methods I utilized and a review of the specific procedural steps I used to protect the human
subjects who participated in the study. As Kane et al. (2002) suggested, researchers should
connect espoused theories of teaching with actual practice, so in the next chapter I will discuss
the findings uncovered via the process that I have outlined in this chapter.
Chapter 4: Findings

The purpose of this study was to describe higher education online instructors’ implementation of the 11 Cognitive Theory of Multimedia Learning (CTML) design principles in digital instructional video created for online learning courses. By articulating current instructor practices, I sought to provide others with insight on the current state of instructor video creation. I focused on thoroughly investigating instructors who self-reported implementing the most CTML design principles, as compared to their peers, in order to provide guidance on areas of video creation where further improvement could occur. Ultimately, the goal of this study was to provide data to assist in raising the quality of instructor-created instructional videos. In this chapter, I report key findings triangulated from a 17-question survey, 5 interviews, and 5 instructional video samples collected during the late fall of 2020 in order to address the four sub-questions that comprise this study. The following four sub-questions guided this study:

(1) Which Cognitive Theory of Multimedia Learning (CTML) design principles are higher education online instructors incorporating into self-made digital instructional videos? \textit{(quantitative)}

(2) Why do higher education online instructors choose components of digital instructional video production to focus on when creating digital video for use in online courses? \textit{(qualitative)}

(3) Which CTML design principles appear in higher education online instructors self-selected “best” self-made instructional video? \textit{(quantitative and qualitative)}

(4) To what extent are CTML design principles an area of focus for higher education online instructors as they create digital instructional video? \textit{(quantitative and qualitative)}
I begin by outlining findings with an overview of the survey response information, as well as profiling the instructors selected for interviews. Then I report on the overall CTML scale findings and provide a triangulated analysis of the data collected from the three sources on each individual CTML design principle. Next, correlations among the principles are explored. Then, I investigate the instructors’ editing decisions and process before concluding with a review of what instructors focus on during video creation and where they learn video creation concepts.

**Survey Response**

In the first phase of the study, I sent a 17-question survey (see Appendix C) consisting of four sections addressing demographics, CTML design principle implementation, video creation, and instructor willingness to share a video artifact to 138 instructors, with 55 instructors completing it during the three weeks it was available. The response rate of 39.86% is average for a web-based survey (Shih & Fan, 2008). Six instructors did not answer most of the survey questions. Two instructors reported that they were not using video in courses they were teaching during the semester and did not receive the remaining survey questions. Two other instructors did not use any videos that they had created in their courses and thus did not receive the remaining survey questions. One instructor stopped responding after reporting on videos used, and one instructor only responded to half the questions regarding CTML principle implementation. Most survey questions had 49 responses; however, as was their right, some participants chose not to respond to an individual question, which caused some questions to have slightly lower n values. I used SPSS and Microsoft Excel to conduct the statistical analysis that follows.
Instructor Profile

Of the 55 instructors who took the survey, 94.6% (52) of them were either strongly interested or somewhat interested in teaching their first online course with 1.81% (1) of instructors neutral and 3.64% (2) of instructors somewhat uninterested (Table 7). Conditions at the University would support this type of initial interest in online education. While not necessarily true for the newest faculty, the instructors are part of a faculty union and the current union contract provides protection so that no instructor is forced to teach online courses if they do not desire. In addition, there is a requirement that faculty interested in teaching an online course must complete a university-offered initial training. Given the protections and the training requirement, it is natural that most instructors would be interested in teaching online courses.

Table 7

<table>
<thead>
<tr>
<th>Interest</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly interested</td>
<td>36</td>
<td>65.5</td>
<td>65.5</td>
</tr>
<tr>
<td>Somewhat interested</td>
<td>16</td>
<td>29.1</td>
<td>94.5</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>1.8</td>
<td>96.4</td>
</tr>
<tr>
<td>Somewhat uninterested</td>
<td>2</td>
<td>3.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Instructors’ previous online teaching experience ranged from no prior experience to 200 online course sections previously taught. I conducted an interquartile range calculation to determine if any of the reported data on previous online course sections taught could be considered an outlier. The 75th percentile of the reported data was 21.5 courses taught and the 25th percentile was 4.24 courses. Subtracting those two numbers and multiplying the result by 1.5 left me with an interquartile range of 25.875. Adding that result to the 75th percentile led to a maximum range of 47.375. Three reported values fell outside that range, and I deemed them
outliers. I excluded the three data points and calculated descriptive statistics on the remaining
data from 49 instructors. The average instructor had previously taught 13 online course sections. The median response was 10 course sections, the mode was 20 course sections, and the standard
deviation was 10.74.

At the time of data collection, the 55 instructors were actively teaching a total of 131
online course sections (see Appendix G), and most were teaching 2 online courses. Even though
data was collected during the COVID-19 pandemic and all university courses were being taught in some sort of remote format, the reported courses were considered online courses and would have been taught as online courses under non-pandemic conditions. Data on the exact
distribution of instructors among the colleges of the University is not available; however, a rough approximation assumes an equal number of instructors among the five colleges with smaller percentages for the School of Music and University College. Working from that assumption, the
distribution of instructors by colleges and departments show that the College of Business and the College of Health Sciences are slightly over-represented in the sample while the College of Arts and Humanities and the Colleges of Science and Mathematics are slightly under-represented (See Appendix H).

**Digital Video Use**

Of the 131 online course sections taught by participants during the semester when this study took place, instructors indicated they used video in 116 (88.55%) of those courses. In those courses, instructors used an average of 23.13 digital videos per class. On average, instructors were using 9.47 videos that others had made and 14.04 videos that they had created per course section. Only 10.2% (5) of the instructors were not planning on making any video during the semester, while 69.4% (34) of the instructors were continuing to create digital videos during the
semester and another 20.4% (10) were considering it. To address the research questions, the focus of this study was on video that an instructor created, which according to the survey results make up 59.72% of all videos used in an average online course section investigated in this study.

**Overall CTML Design Principle Application**

Collected survey data addressed the quantitative oriented sub-question on which Cognitive Theory of Multimedia Learning (CTML) design principles higher education online instructors incorporated into self-made digital instructional videos. Instructors were asked to identify their “best” instructional video and to keep that video in mind as they responded to a series of eight dichotomous (yes/no) questions, three scaled questions, and ten Likert-scale questions addressing the eleven CTML design principles. The Likert-scale questions used a five-point scale consisting of “None of the time (0%)”, “Some of the time”, “Half the time (45 to 55%)”, “Most of the Time”, and “All of the time” (See Appendix C).

**CTML Design Principle Scales**

To identify instructors among the survey population who had the highest CTML design principle implementation in their self-created instructional videos, I created two scale scores. The first scale, which I labeled the simple CTML design principle score, was calculated by assigning 1 point for each response to the yes and no questions that indicated the application of the CTML design principle. Scores could range from 0 to 12 with extra weight given to the coherence principle for its audio and visual components. Among the surveyed instructors, the average score was a 7.0408, the median was 7, and the mode was 8. Scores ranged between 4 and 10. I used this score as the primary mechanism for identifying the five interviewed instructors.

The second scale, which I labeled the complex CTML design principle score, was calculated by assigning a point value between 1 and 5 to each Likert-scale response item. The
response associated with full implementation of the principle earned the instructor a score of 5, and scores proceeded down the Likert-scale in increments of 1. Thus, scores could range between 11 and 55. Among the surveyed instructors, the average complex CTML design principle score was 39, the median was 39, and the mode was 36, with scores ranging from 29 to 47. This score was used to break any ties among instructors’ simple CTML design scores for the purposes of selecting interview candidates.

The scales also provided a means of estimating overall application of the CTML design principles among the sampled population. I divided the average scale scores from the maximum potential score to create an approximate percentage of CTML design principle implementation within this population. The simple CTML design principle score is a less accurate approximation of design principle integration, as it fails to account for degrees of implementation. According to this scoring system, the population is implementing design principles 58.7% of the time. The Complex CTML design principle score provides greater nuance, and according to that scale, the population is implementing the design principles 70.9% of the time. The scales were a collective score and do not investigate the CTML design principles implementation at an individual level.

**Interviewed Instructors**

To identify the five instructors whom I would interview and collect a video artifact, I selected those with the highest simple CTML scale scores from the survey. I was unaware of interviewed instructors’ names until after I completed the identification process using survey data. The first two instructors I selected for interviews had the highest simple CTML scale score of 10. To fill the remaining three interview slots, there were six instructors with a simple CTML scale score of 9. One instructor indicated they were unwilling to share a video artifact, so I excluded them from the interview pool. To break the tie among the remaining five instructors, I
selected the three with the highest complex CTML scale score. Interviews were conducted between November 10, 2020 and December 4, 2020 using a semi-structured interview protocol and each lasted between 30 and 60 minutes (See Appendix D). I combined survey data and information from the interview to create a brief overview of each interviewed instructor. Instructors chose their own pseudonyms, which I used to protect their identities.

George

George, an Earth and Space Sciences instructor with at least ten years of broadcasting experience, taught 15 online course sections prior to teaching the 2 online course sections in the semester in which data collection occurred. When he first got into online teaching, he had a strong interest to do so and he has worked with me in the past to construct online courses. George was not using video in one of his course sections, while in his other course section, he recorded 73 videos himself and used 11 videos from others.

Kristine

Kristine teaches in the Languages and Cultures Department and taught 14 online course sections prior to the 2 online course sections she was teaching in the semester in which she took the survey. Kristine was using 36 videos that she created and 1 video that someone else made in 1 course and she was not using video in her second course section. She reported being strongly interested to begin teaching online. Kristine was the only interviewed instructor to indicate she was not making any videos in the current semester. Of the five interviewed instructors, she has worked with me the closest and the longest. She and I had recently consulted on video work in the summer prior to her interview.
Tessa

Tessa, from the Health Department, taught 6 online course sections prior to the 2 courses she was teaching in the semester in which data collection took place. In one of her course sections, she used 14 videos she created and 15 videos that others had made. In the second course section, she used 30 videos she made and 10 videos that others had created. Overall, Tessa was somewhat interested to begin teaching online. I was her assigned instructional designer, working with her twice a year regarding online course design.

Bertha

Bertha is an adjunct instruction in the Nutrition Department who taught only three online course sections prior to the one course she taught in the semester in which she completed the survey. In that one course she used only 1 video that someone else made and 85 videos that she created. When she first started teaching online, she was strongly interested to do so.

Tiana

Tiana is an instructor of nursing who taught five online course sections prior to the three online course sections she taught in the semester of data collection. She indicated in her interview that she had only been teaching online for two years, but she was strongly interested to begin teaching online courses. In the first online course she was teaching during the study, she used 16 videos that she created and 12 videos that others made. In the second online course, she used 14 videos that she created and 7 videos that others made. In the third online course, she used 4 videos that she made and 2 videos that others created.

In the next sections, I will share the perspectives of these 5 cases, along with the overall data from the 55 survey participants. I will first assess their application of each CTML design principle individually and then I will explore possible correlations among the design principles.
and other collected data. The CTML design principles are presented together with the other principles that address the same cognitive load moving in order from extraneous cognitive load, to intrinsic cognitive load to germane cognitive load.

**Instructors’ Application of the CTML Design Principles**

The study investigated instructor implementation of 11 Cognitive Theory of Multimedia Learning design principles. This chapter will address each of the 11 design principles which include (a) coherence, (b) signaling, (c) redundancy, (d) spatial contiguity, (e) temporal contiguity, (f) pre-training, (g) modality, (h) segmenting, (i) personalization, (j) embodiment, and (k) voice. For each principle, I provide the definition and the survey questions followed by the survey data. Then I describe the principle’s themes that emerged from the interview data before concluding with a triangulated analysis of the video artifact data.

**Coherence Principle**

The Coherence CTML design principle is in use when an instructor includes only elements needed to meet the video’s learning objective and nothing else. Specifically, coherence is the first of five CTML design principles that address extraneous cognitive load (Mayer, 2019). This principle applies to both visual and audio elements that an instructor uses in a video, so I included four questions in the survey to collect data on the implementation of the principle. The survey included two dichotomous response (yes or no) questions, one which asked if the video had music, and the other if it contained decorative visual or video that was not essential for learning. In addition, instructors responded to two related statements using a five-point Likert scale. The statements read, “The video contains music” and “visual or auditory elements that are not essential to the learning are included in the video to add interest.”
**Coherence Principle Application.** When considering the extent of instructors’ application of the coherence principle in their self-selected “best” instructional video created for use in an online course, I investigated the use of music and visual elements separately. In most instances of instructional video, an instructor’s use of music is an extra and unnecessary component in an instructional video (Gunnell, 2017). When asked if their best video included music, 90% (45) of instructors reported that their video did not contain music, while 10% (4) said their videos included music “only some of the time.” Thus, instructors are almost entirely meeting the coherence principle for use of music in an instructional digital video.

Instructors were not as definitive when it came to the use of extraneous visual elements. When responding to the yes or no question, “Does the video contain decorative visuals or video that are not essential for learning?” 73.5% (36) of instructors responded no and 26.5% (13) reported yes. Yet, when given the option to distinguish their use via the five-point Likert-scale, only 54% (27) indicated that they never used extra visual or auditory elements as a means of adding interest in the video they created while 34% (17) said they did include extra elements some of the time. Extra elements were included by 4% (2) of instructors in their video half the time, 6% (3) of instructors most of the time, and 2% (1) of instructors all of the time.

**Why Instructors Apply the Coherence Principle.** The survey data indicated most instructors do not incorporate music into a video but are less consistent applying the coherence principle with visual elements. Yet, the survey data does not capture the instructors’ reasoning behind those decisions. Five instructors who had the highest CTML design implementation scores were interviewed to gather insight into their video creation decision-making processes for the application of the coherence principle. Four themes emerged from the interview data, which assist in explaining why instructors applied components of the coherence principle. Two themes
provide possible explanations as to why instructors chose not to use music in their instructional video, the inappropriateness of doing so, and the barriers preventing its use. Two other themes, concise communication to benefit students and editing processes assist in providing possible explanations for the implementation of the coherence principle with the use of visual elements.

**Inappropriateness of Utilizing Music.** For four interviewees, their justification for not using music was centered on the idea of it being inappropriate for instructional environments. For instance, Bertha, who teaches nutrition courses, reported “[It is not] appropriate for the subject that I teach for me to use any music.” Specifically, Bertha perceived that music did not have a connection to her course content and might diminish the professional demeanor she was trying to convey via the video. Bertha’s response implied that music would distract from the primary focus of the video, which was to teach the content of the course. In comparison, Tessa, who teaches health courses, was less definitive than Bertha when she indicated she was unsure if music is appropriate to use in a video. Tessa expressed a desire to further investigate the incorporation of music into a video before making a decision. In contrast, Kristine, who teaches language courses, viewed music as “fluff” declaring, “I don’t use music for music sake [sic].” The implication in Kristine’s response is that music does not add value nor was needed to meet the instructional goal of the video. Finally, George had what he called a personal belief that it was inappropriate to use music with teaching or teaching of earth and space science. He called music “a great tool, but for whatever reason, I personally don’t like it. So I don’t do it, but I think it’s great.” He did not specify or clarify where this belief originated. The mixed message in his response demonstrated that while he is applying the coherence principle currently, the decision could change in the future.
The four instructors never stated the CTML research or coherence principle directly by name; however, they described the essence of the principle when they discussed the inappropriateness of incorporating music into a video. With Bertha, Tessa, and Kristine, there is an underlying assumption that they would not want to include music if it will not benefit the learner who is watching their video. In the instance of these “best” instructors, even though they were not citing the research directly, they were applying the concept with justifications in line with the principle.

**Barriers to Using Music.** While the decision of the interviewed instructors not to use music in a video appeared to be grounded in decision-making related to the concepts of the coherence principle, the data suggests that instructors were not willing to overcome the combination of barriers and appropriateness concerns. For example, Bertha saw copyright as a barrier to implementation of music into a video. She was concerned about violating or addressing copyright, implying the extra time and effort needed to address those concerns were not worth any projected benefit. Tessa’s barrier to incorporating music was a lack of technical skill, “[I would] love to figure out how to do it, but I just haven’t.” Her response indicated that she might switch to using music in the future if her technical skills improved, which demonstrated a lack of understanding of the coherence principle. If Tessa’s experiences are similar to other instructors, this may be an area of concern to attend to as instructor technical experience improves. While not explicitly about using music in videos, George indicated a desire to create video quickly and efficiently. When I asked if he uses an editing process, which is needed to add music to a video, he noted it was “too much work, [I’m] too lazy” and “I just want to shoot something have it done, plop, ready to move on.” Combining George’s previously mentioned lack of interest in
using music for teaching earth and space science with his desire for a speedy process provides a relevant explanation for why he did not incorporate music into his video.

Instructors reported copyright, technical skill, and interest as barriers to incorporating music into their instructional videos. While currently sufficient to prevent music use, these barriers may not last if instructors gain additional training, information, or experience. Further research would assist in determining how significant a role these barriers play in preventing the incorporation of music into instructional digital video.

**Concise Communication to Benefit Students.** When discussing whether to use or not use extra visuals or auditory elements, all five interviewed instructors described their intent to be concise and focused in order to communicate information in their video content. Bertha, Tiana, and Tessa explained their incorporation of concepts from the coherence principle as a means of benefiting students. Bertha was concerned that too many extra elements would distract students from learning when she remarked, “I think that if we spend too much time with fancy backdrops and changing our PowerPoint design every time, I think we distract the students from the content.” Bertha explained how she developed a video creation process that utilized a standard PowerPoint template for all of her videos. She viewed this action as one way in which she can ensure that when she tells students in her course “that the lectures that I prepare are short and topic focused” that she can follow through on that statement. Bertha’s remarks about the design of her videos are a direct restating of the coherence principle and then she connected that justification with assisting students with their learning.

Tiana’s explanation was similar to Bertha’s reporting, “Everything that’s in the video is meaningful and serves a purpose.” She wants to “directly link” how the video helps students meet their course objectives, a statement she made repeatedly during the interview. Tiana’s focus
on aligning course objectives to video content is also a restating of the coherence principle in her own words. Her intention may stem from a desire to not “get lost in a lot of fanciness, like, I don't want to become more an entertainer than a teacher.” Tiana’s focus on teaching over entertaining is student-learning focused and has shades of similarity to Bertha’s comments about the inappropriateness of using music for its lack of professionalism.

Tessa’s attention to helping students learn is less about distraction and more about the appropriate amount of content to keep students engaged. She described a balancing act during video creation as she wrestles with how much content to include for the students relaying, “I really want to keep it simple. I want to keep it relevant and pertinent to what it is that they're going to be doing. But I also want it to be enough for them.” Her desire is for students to want to watch the videos she created, and she recognized that longer videos and busy slides create situations that risk students not watching. Tessa is motivated to apply the concepts of the coherence principle out of a desire to ensure students watch and learn from the video content.

Kristine and George apply the coherence principle in the preparation stages of video production. Kristine tries to evaluate each informational component in the video to determine if each element was necessary or “nice to have” as she prepared the slides for use in her video. She would pare down the PowerPoint slide set from the textbook publisher to only the absolute essential elements. George also used winnowing processes for a concise message; however, his were formulaic in nature. He called an “effective presentation” one that started with a thesis, articulated three points with supporting information, and then ended with the thesis again. A second organizational formula was for his “field videos” or videos he created while he was out in the world away from his desk. He would start the video describing his location, tell viewers to look at some aspect in the camera’s view, explain “why we’re talking about this content,” and
then end with a concluding statement. The third organizational formula he described was to focus on “giving [students] information clearly concisely [sic].” He used an example with dew points to convey how he attempts to simplify his message for viewers. He posed:

Why would I say our dew points are in the 60s so its humid right now and tomorrow our dewpoints will be in the 50s so it won’t be as humid? Why don’t I just say, yeah, it’s still humid right now. Tomorrow though it is going to be a breath of fresh air. It’s not as humid. Much clearer communication, much clearer method message.

George relied on these formulas when creating his video as a measure for ensuring that he was remaining concise and clear with his message in order to benefit students.

**Editing Processes.** In addition to work done prior to the video creation to reduce/eliminate extraneous materials, interviewees also engaged in editing processes to review content and continue to trim down to essential elements. Each instructor’s editing process was unique. Bertha engaged in editing before recording. She would review her slides to look for punctuation. If she saw a sentence with punctuation she said, “That’s usually an indicator to me that I can go back and edit that down and make it into a short powerful phrase.” Tessa, who only uses PowerPoint to create her videos, would review the video after initial recording and sometimes go back and add a slide “because it may not seem clear.” Kristine didn’t add information when reviewing an initial recording, she “cut off parts that were not relevant.” George would also review his video after recording to consider how he communicated in the video. If he saw he was too wordy or went too long with an explanation he said he would redo it to try and be “more concise, a little bit more clear.” What set George apart from the other interviewees is that he also reviewed his videos after the semester. He described an example where he reviewed one video and found that it had a minute and a half that had no content and
was just him being conversational. He edited the video to cut that part off for the next semester because he wanted to “present information that you need.” All of the interviewed instructors took time to review and edit their videos to ensure that the message to students was focused on their objectives.

**Presence of the Coherence Principle in Video Artifact.** The video artifacts the five interviewees provided broadly supported the survey and interview descriptions. All five instructors responded on the survey with “no” or “none of the time” on the four questions asking about the inclusion of music or extra materials unrelated to the video’s learning objective. Bertha’s video artifact completely applied the concepts of the coherence principle and thus her responses on the survey were in alignment. The video did not use music, had no off-topic audio narration, and all of the visuals pertained to the video objective. Tessa and Tiana’s videos also were almost entirely in compliance with the coherence principle with one minor exception. Both Tessa and Tiana used screen recording to capture their computer screen, so standard elements of their computers such as the icon bar and the software menus and tool bars were visible in the video. Technically those items were not relevant to the stated goals of each video; however, they are also extremely prevalent in society and can be easily ignored by users. During the initial coding process, I didn’t consider them as extraneous because of their ubiquitous nature. Further research into the impact of these extraneous visuals is needed to determine if they impact student learning in videos where they appear. Otherwise, both Tessa and Tiana had videos in compliance with the coherence principle. For example, Tessa’s video described the steps students needed to complete for a class assignment. The video did not use music, had no off-topic audio narration, and all of the visuals pertained to the video objective.
George and Kristine’s video artifacts did not fully implement the coherence principle. George’s video artifact applied the coherence principle in 79% of the video because he had a segment at the end of the video in which he discussed an unrelated topic. For 30 seconds in a 2:20 long video, he broke from the instructional focus of the video, an overview of the geology of Crater Lake, to discuss the hazy view caused by forest fires which was unrelated to the instructional content he delivered. Kristine’s video had two visual elements that were extraneous to the video learning goal. Two images which were not discussed in the video nor clearly related to the video content were visible to the viewer for a total of 103 seconds or 15.1% of the 11:22 long video. Both George’s audio narration and Kristine’s extra visual elements could be considered extraneous materials, unneeded to meet the learning goal of the video and thus in violation of the coherence principle. This evidence demonstrates that while instructors may be applying the principles, they are not doing so from an understanding of the principle itself, but rather from other circumstances.

In summary, the coherence principle has two major components, audio and visual that an evaluator should consider when reviewing a video to determine the principle’s application. Nine out of every 10 instructors are not incorporating music into their instructional videos, and the one individual out of every ten who is using music is doing so for only some of their video. Interviewed instructors indicated that they don’t use music because they view it as inappropriate, unprofessional, and “fluff.” In addition to their views, some instructors identified barriers such as copyright, technical skill, and interest that contributed to their decision not to incorporate music in their video. The application of the visual component of the coherence principle was not as consistent as the audio component as only 54% of instructors indicated they did not use extra visual elements. The interviewed instructors were mostly successful at applying the visual aspect
of the coherence principle because they focused on providing a concise message to benefit their viewer and engaged in multiple types of review and editing of their video product.

**Signaling Principle**

The signaling CTML design principle is when an instructor uses highlighting for important information in a multimedia product (Mayer, 2019). Signaling can take many forms, as evidenced by examples found in the video artifacts collected from the interviewees. Highlighted in Figure 4 are examples including pointing with your finger which George utilized to point out elements of Crater Lake, outlining a key idea with shape and color which Bertha incorporated in the Protein video, or underlining as evidenced in Kristine’s language video. Instructors can also incorporate signals via narrator audio emphasis such as Kristine’s, “you can see a picture there on the right” or with cursor movements which Tiana used to draw viewer attention to elements of the paper she reviewed in her video. To investigate this principle, the survey contained one dichotomous response (yes or no) question which asked, “Does your video include cues (highlighting, arrows, etc.) to draw attention to important information in the video?” and a five-point Likert scale question that said, “Cues (such as changes in voice, highlighting, arrows, etc.) are used in the video to draw attention to important information.”
Figure 4

Examples of Signaling

Note. Screenshots from video artifacts demonstrating different types of signaling.

**Signaling Principle Application.** Just under half of the instructors or 47.9% (24) said they did not apply the signaling principle in their self-selected “best” instructional video created for use in an online course. The negative response dropped to 24% (12) when instructors responded to the Likert-scale question. As seen in Table 8, 26% (13) of instructors reported using signals in their best video some of the time, 14% (7) indicated half of the time, 28% (14) most of the time, and 8% (4) all of the time. There was discrepancy among the instructor responses as 24% (12) of instructors who originally responded that they did not use signaling on the dichotomous question switched their response to indicate that they did use signaling on the Likert-scale question with 16.7% (8) of instructors switching their no response to some of the time, 2% (1) switching to half of the time, and 4% (2) changing to most of the time. Assuming the Likert responses were most accurate, one out of every four instructors are not incorporating signals into videos they create.
Table 8

Instructor Signaling Principle Likert-scale Responses

<table>
<thead>
<tr>
<th>Likert-Scale Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None of the time (0%)</td>
<td>12</td>
<td>21.8</td>
<td>24</td>
</tr>
<tr>
<td>Some of the time</td>
<td>13</td>
<td>23.6</td>
<td>26</td>
</tr>
<tr>
<td>Half the time (45 to 55%)</td>
<td>7</td>
<td>12.7</td>
<td>14</td>
</tr>
<tr>
<td>Most of the time</td>
<td>14</td>
<td>25.5</td>
<td>28</td>
</tr>
<tr>
<td>All of the time (100%)</td>
<td>4</td>
<td>7.3</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>90.9</td>
<td>100</td>
</tr>
<tr>
<td>Missing</td>
<td>5</td>
<td>9.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Why Instructors Apply the Signaling Principle. The survey data indicated that instructor incorporation of the signaling principle varies considerably, but the data does not capture any detail about the types, frequency, or reasons for using signaling. All five interviewed instructors utilized forms of signaling in their best instructional video as a means of highlighting important information for viewers; however, the format of the signaling varied. Three types of signaling actions emerged from the interview data including vocal cues, shapes and colors, and finger pointing.

Vocal focus. In a video that is applying CTML design principles and in particular the modality principle, the creator presents most information via audio narration. Thus, it is logical that most of the interviewed instructors who were best at incorporating CTML design principles used some form of vocal signaling to highlight important information. Tiana explained that she approaches her video as a means to a conversation, similar to what she might do in the classroom with her nursing students, and that she uses her own voice as a tool for signaling important information. For instance, in discussing her editing process, Tiana used an example where she would show a video clip of a nurse and then say to students, “At this point, you can see that the nurse is interjecting.” Thus, she used a vocal cue to draw the viewers’ attention to the key idea.
just as she would have in a face-to-face classroom setting. Bertha’s decision to use vocal signaling was not classroom oriented, but instead focused on the importance of the phrases on her PowerPoint slides. She discussed choosing to read something on the screen aloud to the viewers articulating that “sometimes if it's a one of those phrases that's up there that's powerful I will read it because I'm really, I feel like it needs to be reinforced.” In that example, Bertha’s drawing on her own content expertise to make a decision about what information to vocally highlight. Bertha also mentioned that she will sometimes use phrases like “you’ll see here on the left” to draw attention to elements on her PowerPoint slides.

George’s use of vocal signaling appeared to derive from his video formula concept he uses for his field videos. George stated, “I'll know what concept I want to present and I'm just going to say, ‘Here I am. Look at this. This is why we're talking about this content. We're done’.” The evidence of signaling is when he says “Look at this” to draw viewers’ attention to a particular concept. For example, in his video artifact around the 10 second mark he says, “This was a gigantic, big volcano” as he points with his hand. In that example, he is combining the vocal cue with a physical cue to draw attention.

Kristine also uses vocal cues in combination with another signaling technique to draw viewers’ attention to key concepts. For example, she described a scenario when she would read onscreen text aloud articulating, “Even when I read, I would stress particular words and those words are normally in a different color.” In that example she combined a vocal cue with a color change. She also reported that when she reads text out loud, she “would stress particular words” another example of vocal signaling. When I asked a question about what she keeps at the top of her mind as she is preparing a video, Kristine responded with, “as you’re talking about the content some things are more relevant to the final project than others. And with those things I'll
say okay so this one is very important for the final project. Pay attention. And some of the others not so much. I wouldn't say that.” In that example, Kristine is mentally distinguishing the importance of the information she is conveying and using a vocal signal to draw viewer attention to the important elements of information in the video.

**Use of Shapes and Color.** In addition to the use of vocal cues, some of the instructors also incorporated shapes and colors to distinguish important information. Tiana learned to utilize this technique from watching K-12 teachers use it in videos her child watched during remote learning of the COVID-19 pandemic. She adds the shape cues prior to recording saying, “I'll just pull up what I want them to see, and then I'll like insert a shape with like a big red arrow or I’ll highlight the document.” In that example, Tiana is describing the use of both color highlighting and the incorporation of arrow shapes. Bertha uses a similar editing process but does it after recording, articulating, “I go through the lectures and I try to add in a few call outs, if you will, a few arrows that point to things.” She explicitly stated that her goal in adding these elements is “so people can see what it is that I’m talking about.” In addition to shapes, she also uses “red as the font color to highlight things.” Bertha is careful not to overuse signaling cues out of a concern that her videos would turn into video games and lose “some of the authenticity and some of the seriousness of the subject matter.” She was the only interviewed instructor to discuss limiting the use of signal cues.

Tessa’s motivation for using signaling cues appears to stem in part from a desire to create variety for her student viewers. Tessa mentioned that “I’ll put like you know things in circles or things in boxes. Just to change it up a little bit so it’s not just literally black writing on a white right background (chuckles) which I mean can be boring to watch, week after week after week.” Tessa’s use of signaling may not be for information highlighting, but instead as an engagement
tool. She also does some annotation editing work prior to recording stating that “part of the process is annotating the paper, you know, pointing out, you know, this is what a study design looks like, this is what a sampling looks like, etc. etc.” It is unclear from her response and her video artifact if the annotation work is in fact a form of signaling important information or just a method of organizing information. Even though he thinks other video creators should use highlighting in their videos, George does not use highlighting in his videos because he doesn’t have time for it.

**Finger Pointing.** The signaling technique that only George described incorporating in his videos is finger pointing. When he is recording, “[I will] point something out with my finger” a strategy he uses in both his field videos and his presentation videos. His description of how and why he uses finger pointing makes clear that he grasps the underlying concept of the signaling principle. He noted:

> When I point at something you look where I point. So when I do, do a video. It's important to me that I literally stick my finger, and you'll see me point to something I'll direct your attention to something, because I know you'll look and I know there are studies that will echo what I just said that says if I point at something you'll go to that. I think the same would be if someone made a lecture video and they have like a little circle thing. And all of a sudden like that text highlights the eyes would be drawn to that. So I think that's a powerful opportunity.

While he does not name the principle or the underlying theory, George is aware of research supporting the concepts of the signaling principle and his choice to use finger pointing. Even though he chooses not to use highlighting, he does recognize its value saying, “text highlights the eyes would be drawn to that.” Based on his comments about wanting to quickly create video and
the way he incorporates himself into the videos he makes, it appears that George defaulted to using finger pointing as a simple and easy method of signaling important information to viewers.

**Presence of the Signaling Principle in the video artifacts.** Measuring signaling in a video artifact is difficult as audio references, pointing with a finger, or circling an item with a mouse may take just a few seconds to occur whereas using a text color change, highlighting, or a callout box could be visible on the screen for minutes at a time. Because of this challenge, I chose to report both the number of times an instructor applied the signaling principle, as well as the percentage of the total video in which the examples were present. As evidenced in Table 9, there is a lack of congruence among instructor Likert-Scale responses and the information derived from their video artifacts indicating that instructors may not have a clear sense of the extent to which they are applying or not applying the signaling CTML design principle. For example, there is some discrepancy between the comments Kristine made about her use of audio signaling and the lack of evidence of such examples in her video artifact. The Likert-scale question may also be unreliable and thus further research is recommended for determining how instructors apply this principle.

**Table 9**

*Instructor Survey Responses and Instances of Signaling in their Video Artifact*

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Used Signaling?</th>
<th>Likert Response</th>
<th>Instances of Signaling</th>
<th>Percent of Video in Use</th>
<th>Video Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tessa</td>
<td>No</td>
<td>Some of the Time</td>
<td>0</td>
<td>0.0</td>
<td>05:45</td>
</tr>
<tr>
<td>Kristine</td>
<td>Yes</td>
<td>Most of the Time</td>
<td>4</td>
<td>20.2</td>
<td>11:22</td>
</tr>
<tr>
<td>Bertha</td>
<td>Yes</td>
<td>Some of the Time</td>
<td>7</td>
<td>79.3</td>
<td>11:07</td>
</tr>
<tr>
<td>George</td>
<td>Yes</td>
<td>Half the Time</td>
<td>9</td>
<td>10.7</td>
<td>02:20</td>
</tr>
<tr>
<td>Tiana</td>
<td>Yes</td>
<td>Half the Time</td>
<td>15</td>
<td>5.0</td>
<td>07:40</td>
</tr>
</tbody>
</table>

Data I gleaned from the video artifacts confirmed the interview discussions from George, Tessa, and Bertha. All nine of George’s instances of signaling were his finger or hand pointing to
various elements of the Crater Lake geography which affirms what he discussed during the interview (See Table 9). Aside from the Likert question response indicating she used signaling some of the time, the remainder of Tessa’s data from the survey, the interview, and the video were in alignment. The video artifact she shared did not include any examples of signaling. The boxes and red text referenced during Tessa’s interview and visible in the video were used to organize information and not to signal important information. Bertha’s video contained signaling examples that used yellow callout boxes and red text which is congruent with her interview discussions.

While the video artifacts did confirm the use of some signaling techniques discussed during the interviews, they also highlighted additional techniques that the instructors used to indicate the importance of information. For instance, all 15 examples of signaling found in Tiana’s video artifact used mouse circling or moving the cursor around an item to highlight it. Kristine had an instance of underlining to signal the importance of a word and used bolded text to signify the importance of certain words and phrases on two slides of her presentation.

In summary, the survey data indicated that one out of every four instructors are not using the signaling principle in videos they created, but for those instructors who do there are many different methods for highlighting important information. Signaling via vocal cues is a natural extension of the application of the modality principle and a popular method among the interviewed instructors. Some instructors choose to signal with shapes and colors inserted prior to recording or during the editing stage after recording. One instructor utilized his own finger to point out key information and was the only instructor interviewed to reference research supporting the use of his signaling technique.
Redundancy Principle

An instructor applies the redundancy principle in a video when onscreen text visible to a viewer is not read aloud by the video narrator (Mayer, 2019). To measure the principle’s use by instructors, I used two survey questions: a scale question which asked instructors to approximate the percentage of the video containing text on the screen that was also read by the video narrator and a five-point Likert-scale question for the statement “Text is included on the screen at the same time that a narrator is speaking it.” The scale question provided instructors with options ranging from 0% to 100% in 10% increments.

Redundancy Principle Application. The extent to which instructors applied the redundancy principle in their self-selected “best” instructional video is evidenced in Figure 5 which reveals that 12.2% (6) of instructors reported completely following the principle and 22.4% (11) kept their reading of onscreen text to approximately 10% of the overall video. Another 34.6% (17) of instructors reported between 20% and 50% of the onscreen text being read aloud by the narrator while the remaining 30.5% (15) reported reading aloud onscreen text in more than half of the video. Instructor responses on the Likert-scale question were less favorable to the application of the principle even though 12% of instructors continued to indicate they did not have onscreen text read aloud by the narrator. Only 16% of instructors indicated they had on screen text read aloud some of the time and 12% half the time. A total of 60% of instructors indicated that the narrator in their video read on-screen text aloud either most of the time (28%) or all of the time (32%).
Why Instructors Apply the Redundancy Principle. With more than 60% of instructors failing to apply the redundancy principle in a substantive way, the instructors who are best at applying the CTML principles overall can reveal methods that provide opportunities for corrective action. Two themes emerged that have the potential to improve instructor application of the redundancy principle, (a) instructor use of certain visual designs and (b) improvements that come with experience. A third theme, (c) an instructor’s need to reinforce key concepts may explain why some on-screen text was read out loud by the video narrator.

Visual Design Influence. One method for improving instructor application of the redundancy principle is to create videos that reduce or eliminate on-screen text so reading slides out loud becomes difficult or impossible. For example, George applied the redundancy principle in full because his field videos don’t contain any onscreen text. Thus, it is impossible for him to have a narrator reading text that is also being displayed on the screen. Bertha recognized this
method as a possibility for her video creation process and identified it as an area she was working to improve. She described her editing processes as “it's really a matter of trying to keep as few words on the slides as possible while still giving them the necessary information that they [students] need.” Bertha also utilized this concept, without recognizing it, when she explained how she creates three-minute weekly wrap-up videos with just her talking to the camera. Tessa also indicated that she doesn’t like her PowerPoints to be “really wordy” because she found it to be “really distracting, even as somebody who’s reading them.” Tessa went on to explain, “What I’ll do is I’ll you know have like the word show up and then I’ll be like this means blah, blah, blah, blah.” Tessa let the on-screen words serve as her guide and then narrated the explanation rather than include the explanation on the slide. All three of these instructors utilized video design elements to create situations in which they would not be tempted or could not be tempted violate the redundancy principle by reading read on-screen text out loud.

**Improvement with Experience.** Another method the instructors reported helping them improve on their application of the redundancy principle was gaining video creation experience. Bertha mentioned that she initially read more on-screen text aloud when she first started recording videos because she “was very uncomfortable with the camera,” and she was also “concerned that I presented all of the material properly and said things correctly and gave the correct statistics.” As a new video creator, she relied on the text displayed on the screen to help her convey correct information at the expense of applying the redundancy principle. As she gained more creation experience, she improved and now she does not “read as many words off the screen as I used to.” One motivation for improvement came via student feedback. Bertha said, “I've even gotten you know comments over the semesters from students who say, you know, sometimes it looks like you read a lot off the screen in your PowerPoints.” Based on the
student feedback and creation experience, she recognized, “It would be awesome if I never ever had to read a word off of the screen in front of me, but I don't know that that's a realistic goal.” She is aware that this is something to strive for, but also recognizes that she has not fully met this expectation in her current work.

**Reinforcing a Key Concept Leads to On-Screen Reading.** A third theme to emerge on why instructors may not always apply the redundancy principle is a desire to emphasize or reinforce a key concept. For example, instructors may need to signal the importance of a particular element in the video through vocal narration that requires that they speak the text currently visible on the screen. Bertha reported:

[I don’t] read as many words off the screen as I used to. However, sometimes if it's a one of those phrases that's up there that's powerful I will read it because I'm really, I feel like it needs to be reinforced, not just by being there visually for the students but by them hearing it spoken out loud.

Bertha appears willing to violate the redundancy principle in order to engage in the signaling principle. Evidence suggests that she based this decision on her own understanding of the information’s significance. Tessa also identified an approach that focused on speaking the on-screen text as a means of emphasizing key vocabulary explaining, “Sometimes it has to happen just because if it's a definition for example it has to happen.” She quickly followed that statement with the qualifier, “I try not to do a lot of it,” demonstrating that she understands it is not desirable. Kristine described reading onscreen text aloud, but also demonstrated confusion around the subject. When I asked her if she spoke any text on the screen when making the video she replied in the affirmative, then the negative, and then “I do. But then, most times I read, and then I would elaborate.” Given this response and data from her video, Kristine’s method is to
read the onscreen text and then elaborate with additional explanation. She justified this decision by indicating that the elements of on-screen text that she reads out loud are needed to indicate importance to students.

**Presence of the Redundancy Principle in the Video Artifacts.** Among the five instructors, there was a range of congruence among the data from the survey, the interview, and the video artifacts, with some instructors reporting data that aligned among the three sources and others with data that conflicted. As seen in Table 10, George and Bertha had data that appears to be mostly or completely congruent. For example, George applied the redundancy principle in full because his field videos don’t contain any onscreen text. He didn’t give any indication in the hour-long interview that he ever reads aloud from slides. He reported none of the video contains text that appears and is read by the narrator on both survey questions addressing this principle. Bertha had mixed responses on her survey reporting she read onscreen text aloud 50% of the time and “all of the time” on the two survey questions. Her video had 28 instances of redundant reading accounting for 12.89% of the total video time and her interview contained descriptions of when she did read the on-screen text and her efforts to cut back on it.

Tiana and Kristine had congruence among the interview and video data, but not with their survey responses (See Table 10). For example, Tiana reported that she doesn’t read aloud on-screen text “because if they [students] want to read it, then they can, they're capable of reading.” She saw this as an extension of her face-to-face classroom behavior as she “wasn't the type of person in the classroom to read a slide to people.” When I asked her how much of the text that is shown on screen did she read to students in the video she replied, “None, okay, well let's it will say like 5% because I probably do it every once in a while.” Her video artifact supported her interview assertion with only 8 instances of redundant reading accounting for 6.74% of the total
video length. Yet in the survey, Tiana indicated she read on-screen text 30% of the time and most of the time on the Likert scale question, which would suggest a higher rate of on-screen text reading by the video narrator. Kristine responded on the survey that she read on screen text aloud 100% of the time in her “best” instructional video and responded via the Likert-scale that she did it most of the time. Her video artifact had 32 instances of redundantly reading text that was also displayed on the screen accounting for 17.89% of the total video time. In the interview, Kristine articulated a method where she reads some of the text and then explains it. Based on the data from these three sources she too appears to be over stating her use of on-screen text reading in the survey responses.

Finally, Tessa did not have congruence among the three sets of collected data. She said during the interview, “I try not to like just read off the slides because that kind of defeats the purpose of me doing the video.” This may be in part because she doesn’t like her PowerPoint slides to be “really wordy.” Slides without words or with few words made it easier for her to meet the redundancy principle. However, she reported on the survey that 90% of her video had the narrator reading aloud onscreen text and responded with most of the time on the Likert question which is almost the opposite of her interview data. Tessa’s video had 9 instances of redundancy, accounting for 18.84% of the total video time.
Table 10

Survey and Video Data on Instructors Use of the Redundancy Principle

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Survey Responses</th>
<th>Video Artifact Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent On-screen text read aloud?</td>
<td>Instances of Redundancy</td>
</tr>
<tr>
<td>Tessa</td>
<td>90 Most of the Time</td>
<td>9</td>
</tr>
<tr>
<td>Kristine</td>
<td>100 Most of the Time</td>
<td>32</td>
</tr>
<tr>
<td>Bertha</td>
<td>50 All of the Time</td>
<td>28</td>
</tr>
<tr>
<td>George</td>
<td>0 None of the Time</td>
<td>0</td>
</tr>
<tr>
<td>Tiana</td>
<td>30 Most of the Time</td>
<td>8</td>
</tr>
</tbody>
</table>

Summarizing the findings regarding the redundancy principle, over 60% of instructors reported that the narrator in their video read on-screen text aloud in 20% or more of the video. The five interviewed instructors highlighted themes that provide guidance on how to avoid speaking aloud on-screen text and explain why it may be occurring more frequently than expected. The visual design of a video can assist in negating the possibility of a narrator reading on-screen text out loud. Instructors who gain experience by creating videos and receiving student feedback about them can lead to an improvement in meeting the redundancy principle. Nevertheless, instructors may find it necessary to occasionally violate the principle in order to meet the signaling principle. Again, instructors do not appear to be aware of the CTML-specific research around this principle.

Spatial Contiguity

Shifting from text and narration to text and images, an instructor applies the Spatial Contiguity CTML design principle when they create a video in which all related words and images appear together (Mayer, 2019). The survey included one dichotomous response (yes/no) question, which asked if related words and images were presented near each other in the video.
and a five-point Likert scale statement that said, “Text is included on the same screen as the picture or footage for which it applies.”

**Spatial Contiguity Principle Application.** The extent to which instructors applied this principle in their self-selected “best” instructional video was self-reported at 79.6% (39) on the dichotomous question, meaning 20.4% (10) of instructors reported not applying the principle. As has been the case demonstrated in the last few CTML design principles, instructors changed their response when given the opportunity to provide a more detailed response via the Likert-scale question. As evidenced in the crosstabulation of Table 11, 10.2% (5) of instructors switched from a no response to a positive response on the Likert-scale and 4.1% (2) of instructors changed from a yes response to none of the time on the Likert-scale question. There were 38.78% (19) of instructors who responded that they always included text on the same screen as the picture or footage for which it applies and another 20.41% (10) who reported doing it most of the time. Of the remaining instructors, 12.24% (6) reported keeping text and related images together half of the time, and 14.28% (7) reported some of the time, and another 14.28% (7) none of the time.

**Table 11**

*Crosstabulation of Questions Addressing Spatial Contiguity*

<table>
<thead>
<tr>
<th>Likert Scale</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None of the time (0%)</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Some of the time</td>
<td>6</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Half the time (45 to 55%)</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Most of the time</td>
<td>9</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>All of the time (100%)</td>
<td>17</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>39</td>
<td>10</td>
<td>49</td>
</tr>
</tbody>
</table>

**Presence of the Spatial Contiguity Principle in the Video Artifacts.** None of the five interviewed instructors mentioned the spatial contiguity principle during their interview. Three instructors did not include non-text visuals in their videos. George had only images of Crater
Lake and no text on the screen. Tessa’s and Tiana’s videos were reviews of assignments which meant that all of the visual components were text, rendering the principle moot. Two instructors incorporated only one visual related to the video content. Bertha had one visual in her presentation explaining how proteins transport substances throughout the body, and as seen in Figure 6, it had text labels in close proximity to all the visual components. Kristine had four images in her video, but only two were relevant to the video content and both were in close proximity to the related text. For example, as seen in Figure 6, she had the text “Word walls” to the left of an image of a word wall.

**Figure 6**

*Example Screenshots of Spatial Contiguity*

Three instructors had complete congruence between their survey and video data while two others did not. George’s survey responses accurately reflected the conditions of his best instructional video because he responded no to the question about related words and images being near each other and responded with none of the time to the Likert-scale statement. His condition may be relevant for other instructors who responded no on the survey. The collected survey data is insufficient to determine if this is true for other instructors and thus further research is needed on the application of this principle. Bertha and Kristine also had alignment between their videos and survey responses as they reported “yes” and “all of the time” on the
survey and had videos with images near related text. Tessa and Tiana both didn’t have any non-textual visuals in their video artifacts, but Tessa reported in the survey that she kept images near corresponding text all of the time, and Tiana indicated she did so half the time.

In summary, the interviewed instructors did not address the spatial contiguity principle or any concepts related to it during the interviews. Three of the five interviewed instructors used a video style that rendered the principle moot. With the survey data indicating that 28.56% (14) of instructors are not meeting this principle, further research is needed to determine the extent of its application.

**Temporal Contiguity**

The temporal contiguity principle is the fifth CTML design principle to address extraneous cognitive load, and it states that images should appear as the narrator discusses them (Mayer, 2019). I included two questions in the survey to collect data on the implementation of the principle. The first question was a scaled question that asked instructors to indicate the approximate percentage of the video containing audio narration spoken at the same time as related images were appearing on the screen using a range from 0% to 100% in 10% increments. The second question asked instructors to respond to the statement, “The video narration occurs at the same time as related images or video footage” using a five-point Likert-scale.

**Temporal Contiguity Principle Application.** The extent to which instructors self-reported their application of this principle in their “best” instructional video is evidenced by the data in figure PPP. Among the surveyed instructors, 32.65% (16) reported 100% application of the principle, with another 22.45% (11) indicating the principles application in 90% of their video. Adding in the 20.4% (10) of instructors who applied the principle, either 80% or 70% of the time, three quarters (75.51%) of the surveyed instructors were incorporating spoken audio at
the same time as related images in more than half of their best video. On the other extreme, 12.24% (6) of instructors indicated that 0% of their video had images appearing as discussed by the narrator. Another 12.24% (6) of instructors indicated application ranging from 10% to 50% of the video. Instructor reported application declined slightly with the Likert-scale question as 60% (30) of instructors selected all of the time or most of the time, 12% (6) selected half the time, 16% (8) selected some of the time, and 12% (6) selected none of the time.

**Figure 7**

*Frequency of the Temporal Contiguity Principle Application Rate*

![Bar chart showing the frequency of application rate for the Temporal Contiguity Principle. The x-axis represents the percentage of video containing audio narration spoken at the same time as related images appear, ranging from 0% to 100%. The y-axis represents the frequency of instructors who applied the principle at each percentage level.]

**How Instructors Apply the Temporal Contiguity Principle.** The survey indicated that somewhere between 60-75% of instructors incorporated audio narration that explains on-screen visuals in a majority of their video, but the data does not articulate how this process occurs. The five interviewees reported on the survey that their “best” instructional video incorporated narration at same time as related images in either 90% or 100% of their video. Data from those interviews revealed a technique that helps to explain how instructors meet the temporal
contiguity principle and a related variation. The technique involves instructors displaying a
content-based image or figure and then narrating about it with a sub-variation of the technique
involving tracing or drawing out a process.

All the interviewed instructors described a process where they display a content-related
image and then discuss it as part of the video creation process. When asked to explain why she
used PowerPoint when making her video, Kristine articulated the temporal contiguity principle
connecting the idea of displaying and discussing a visual, “there does need to be some kind of
visual for students because it's a multi-modality of um instruction where what you say and what
students see they must go together and PowerPoint does that really well.” George indirectly
described the temporal contiguity principle as he gave an example of how he incorporates images
with what he is narrating, “I'll do pictures and say, hey, you will need these tomorrow - you will
need sunglasses - and a I’ll point to the picture.” In that quote, he is speaking about sunglasses
and the need to use them at the same time he points to the picture of sunglasses. Tessa used the
technique, but for a different reason than those articulated by Kristine and George. She doesn’t
include a lot of text on her slides, but rather uses figures or pictures. She described her process
as, “I kind of walk them through what the figure is showing or if it's a picture, walk them through
the what the picture is showing related to the concepts were learning about.” Tessa used an
example of discussing health disparities to emphasize her technique saying, “I have you know a
collage picture… and I kind of talk through what the disparities are.” Again, her example
describes the pattern of displaying an image and then discussing it.

A related variation of the display and discuss technique is when the instructor traces or
draws the image as they discuss it. Bertha described her implementation of this related process
as, “we’re spending the entire time looking at one graphic image as we trace, you know, the
carbohydrates through the metabolic pathways.” Bertha has a process image displayed and then works through a sequence of describing its components. Another example of the display and discuss technique appeared in Tessa’s interview when she discussed a similar concept for a flow chart, “So what I do is I include the figure that kind of has like the flow chart for program planning but then I go through each of the different steps individually to illustrate how they're all kind of linked together, but how you go from one step to the next.” Tiana had the most involved method for implementing this technique because she used a specific tool, Educreations, to create video of images with her narration, explaining:

So I'll copy and paste a print screen onto Educreations. I’ll draw on it. Like if I need to diagram, something like let's say I want to take a picture of a heart, right. And I want to draw on it right to show the flow of blood or something. I'll use Educreations for that. Educreations is a tool that allows for narration of diagrams or drawings, thus allowing an instructor to apply the temporal contiguity principle in a video.

**Presence of the Temporal Contiguity Principle in the Video Artifacts.** The video artifacts the five interviewed instructors submitted demonstrated that three instructors were consistent among their survey and interview responses and two were mostly consistent. In their videos, George and Bertha always discussed the images they were displaying and thus fully met the temporal contiguity principle. The video artifact supported their survey responses of “100%” and “all of the time” to the questions about narration occurring at the same time as relevant visuals. Tessa did not have images in her video, so the temporal contiguity principle did not apply. Her video provides an example of a situation in which the temporal contiguity principle may not be relevant for certain instructors and may help to explain why some instructors responded on the survey that they did not have images appearing as the narrator discussed them.
Tessa chose to respond on the survey with “100%” and “all of the time” which are both accurate responses given her video artifact. These three instructors had alignment among their data.

Two instructors had partial alignment among the three data sets. On the survey, Kristine indicated that 100% of the visuals appear as the narrator discusses them and the video artifact partially supported that response. Kristine had four images and one diagram in the video, and two of the images could be considered decorative. She did not discuss the decorative images but did reference the other two images and the diagram shortly after they appeared. For those images, she referenced she fully met the principle; however, for the two images she didn’t reference the principle was not met.

During her interview, Tiana discussed creating other types of video and alluded to the use of the temporal contiguity principle mentioning, “The other type of presentation I'll do is a navigational thing and that's really just me showing them the different parts of the D2L site.” A portion of her video artifact included her use of the technique she described. She displayed the weekly page in D2L with the information related to the assignment she was explaining as she demonstrated where students were supposed to navigate to find the assignment. The rest of the video did not include visuals and thus met the temporal contiguity principle. Tiana reported that 90% of images appeared as discussed in the video and responded with most of the time on the Likert-scale question. While not perfectly aligned with the video artifact, both survey responses are close. The discrepancy is attributable to a combination of the lack of precision in the survey instrument and instructors lack of detailed knowledge regarding the CTML design principles.

In this study, 90% of narrators discussed images as they appeared in instructional videos. The primary way in which the interviewed instructors met this principle was through a technique where they would display an image and then discuss it. A related variation on this technique was
to draw or diagram a process or figure as it was narrated. The three sources of data remained mostly consistent regarding this principle; however, instructors did not appear to have in-depth knowledge or understanding of the principle even though they were applying it properly.

**Pretraining**

Pretraining is a challenging design principle to investigate because it does not directly relate to the video itself. Instead, pretraining concerns the instructional context of the video. The principle states that, prior to their viewing of a multimedia product, instructors should provide terms and definitions of key concepts for learners (Mayer, 2019). The survey included one dichotomous (yes or no) question which asked instructors, “Were students taught general concepts or key vocabulary found in the video prior to viewing the video?” It also contained one statement that said “General concepts and / or key vocabulary are taught prior to students viewing the video” which instructors responded to via a five-point Likert-scale.

**Pretraining Principle Application.** Two-thirds of the instructors, or 67.3% (33), said that they did teach students general concepts or key vocabulary from the video before students were expected to watch it. Drilling down on that use via the Likert-scale question, 30% (15) of instructors said “all of the time”, 24% (12) said “most of the time,” 6% (3) said “half the time,” 16% (8) said “some of the time,” and 24% (12) said “none of the time”. Thus, one out of every four instructors reports that they are not instructing students on key vocabulary or concepts prior to watching their instructional video.

**Why Instructors Apply the Pretraining Principle.** None of the five instructors explicitly stated that they taught general concepts or vocabulary prior to having students watch their video, even when asked what students did before they watched the video. Two themes
emerged regarding why instructors may or may not be applying the pretraining principle: (a) pedagogical approach to using video and (b) course structure.

**Pedagogical Approach to Using Video.** One theme to emerge as a possible justification for why instructors may not fully apply this CTML design principle is their pedagogical approach to using video in an instructional setting. If an instructor has a pedagogical approach that provides students with choices as to how they engage with learning material and does not presuppose students will engage in a defined order, that instructor cannot ensure that the pretraining principle is implemented. This pedagogical approach of student choice appears to explain why George indicated on the survey that he teaches general concepts or key vocabulary prior to the students viewing a video only half the time. In discussing how he organizes his course George said, “I want two redundant sources of that content in a readable medium in case a student’s [sic] lazy and doesn’t want to watch the videos and they just want to be quick. I want them to have that choice.” Later in the interview George went into greater detail, “Everything you need for the class is video. It’s repeated as PowerPoint slides” and then again reaffirms his desire for students to have flexibility saying, “I want to make sure my class gives you the flexibility.” George’s teaching approach does not assume that students would engage in a pretraining activity as part of his course prior to watching a video, yet they do have that option if a student chooses to review the PowerPoint before watching the video. While he does not explicitly say so, George’s response is predicated on providing students with choice in how they engage with the course content.

Where George’s approach allows for the possibility of pretraining, Kristine’s pedagogical approach does not. She was the only one of the five interviewees who reported on the survey that she did not adhere to the pretraining principle with her “best” instructional video. Explaining
why during the interview, she noted that she saw video as a means for the sharing of information occurring as part of a series of activities that students did to prepare for a synchronous session. She represented the videos as the initial training component in her course and considered them a textbook replacement. The pedagogical approach of viewing the video as a textbook and having students engage with it before a synchronous class time is an approach that does not leave space for a pretraining activity.

**Course Structure.** A second and related theme impacting the incorporation of the pretraining principle is an instructor’s utilization of the structure of an online course. Certain course structures are needed in order to create the opportunity for pretraining to occur, and there are course structures which would preclude pretraining from occurring in a timely manner. For example, Tessa described her course structure saying, “So the first thing in the actual content for the week is going to be the video that comes up. So it’s the video, um the slides and then anything supplemental and then after that I have a um link to a discussion board that they have to complete.” In Tessa’s course design as she described it, there is no opportunity for pretraining to occur in the weekly unit because watching the video is the first action that occurs. It is possible that a pretraining action could occur in a previous week; however, the effectiveness of pretraining at such a time distance from the actual viewing is an area in need of further research.

On the opposite side of the course structure spectrum, Tiana and Bertha both have a course structure that allows for the possibility of pretraining to occur, although both did not explicitly state that it happens in their courses. Tiana reported, “Before the students watch the video, they are doing their assignment or they are participating in their discussion board” and Bertha said, “And within each module there are these different topical videos that people are watching and that is to compliment the readings that they do in their textbook and any other
assigned journal articles that I may have assigned for them to read.” In both of those instances, students would be engaging in activities that could include pretraining prior to watching the instructional video. While neither instructor explicitly states that pretraining occurred, the possibility exists in the course structure they described.

**Presence of the Pretraining Principle in the Video Artifacts.** Detecting pretraining in a video artifact is impossible unless there is a specific reference to a previous activity in the video. George and Kristine had no references to previous materials or lessons in their videos. Bertha had two references that suggest the possibility of a pretraining existence but do not confirm its presence. For example, she said, “Some of the important ones that we think about that we’ve talked about already in this nutrition course are insulin and ghrelin, and glucagon.” Students may have had a pretraining activity that addressed insulin, ghrelin, and glucagon, but it is also equally likely that those items were addressed in another video. Her survey responses indicated that pretraining did occur and, since her course structure allows for the possibility, the triangulated data appears to confirm Bertha’s application of the pretraining principle.

Tessa and Tiana created videos explaining upcoming assignments. In their videos, they did reference previous assignments, which could be considered examples of pretraining. Tessa said in the video, “This ah [activity] should have been completed on your EDNP worksheet.” and Tiana’s narration included, “Now in our APA assignment from our database search we learned how to cite or how to present one source. Now we are going to expand that to three.” In both instances, the instructors refer to previous student work that the students will use in the assignment that the instructor is explaining in the video. The instructors references to previous student work could be considered examples of pretraining. Tiana’s video, survey, and interview data are in alignment and appear to confirm her application of the pretraining principle. The
video data and survey data from Tessa indicate the presence of pretraining in her course, yet her interview description of the video’s position in the online course does not, leaving a question about her understanding of the pretraining principle.

In summary, the interviewed instructors demonstrated two concepts that can impact implementation of the pretraining principle and assist in explaining how three out of every four instructors are teaching general concepts or key vocabulary prior to video viewing. The first concept is an instructor’s pedagogical approach, which can positively or negatively impact the use of pretraining. For example, if an instructor has a pedagogical approach which provides students with freedom to move through course content in their own way, they cannot guarantee that pretraining will occur. The second impact on the implementation of the pretraining principle is the online course structure. If a video is the first activity a student engages in for a given online unit, then the structure precludes the use of pretraining; whereas if the video comes after other activities, then the course structure allows for pretraining to occur. Evidence from the three data sources indicates that among the five interviewed instructors there is no explicit knowledge of the pretraining principle.

**Modality**

Another CTML design principle to address intrinsic cognitive load, the modality principle, states that words should be presented via audio narration rather than as text on the screen (Mayer, 2019). The survey had one dichotomous response (yes or no) question which asked, “Does the video contain audio narration?” and one statement instructors responded to via a five-point Likert scale which said, “The video contains audio narration.” I assumed that if a video included narration, the narration would be the primary means of communicating text-based information.
**Modality Principle Application.** Audio narration was present in 97.91% (47) of instructors self-selected “best” instructional videos and 2.1% (1) reported it was absent. The Likert scale responses delineated instructor use of audio narration with 76% (38) reporting the video contained audio narration “all of the time” and another 22% (11) indicating it contained audio narration “most of the time,” and 2% (1) reporting “none of the time.” If the assumption that instructors are using narration to communicate text-based information is true, then instructors appear to be thoroughly implementing the modality principle.

**How Instructors Apply the Modality Principle.** To add support to the assertion that audio narration is the primary means of communicating information, I examined the interview transcripts from the five instructors for evidence that would prove or disprove the assumption. All five interviewees indicated the importance of audio narration for communicating essential information. Bertha reported that "What matters is what I’m saying,” and Tessa described her primary mechanism of delivering information as “walking through and explaining things.” Kristine articulated a narration process of “most times I read, and then I would elaborate.” All three instructors saw their narration as a critical component of the video. George also viewed narration as a significant component of the communication process, as he spent substantial portions of the interview describing how he attempted to communicate a clear message or “weather story” as he called it. In addition, he described a scenario where if he did not like the audio of a video, he would strip it out and do it again. He would play back the video while recording a new audio track on his phone. Both his focus on story and his anecdote of reworking audio demonstrate that he places value on the audio medium for communicating information. Tiana described her video process as “giving a presentation,” which has an underlying
assumption of narration as a key component. Based on the interview data, all five interviewed instructors used audio narration and appeared to be implementing the principle.

**Presence of the Modality Principle in the video artifacts.** While the self-reported data from the instructors demonstrated a positive application of the modality principle, a review of the video artifacts was necessary because it is possible that audio narration is supplementing information conveyed through on-screen text. Because of the close relationship between the modality principle and the redundancy principle, I also utilized the data regarding on-screen text being read aloud by a narrator to assist in approximating how well words were spoken rather than presented on screen. I reviewed the five video artifacts for evidence of the modality principle’s application and found compelling evidence that the principle is not being met.

Among the five instructors, only George fully met the modality principle because there was no on-screen text in his video, as all words were presented via audio-narration. As seen in Table 12, the remaining four instructors had significant portions of their video with on-screen text that could be considered important information which was not being spoken by the narrator.
Table 12

Percentage of Video with Textual Slides and Redundant Reading

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Majority Text Slides (percent)</th>
<th>Redundant Reading (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>George</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Kristine</td>
<td>47.36</td>
<td>7.92</td>
</tr>
<tr>
<td>Bertha</td>
<td>82.46</td>
<td>12.59</td>
</tr>
<tr>
<td>Tiana</td>
<td>100.00</td>
<td>6.74</td>
</tr>
<tr>
<td>Tessa</td>
<td>100.00</td>
<td>18.84</td>
</tr>
</tbody>
</table>

Note. Redundant reading reported in this table was only measured during the majority text slides time frame.

The evidence indicates that substantial information was conveyed via on-screen text, with some information read aloud and some not, which would not meet the modality principle. Given the disconnect between the initial survey questions and the video artifact findings, it appears that the initial question was not sufficient to properly measure instructors’ application of the principle.

In summary, 98% of instructors are utilizing audio narration to convey information in their self-selected “best” instructional video, and this was fully supported by data from the interviewed instructors. However, the modality principle is not applied if audio narration is present, there must also be a lack of on-screen text. The video artifacts from four of the five instructors demonstrated that significant portions of on-screen text existed in the videos and were conveying important information. The data appears to indicate that instructors do not have a full grasp of the entirety of the modality principle.

Segmenting

The CTML design principle of segmenting is in use when an instructor creates a multimedia product that is divided into organized and manageable chunks or segments (Mayer, 2019). Because organization can be contextual, I used video length as a measure for addressing this principle across disciplines and included one question in the survey which asked instructors
to report the length of their “best” video. For analysis purposes, I divided responses into time segments of less than 1 minute, 1 to 3 minutes, 3 to 6 minutes, 6 to 15 minutes, and over 15 minutes based on a combination of research and my own experiences as an instructional designer. According to Guo et al. (2014), videos of six minutes or less maximized student viewing until the end of the video and the Quality Matters Higher Education Rubric, Sixth Edition (2018) lists 15 minutes as the length videos need to remain under to meet their standards.

**Segmenting Principle Application.** Instructors’ implementation of the segmenting principle in their self-selected “best” instructional videos as measured by video length varied considerably, ranging from 1 minute to 1 hour and 15 seconds. The average video length was 15:43, the median was 11:08, and the standard deviation was 13:10. Videos longer than 15 minutes were reported by 38.3% (18) of instructors and another 42.6% (20) of instructors reported their video was between 6 and 15 minutes long as seen in Table 13. Videos in the ideal time range of 3 to 6 minutes identified by Guo et al. (2014) accounted for 17% (8) of instructors and 2.1% (1) of instructors had a video between 1 minute and 3 minutes in length.

**Table 13**

*Video Length by Time Intervals*

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 15 Minutes</td>
<td>18</td>
<td>32.7</td>
<td>38.3</td>
<td>38.3</td>
</tr>
<tr>
<td>6 to 15 Minutes</td>
<td>20</td>
<td>36.4</td>
<td>42.6</td>
<td>80.9</td>
</tr>
<tr>
<td>3 to 6 Minutes</td>
<td>8</td>
<td>14.5</td>
<td>17.0</td>
<td>97.9</td>
</tr>
<tr>
<td>1 to 3 Minutes</td>
<td>1</td>
<td>1.8</td>
<td>2.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Less than 1 Minute</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>Missing</td>
<td>8</td>
<td>14.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**How Instructors Apply the Segmenting Principle.** Data from the interviewees revealed two themes which provided explanations for why and how instructors applied the segmenting
principle. First, instructors who reported applying more CTML design principles than their peers chunked the content they were teaching into short segments which then became videos. Second, they imposed length limits upon themselves when recording. Considering that only 19.1% of instructors reported that their “best” instructional video was six minutes or less, these two themes reveal practical approaches for instructors to consider to assist them in meeting the segmenting principle in future videos.

**Chunking Content Leads to Shorter Videos.** All five instructors described methods of dividing potential video content into smaller portions and then working to create video for each of the smaller portions of content. Kristine used a literal approach to content division, taking each of the 24 chapters in the textbook and splitting the content into two halves. She then created a video for each half trying to stay between eight and 15 minutes in length for each video. When Bertha first started to create video for use in her online course, she used a similar approach to Kristine and Bertha described, “[I] prepare as if I was teaching my normal 40-minute class.” She would typically record one lecture video per week and “try to keep it around 40 minutes.” Her perspective on video length changed as she learned more about instructional design and “now there could be six, seven, eight” short videos per week in her course. Bertha described how she got the content into those smaller video segments:

> I went through the topic for the week and I broke it down into the big chunks of data, you know. So, for example, during week two, we're going over the six nutrient classes. We're going over the relationship between diet and health. We're going over the ABCD method. We're going over the average American diet and we're explaining what scientific method is. Each of those became its own separate, short, content focused video.
Once Bertha made the commitment to shorter video lengths, she needed to review her content and divide it into segments before she could begin to create the video lectures. Overall, she created 83 videos for the fifteen-week course.

Tessa also utilized a content-driven winnowing process to help create shorter videos but wrestled more with the tension between content coverage and video length. She described starting with the textbook PowerPoint slide deck and paring it “down the PowerPoints to between maybe eight to 15 slides” focusing on the most important elements for the student viewers. She would then use those slides to create her video and try to keep the “videos to less than 10 minutes.” Describing a tension between deciding what content to include and maintaining the desired video timing she said, “Sometimes it's hard if the concept is really broad and not really focused, or if it's something that's a little bit more technical or quantitative for students because I find that if is quantitative they need a lot more help with it.” This statement was her justification for creating videos that might be longer than 10 minutes and highlights tension between content coverage and video length. Whether a literal division of textbook chapters, an exploration of natural break points in the content, or wrestling over content coverage and timing, Kristine, Bertha, and Tessa all incorporated their content knowledge expertise to segment their videos into smaller portions.

**Imposed Video Length Limits.** All five instructors had a self-imposed time limit that they attempted to meet when creating their videos, but the justifications for their limits varied. Tessa set her video length limit from 6 to 10 minutes, based on research she conducted into the use of video for instruction. She stated that she tries to keep her “videos to less than 10 minutes” and won’t “create a one-hour video.” George set limits because he saw himself in a competition with social media for student attention. He cited a “stat that tells you there’s a sweet spot for how long
a video can be for YouTube to get the most views. I think its 30 seconds to 2:30.” George never wanted lecture videos, which were him in front of PowerPoint slides, going longer than five minutes though he admitted on occasion some were seven minutes long. His aspirational preference was to create a series of “like 20 one-minute videos” because he could “better compete with Tik Tok and YouTube.” He credited the one-minute update videos he receives from his instructional designer as the inspiration for his interest in creating short videos for a future course.

Bertha also cited a University resource along with a former teacher as the inspirations for her video length limit target. She had seen that the University had issued a preference that video lectures were “10 to 15 minutes long.” In addition, she had encountered an instructor during her “undergraduate work who did really short lectures, like two to three minutes long, that were topic focused.” She coupled the undergraduate experience with the University recommendation and decided to create shorter videos. Each time she gets ready to record she reminds herself that “the goal here is to keep it under five minutes.”

Tiana and Kristine both highlighted the importance of keeping videos shorter; however, they didn’t cite any sources or rationales to justify their limits. Tiana considers 11 minutes to be the sweet spot in length for the type of video she typically creates but acknowledged that her videos ranged in length from 10 to 15 minutes. When asked what makes an instructional video good, Kristine responded, “It needs to be short, as well.” She did not cite any sources for her focus on creating videos that ranged in length from 8 to 15 minutes.

**Presence of the Segmenting Principle in the Video Artifacts.** The five videos the instructors submitted mostly confirmed what was reported in the survey and through the interviews. All five videos were less than the survey mean length of 15:43, and all but Kristine’s
11:21 video was less than the survey median length of 11:08. Kristine and Bertha both reported video lengths that were identical to the lengths of the videos they submitted. George reported a longer time of 4:00 on the survey than the 2:20 of his video. The shorter time of his submitted video would have placed him in a higher scoring time segment tier rather than the middle tier when calculating the simple or complex CTML score. Tessa and Tiana reported shorter times than the videos they submitted. Tessa’s video was 5:45, but her survey reported it as 3:08 and Tiana’s video was 7:40, but her survey reported it as 6:09. Neither of their responses would have changed the time tier they were in for the purposes of the CTML simple and complex scores. George, Tessa, and Tiana may have been thinking about a different video other than the one submitted for analysis when they completed the survey, raising an interesting question for future research on how instructors view the quality of the videos in comparison to one another.

In summary, with more than one third of instructors reporting that their “best” video is longer than 15 minutes, the interviewees’ identification of the techniques of content chunking and self-imposed time limits offer two practical strategies for instructors to utilize in the creation of future videos. Instructors can utilize literal divisions such as textbook chapters, natural break points in the content, and continue to wrestle over content coverage and video timing. Identifying a self-imposed time limit through sources such as research, examples from others, or University guidance and attempting to stick to it was another practical implementation concept. Again, even though the interviewed instructors were implementing the concepts of the segmenting principle in their videos, they don’t appear to have detailed knowledge of the segmenting principle itself.

**Personalization Principle**

Instructors incorporate the personalization principle in their instructional video when they include narration that uses a conversational talking style (Mayer, 2019). The personalization
principle is a CTML design principles that address intrinsic cognitive load and the survey contained two questions investigating the principles use among instructors. The first question was dichotomous (yes or no) and prompted, “Is the narration personalized (i.e., uses terms like “you”” and “I”) as opposed to third-person narration?” The second question asked instructors to respond to the statement “The voice of the narrator is personalized, such as using terms like “you”” and “I” as opposed to third-person narration.” via a five-point Likert scale.

**Personalization Principle Application.** Most instructors utilized the personalization principle as 93.6% (44) reported that they did use personalized narration and only 6.4% (3) indicated they did not. Detailing their use of the principle via the Likert-scale question, 68% (34) of instructors reported speaking conversationally throughout all of their video, and another 14% (7) indicated doing so “most of the time.” Only 4% (2) of instructors reported not using personalized narration in their best video and the remaining 14% (7) of instructors used it “some of the time” (3) or “half the time” (4).

**How Instructors Apply the Personalization Principle.** To further explain how personalized narration is incorporated into the 82% of instructors self-selected best instructional videos, I reviewed the interview data from the five instructors who had the best overall CTML design principle implementation scores for insights. All five interviewed instructors reported using a conversational talking style 100% of the time in their videos, and that assertion is supported by evidence from the video artifacts. Two themes emerged including a focus on the use of “you,” “we,” “me,” and “I” and instructors focus on being conversational.

“**You,” “We,” “Me,” and “I”**. The first theme was instructors’ use of personalized words such as “you,” “we,” “me,” and “I” throughout their video narration. Evidence of instructor use of personalized language was available during the interviews when instructors
described or mimicked what they said in their video. For example, Tiana described how she tried to conclude one of her videos saying, “What happens after it is if you still are struggling with this concept or you have follow-up questions don't hesitate to meet me in my office hours tonight from seven to nine.” Her use of “you” in this example is meant to refer to the student viewers, and she refers to herself with the word “me,” which are both examples of personalized language. Bertha applied the personalization principle uniquely through a formulaic component in the creation. She always thanks her student viewers for their time watching at the end of a video. Both Bertha and Kristine referenced examples where they refer to previous videos as resources for their student viewers with Kristine articulating, “Then I will say, Okay, I talked about this in this video.” The instructors consider that they are talking to their students through the video format and thus use personalized language such as “you,” “we,” “me,” and “I” throughout their video narration.

**Conversational Focus.** The second theme was the instructors’ emphasis on improving the conversational focus of their video narration. George’s interest in being conversational stemmed from his focus on clear communication. He described asking himself the question, “How am I going to make that into a story so that it is a conversation?” when thinking about what he wanted to say in his video. He was focused on how to convert the information he needed to convey “into a story to that it is a conversation.” One way George tries to be conversational is to “say stuff like stupid stuff like you know, it’s magma when it is downstairs.” He equated conversational narration with clear communication. Bertha’s approach to conversational narration was also focused on communicating clearly with student viewers, but also with her own self-improvement. She said, “there's definitely room for me to continue finding a way to be more conversational, you know, a little, a little more conversational with the students, a little less
staged.” Bertha had been working on becoming “a little more relaxed, a little more conversational with the tone of my voice and the cadence at which I speak.” Her concern was speaking in a manner that enough “people can understand what you’re saying, but quickly enough so that it still feels conversational.” Bertha saw the importance of a conversational tone for communication to viewers and recognized that it was something she could continue to work on improving as she continued creating video.

All five of the interviewed instructors implemented the personalization principle in their video artifact and reported doing so in their surveys. The interviewees indicated they used words such as “you,” “we,” “me,” and “I” as they focused on being in conversation with student viewers. With more than 9 in 10 instructors also reporting that they use a conversational talking style, this principle appears to be robustly implemented. None of the interviewees explicitly mentioned the personalization principle, but they were implementing it with fidelity.

**Embodiment Principle**

An instructor applies the embodiment principle when they use natural human gestures in a video (Mayer, 2019). I assumed that if an instructor was visibly present in the video, then human gestures would also be present. The survey included one dichotomous yes or no question which asked if the instructor could be seen in the video at any time. It also contained one statement that said, “A human narrator was at least partially present (visible) in the video” which instructors responded to via a five-point Likert-scale.

**Embodiment Principle Application.** The extent to which instructors applied the embodiment principle in their self-selected “best” instructional video by being visibly present was 51% (25) and the instructors who indicated they were not visibly present in the video was 49% (24). Detailing the visibility via the Likert-scale question, 50% (25) of instructors said they
were not visible at all while 18% (9) were visible partial amounts of time during the video and 32% (16) were visible for the entire video. According to the survey data, half of instructors incorporated the embodiment principle in some manner and half did not.

**Why Instructors Apply the Embodiment Principle.** Given that half of instructors are reporting that they do not incorporate themselves in a visual manner in their created videos, the reasons and methods the five interviewed instructors described for including themselves in at least a portion of their video artifacts can help to illuminate the survey data. Two themes emerged, including: (a) concern about appearance and (b) video purpose.

**Concern About Appearance.** The first theme to emerge are instructors concerns about how they look in the video. Tiana highlighted the contrast between the embodiment principle and human concern over appearance when she said, “I think that my [physical] person is an important learning tool [in the video]. Even though I don’t particularly love to see my face on the screen.” She recognizes that she needs to be part of the video, while also acknowledging it may not be comfortable to do so. Tiana knows “it's important for the students to see like my nonverbals.” Bertha, who has previously expressed concerns about appearing appropriate before students, described how she used to gesture with her hands when she was talking, but is now trying to stop because she noticed, “[Gesturing] doesn’t always come across as powerful or effective. It doesn’t seem like it works well in the videos.” Bertha appears to be moving away from the embodiment principle over concerns about effectiveness. Tessa highlighted a worry about how she would look on the camera as a reason for why she used PowerPoint to create her videos. She utilized the notes feature of PowerPoint, so she can focus on reading her script and not be worried about “looking away and stuff like that.” All three instructors expressed concerns about their appearance which may help to explain why other instructors choose not to be visibly
present in their videos at all. These comments reflect a lack of thorough understanding of the embodiment principle and its justification for being visually present in an instructional video.

The other two instructors acknowledge the awkwardness of seeing oneself on screen but provide justification for why instructors should push past the uncomfortableness and be visible. Kristine acknowledged instructors concerns about appearance, especially with novice online instructors saying, “I think every, every online instructor gets to the point where they are just the first time they see themselves or hear themselves. They are like you. That’s just weird.” She is acknowledging that it can be uncomfortable to see and hear yourself on camera if you have not done so before. For her, the next step was to keep going past the discomfort as she gained more experience. She reported, “After a while you kind of get used to that and you’re like, I’m, I’m okay. And now I have no problem, you know, seeing myself on video.” Based on her growing video creation experience Kristine said, “I believe that the instructor should be visible in the videos,” and she indicated that they should be visible “the whole time.” She did not cite or base her justification on the embodiment principle even though she is following the principle.

George also echoes the concerns about appearance driving decisions to be visible on camera or not, if he is not looking good when he goes to film, he won’t include himself visually on the video in any substantive way. Extending on this idea he noted, “I’m a big proponent of you should always be on camera. I don’t practice what I preach.” Even with his concerns about appearance, he still stressed the importance of being on camera even if it is just “bookending” the video offering two justifications. The first justification was that he wanted “to mimic the classroom experience” with his videos. The second, and one that appears in close alignment with an understanding of the embodiment principle is, “I want my face in front of content because I know you will, it’ll stick better with you.” He knows that if he is on camera explaining
something that the learner is going to have a better chance of remembering it, and he has learned this from his experiences of being on TV. He sums up this understanding articulating, “If I’m in front of a weather map and do the weather, you will have dissected or digested that message or gotten more of that message much better than if I’m literally off camera and say the exact same thing.” George also does not explicitly state the CTML embodiment principle, but he comes closest among the five interviewed instructors of describing the principle.

**Video Purpose.** The second theme to emerge regarding why instructors may incorporate the embodiment principle into their video is the intent or purpose of or actions in the video. Certain video types or actions require the visual presence of an individual. For example, Bertha, Tessa, and Tiana reported creating weekly video announcements that all included their visual presence. The assumption is that they view their presence as a critical component of that video style. In addition to the announcement videos, Tessa also creates videos from PowerPoint that do not include her physical presence because she doesn’t know how to use the tool to include herself. Thus, the video style she has chosen, coupled with her own lack of technical knowledge prevents her from meeting the principle. Her video artifact represents a third style of video, a narrated screencast, in which she is visibly present. The three video types employed by one instructor demonstrate how video type may influence the use or non-use of the embodiment principle.

Another example of video design impacting the incorporation of embodiment is the use of a particular aesthetic style, such as the “floating head look” that Bertha described using in her video. In this style, Bertha is visibly present from her shoulders up to the top of her head in a corner of the video. She creates this effect by filming in front of a green screen and then removing the background during editing, allowing the PowerPoint slides to appear behind her.
She made the choice to switch to this aesthetic style after conducting research that indicated students preferred this visual over a split screen style. Thus, her choice of video style necessitates her visual presence in the video, allowing her to meet the embodiment principle.

In addition to the overall video intent or purpose, instructors also have intent or purpose in actions taken in the video. For example, an instructor might physically move to change their orientation in the camera to enhance a particular concept. Kristine, who teaches languages and cultures, described a situation where “sometimes I would move backwards and until they can see more, particular, if I'm doing something so that they're not only seeing my face um so I may move backwards so that I can be demonstrating something.” This comment highlights that Kristine views her presence in the video as a teaching tool to assist the learner and one that she can manipulate through physical movement during recording. Bertha described occasionally using props saying, "I will hold up, you know, like an apple or a bottle of vitamins or something like that.” Picking up and holding an item in front of the camera is a natural human gesture. Both examples highlight how purpose can drive the inclusion of self and assist instructors in meeting the embodiment principle.

**Presence of the Embodiment Principle in the Video Artifacts.** When comparing data from the five interviewees across all three data sources, three of the five instructors were mostly congruent among their response and two were not. All five instructors reported they were visible in their “best” instructional video, and this was confirmed by their video artifacts. However, the gradations of visibility were not always in alignment. The first instructor who had unaligned data was George, who reported on the Likert-scale question that he was visible in his video “half the time”; however, he was only partially visible for 12.86% of his video. Kristine was also divergent, reporting she was visible “all of the time” in her best video, but only appearing for
50.88% in her video artifact. The remaining three instructors all reported being visible “all of the time” in their best video; however, Tessa was the only one who was truly visible for 100% of her video. Tiana was visible in her video artifact for 95% of the video, and Bertha was visible for 82.91% of her video. These variations in response may be occurring because instructors are conflating audio presence with visual presence when responding to the survey questions.

In summary, half of instructors are not meeting the embodiment principle in their “best” instructional video. The interviewees highlighted that this may be driven in part by concerns about appearance, with some instructors choosing not to be visible because of how they look. Kristine recommended that instructors push through the discomfort as she found that she eventually got comfortable with seeing herself on camera. The purpose of a video such as for announcements or narrated slides may dictate whether instructor presence is warranted or not in a video. Finally, the interviewees had a difficult time accurately representing their visual presence in the survey when compared to their video artifacts. As has been the case thus far with other CTML design principles, there continues to be an absence of specific knowledge regarding the Embodiment principle among the interviewees.

**Voice Principle**

An instructor applies the CTML design principle of voice when they incorporate a natural, friendly human voice in a multimedia product (Mayer, 2019). The survey included one question which asked instructors if the video narrator had a human voice, a computerized voice, or both voice types. All but one instructor or 97.9% (46) responded with the human voice option and 2.1% (1) selected that they used both voice types. The five interviewed instructors all reported using a human voice on the survey, and their video artifacts all included natural, human voices for the audio narration.
Explaining How Instructors Apply the Voice Principle. The survey data indicates that all instructors are using a natural, human voice for at least a portion of narration in their self-selected “best” instructional video, but the data does not provide any explanation as to why this is the case. Data from the five interviewed instructors highlights three themes that explain why those individuals applied the voice principle: (a) instructors as narrators, (b) relationship building with the student audience, and (c) speaking with expression.

Instructors as Narrators. When instructors are creating their own videos, they are serving as the narrator. All five interviewed instructors indicated they were the primary narrator in their self-selected best video, and data from the video artifacts supported their claims. There were many instances, in passing, during the interview conversations where all five instructors alluded to their role as narrator. For example, George said while explaining how he creates a field video, “I’ll say Hey, I’m here, right underneath some clouds” or Bertha discussing her early video format reported, “I had that split screen here’s the slide. Here’s me talking. And so I went with that.” In both of those examples the instructor made reference to their own speaking in the video. Among the five interviewees, Kristine was unique in that she had a graduate student play the role of a pretend student in her video for the purposes of a demonstration. The graduate student still used his natural human voice when talking, meaning that the video had two narrators, both of whom used their natural human voices.

Relationship Building with the Student Audience. A second theme that emerged from the interview conversations was an intent to use their presence and voice in a video as a means of conveying personality and presence to the student audience. This was born out of a desire to replicate as best they could the in-class experience of student to instructor interaction in an online environment. Kristine described how she talked as a means of “trying to let more of my
personality as the instructor come forth.” Kristine suggested that she wanted students to know her as an individual through the video medium. Tessa’s decision to incorporate her own voice came from her research into using video for online courses in which she discovered that students “like to hear the professor’s voice.” The implication of that comment is that Tessa included herself as narrator because it benefits student viewers and assists in forming connection. The interviewees incorporated their own voice as a means of building social connection with their students.

**Speaking with Expression.** A third theme driving instructors to incorporate a natural, human voice for the narration was to avoid speaking in a monotone or stiff manner and to speak with expression. Bertha discussed how she had to train herself to speak in this manner because when she first started recording videos, she “was very stiff and very static and very rehearsed.” She attributed that initial stiffness to prior work experience where she had to narrate a menu for a voicemail message, but after comments from her husband indicating that it sounded boring, she has “been trying to become a little more relaxed, a little more conversational with the tone of my voice and the cadence at which I speak.” Bertha is transitioning towards being a more natural, human speaking narrator in her video recording. Kristine also spoke of transitioning to a less monotonous narration and when asked what makes an instructional video good responded with “an instructor needs to be expressive. So you definitely don’t want to be speaking in monotones.” Kristine equated an instructional video being “good” with an expressive narration. Another example of expressive speaking appeared when George gave an example of what he would say when on camera. When he started speaking he used a different vocal dynamic than he had been using during the interview. George’s expressive “video” vocal dynamic, present in the
artifact, was mostly absent during the interview. Thus, George unintentionally demonstrated how he speaks with greater expression when narrating for his videos.

The collected data indicated that the CTML design principle of voice is implemented with full fidelity by instructors. The interviewed instructors who were best at implementing the CTML design principles indicated that they serve as the narrators in their own videos because they view it as an opportunity to build relationships with their student audience. They also expressed the importance of speaking with expression and not monotones which aligns with the voice principle. While these instructors recognize they need to utilize their own voice for narration in their videos, there was no reference to CTML principles or research to support their decisions.

**Overall CTML Design Principle Implementation**

With the application of each CTML design principle individually assessed and partially explained from the five cases, I will now explore which CTML design principles instructors are incorporating into their self-made digital instructional videos, as well as correlations among the principles. Examining the survey data for the 11 design principles collectively reveals which principles instructors implemented with fidelity and which principles are absent from instructors self-created videos. As seen in Figure 8, instructors robustly implemented the coherence, modality, voice, and personalization principles, but they had weaker implementation of the signaling, redundancy, and segmenting principles. The spatial contiguity, temporal contiguity, pretraining, and embodiment principles had mixed implementation from the instructors. Examining implementation across all of the principles, instructors appear to be implementing more of the design principles than not.
CTML Principle Correlations

To test for possible correlations between the CTML design principles I calculated a series of Spearman’s Rank Order Correlations among the Likert scale responses. There were 14 statistically significant correlations out of 66 possible combinations (See Appendix J). Only the segmenting principle had no statistically significant correlations with any of the other design principles suggesting that video length is not related to the implementation of other principles. The video artifacts from the five interviewees provide additional evidence of the lack of a relationship between segmenting and the other principles. As reported in Table 10, there is a considerable range in the length of the videos from those who had the highest implementation of CTML design principles from 2:20 to 11:22.
Two of the design principles had statistically significant correlations with two other design principles. The embodiment principle had a weak positive correlation with the extra’s component of the coherence principle (.280, p < .05) and a moderately positive correlation with the personalization principle (.360, p < .05). Given that the interviewees were all physically present in their videos serving as narrators and using a conversational talking style, it is natural to expect that a relationship would exist between the embodiment and personalization principles. It appears that instructor presence in a video may lessen the use of extraneous elements which would help instructors meet the coherence principle; however, further research in this area is needed. The spatial contiguity principle had a statistically significant, moderately positive correlation with the music component of the coherence principle (.326, p < .05) and the pretraining principle (.305, p < .05); however, the interview and video artifact data does not offer any possible explanations for those relationships. The significant correlations identified with the temporal contiguity principle and the redundancy principle warrant additional explanation.

**Temporal Contiguity Principle**

The temporal contiguity principle had a moderately positive correlation with the extra elements component of the coherence principle (.387, p < .01.), the signaling principle (.346, p < .05.), and the pretraining principle (.301, p < .05.). There was also a strong positive correlation between the temporal contiguity principle and the spatial contiguity principle (.586 p < .01). Except for the pretraining principle, these design principles all address the non-human, visual instructional media components of a video suggesting there may be some interconnectedness among these principles regarding their presence or absence in a video.
Redundancy Principle

The redundancy principle had the most statistically significant correlations among the design principles with five negative correlations and one positive correlation with other CTML design principles. Both the no music (-.348, p < .05) and no extras (-.310, p < .05) components of the coherence principle had a statistically significant, moderate negative correlation and the modality principle (-.280, p < .05) had a weak negative correlation with the redundancy principle. Three CTML design principles had correlations that data from the interviews and video artifacts could assist in explaining.

The first pairing between the redundancy and spatial contiguity principles had a strong negative correlation of -.721 significant at the 0.01 level. The redundancy principle was implemented if an instructor indicated “none of the time” on the survey, while the spatial contiguity principle was implemented if an instructor reported “all of the time.” Thus, the negative correlation taken to its extreme represents instructors responding to both questions with the same response. Instructors who reported that they did not read text displayed on the screen also reported that they did not have text appearing on screen at the same time as images. George’s survey response demonstrated this strong negative correlation, as he reported the video narrator did not read aloud on-screen text, and he did not have related words and images appearing together. His video artifact demonstrated one reason why this situation might occur. He didn’t use any onscreen text because his video incorporated real world visuals while he narrated. Bertha also demonstrated the negative correlation, but with the opposite of George’s situation. Bertha reported that she did read aloud on-screen text all the time and had related words and images appearing together all the time. Her video contained text heavy PowerPoint slides with occasional images, and she engaged in 28 instances of redundant reading. George and
Bertha provide examples of how the negative correlation between the redundancy and spatial contiguity principles applied in practical contexts.

Similar in nature to the spatial contiguity principle, the temporal contiguity principle had a moderate negative correlation of -.451 which was significant at the 0.01 level with the redundancy principle. Bertha’s survey data mimicked this correlation as she reported that on-screen text was read aloud by the video narration and the video narration occurred at the same time as related images or video footage appeared all the time in her video. Her video artifact affirmed this correlation as the visuals of her text heavy slides appeared as she read the text displayed on them aloud.

The redundancy principle had a moderate positive correlation of .324 with the embodiment principle, a relationship which was demonstrated by the four interviewees who reported they redundantly read aloud on-screen text most or all of the time. Those four individuals incorporated on-screen text through most of their video artifacts, but also incorporated their physical presence through the majority of their videos. The emphasis Bertha, Tiana, Tessa, and Kristine placed on being visibly present coupled with the text heavy style of video may lend itself to creating this identified relationship.

The statistically significant correlations uncovered among the 14 correlations between the design principles can only be partially explained with data collected from the interviews and videos. As evidenced by the examples of Bertha and George for the pairing between redundancy and spatial contiguity, multiple explanations may exist to explain the data. Correlation between the items does not prove that either is the cause of the other and thus further research is needed to identify how these correlated components are related. One area that may provide insight into
how the design principles influence and interact with each other is through an instructor’s video creation process.

**Video Creation Process**

Implementing CTML design principles such as, but not limited to signaling, coherence, and segmenting often require that an instructor use video editing techniques in the creation process. An instructor’s creative process also reveals which components of digital video production they focus on as they create video for their online course. To investigate instructor focus and further explain CTML principle implementation, the survey included one question that asked instructors to approximate how much time it took them to create their “best” instructional video and to indicate the tools they utilized to create the video. Additionally, an open-ended question asked instructors what instructional technique or techniques they used in the video.

**Instructor Editing Time**

Instructors reported an average video creation time of 1:48 with a median of 1:30 and a mode of two hours as shown in Table 14. I conducted an interquartile range calculation to determine if any of the reported data on instructors’ average time spent creating their “best” video could be considered an outlier. The 75th percentile was 3 hours and the 25th percentile was 52 minutes. Conducting the calculation led to an upper-bound of 6 hours and 12 minutes. Two instructors reported taking ten hours and one instructor reported taking 20 hours, so I considered those data points outliers and removed them before calculating the descriptive statistics.
Table 14

*Descriptive Statistics for Instructor Time to Create a Video*

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>40</td>
</tr>
<tr>
<td>Mean</td>
<td>1:48</td>
</tr>
<tr>
<td>Median</td>
<td>1:30</td>
</tr>
<tr>
<td>Mode</td>
<td>2:00</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1:26</td>
</tr>
</tbody>
</table>

*Note.* Time is in hours.

*Instructor Tool Selection*

Instructors reported the tools they used to create their video, and as evidenced in Table 15, Camtasia was the most popular choice followed by Kaltura, Zoom Meeting, and Microsoft PowerPoint. Almost two-thirds of instructors or 64.58% (31) reported using just a single tool for creating their video while 20.83% (10) indicated they used two tools, 12.5% indicated they used three, and 2.08% (1) reported using five tools. The top four options seen in Table 15 represent tools that are supported by the university and available to all full-time instructors.
Table 15

*Video Creation Tool Use*

<table>
<thead>
<tr>
<th>Tool</th>
<th>Valid Percent</th>
<th>Instructors Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camtasia</td>
<td>43.75</td>
<td>21</td>
</tr>
<tr>
<td>Kaltura</td>
<td>29.17</td>
<td>14</td>
</tr>
<tr>
<td>Zoom Meeting</td>
<td>22.92</td>
<td>11</td>
</tr>
<tr>
<td>PowerPoint</td>
<td>12.50</td>
<td>6</td>
</tr>
<tr>
<td>iMovie</td>
<td>8.33</td>
<td>4</td>
</tr>
<tr>
<td>Mobile Device (phone or tablet)</td>
<td>8.33</td>
<td>4</td>
</tr>
<tr>
<td>QuickTime</td>
<td>6.25</td>
<td>3</td>
</tr>
<tr>
<td>Recording Booth</td>
<td>6.25</td>
<td>3</td>
</tr>
<tr>
<td>Screencast.com</td>
<td>2.08</td>
<td>1</td>
</tr>
<tr>
<td>SnagIt</td>
<td>2.08</td>
<td>1</td>
</tr>
<tr>
<td>Digital Camera</td>
<td>2.08</td>
<td>1</td>
</tr>
<tr>
<td>YouTube</td>
<td>2.08</td>
<td>1</td>
</tr>
<tr>
<td>Audacity</td>
<td>2.08</td>
<td>1</td>
</tr>
<tr>
<td>Keynote</td>
<td>2.08</td>
<td>1</td>
</tr>
<tr>
<td>Clips</td>
<td>2.08</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note.* Instructors could select more than one tool. *n = 48*

*Instructional Method*

Instructors provided short descriptions of the instructional technique utilized in their self-reported “best” instructional video via a question on the survey. Thirty-eight instructors responded to the question and 76.32% (29) either directly indicated they utilized a lecture technique or described a lecture technique. As seen in Table 16, 10.53% (4) of instructors described a course logistics video, which might explain a major course assignment or overview the syllabus. One instructor created a tutorial video on creating an avatar and another created a video responding to student questions. One response, which was labeled inconclusive, indicated that they used the CTML design principles of “coherence, signaling, redundancy, continuity, pre-training, personalization, voice, and segmenting” but not embodiment. It was the only specific reference to the CTML design principles in all data collected during the study.
Table 16

*Self-reported Video Instructional Style*

<table>
<thead>
<tr>
<th>Instructional Style</th>
<th>Number of Instructors</th>
<th>Valid Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture – directly stated</td>
<td>15</td>
<td>39.47%</td>
</tr>
<tr>
<td>Lecture – assumed</td>
<td>14</td>
<td>36.84%</td>
</tr>
<tr>
<td>Course Logistics</td>
<td>4</td>
<td>10.53%</td>
</tr>
<tr>
<td>Tutorial</td>
<td>1</td>
<td>2.63%</td>
</tr>
<tr>
<td>Question &amp; Answer</td>
<td>1</td>
<td>2.63%</td>
</tr>
<tr>
<td>Inconclusive</td>
<td>3</td>
<td>7.89%</td>
</tr>
</tbody>
</table>

*Explaining Instructors Creation Process*

Survey data alone is incapable of capturing the complexity of an instructor’s video creation processes. The five interviewed instructors provided rich descriptions of their processes and five themes emerged from those descriptions. Instructors consider elements such as time commitment, time pressure, preparation, editing, and tool use when creating and using instructional video.

*Time Commitment to Create Video.* The five interviewed instructors reflected a wide array of time committed towards making a single video. The extremes ranged from Tiana who reported that each video takes “about three hours” to create to George whose survey and interview indicated that it took him “five minutes” to create his “best” instructional video. Kristine represented the amount of time to create her video as a ratio of at least four minutes of work for every 1 minute of video and identified that “part of it is not just the physical time. It's also the mental preparation.” In the survey, Kristine indicated it took her an hour to create her 11:22 “best” instructional video, a time frame not far off from the one to four ratio she described. Tessa distinguished that different video types had different creation time frames. Her survey response and interview response reflected that it took her an hour to create a PowerPoint style video, but she also described a “paper video” or a video about an assignment as taking her an
hour and a half to create. She attributed the difference to having notes to reference with the PowerPoint style and having to work without notes on the “paper” video style. Tessa used PowerPoint’s note feature to let her see her script, but she indicated she did not have a similar feature when doing a screen recording of an assignment. Bertha’s video creation process was different from the others in that she created her videos in batches, instead of one at a time, which made it more challenging for her to specify a specific amount of time for the creation of a single video. Bertha’s survey response represented that her best video took about 40 minutes; however, she said “more than an hour” during the interview. Among these five instructors who are the best at implementing the CTML design principles, there is no clear indication that time spent on the video correlates in any way to implementation of the design principles as each instructor used a process that appeared to work best for their style. Different processes occurred within the instructors’ video creation time.

**Time Pressure to Create a Video.** In addition to video creation being a time commitment, the interviewees also expressed time pressure to create and complete their videos. Bertha described the situation best as, “I'm also aware that I have to get this done in a short period of time.” Kristine articulated spending all summer working to get her videos created for the semester and then said, “It is so much work.” Evidence of her time pressure emerged in comments such as, “if I've already recorded something and rerecording is way too much work, then I would you know just cut them out” and “the captioning, although it's not accurate, but I don't care. And I'm not about to go back and change it.” In those examples Kristine was sacrificing the quality of video elements because of the time demands. George had a similar reaction explaining why he doesn’t use more editing processes, “I don't have the time. It's hellish enough to create a web class, the sheer amount of work that goes into it... I just want to shoot
something have it done plop, ready to move on.” He was seeking to use the most efficient process he could because he “would rather do other things” with his time. The instructors did discuss techniques that they employed in an attempt to be more efficient and save time. Bertha did preparation work on her slides “that eliminated some editing time at the end.” She also discussed using a meta cognitive reflective process, “When I find myself repetitively editing the same thing over and over and over again I start to look at it and realize like, okay. Is this like a duplication of effort?” George focused on trying to make “content that is sustainable” because he didn’t “want to remake stuff.” Tessa selected PowerPoint for recording because it allowed her to work more efficiently because she could re-record specific slides if she found a mistake and not the whole video. Thus, the time pressure did lead instructors to make some adjustments in their process.

**Preparation.** Preparation work before recording was one process that most of the interviewed instructors articulated as necessary in the video creation process. Preparation is made up of different elements and those steps varied per instructor. For example, Bertha reported she had a seven-step process she followed to create each of her videos on a weekly schedule, but George operated more spontaneously. Within the preparation process, data from the interviews revealed three sub-themes of content review, PowerPoint preparation, and an exception.

**Content Review.** The first sub-theme was the interviewees focus on reviewing content to be covered in the video before recording. For example, both Bertha and Kristine spent time reviewing their course content to determine what elements they wanted to incorporate in their videos. Kristine began by rereading the textbook chapter to keep the content fresh in her mind as she began to prepare to create a video. Bertha would review the content to be covered in each week in her course and then break the content down into topics, with each topic becoming its
own video. Thus, Bertha’s initial review process led her to implement the segmenting principle. Content review then led instructors into script preparation. Kristine focused on planning out what she wanted to say. Tiana wrote notes to herself during her preparation, especially “speaking pieces” about what she wanted to say during recording. Bertha would type up a notes document that she would review before she recorded her video. These preparation actions taken by the instructors created conditions that likely assisted them in meeting both the redundancy and modality principles. The act of considering what to say prior to recording highlights the use of audio narration as a means of communicating information which addresses the modality principle and reviewing what they intended to say prior to recording would make instructors less likely to read on-screen text which would violate the redundancy principle. Thus, preparation actions such as content review and scripting appear to be actions that can assist instructors in applying CTML design principles.

**PowerPoint Preparation.** For the four instructors who used PowerPoint in their videos, one of the key components of preparation was the creation of the PowerPoint itself. Tessa and Kristine worked from PowerPoints they already had created or had from the textbook. Both indicated they spent time paring the PowerPoint presentations down to the critical learning elements. Tessa aimed to create between eight and fifteen slides “focused on definitions for certain terms” and “included a couple of examples to kind of illustrate what was going on” while Kristine reduced them to “what’s absolutely necessary.” Tiana created her slides to be an outline of the topics she wanted to cover in the video to help her stay on topic. Bertha created slides based on what was needed to “properly explain the material.” All four instructors spoke of narrowing the content down to the key components, an example of implementing the segmenting CTML design principle. Because slides can include text or visuals and often serve as an outline
of what to say, they have the potential to impact CTML design principles such as coherence, signaling, redundancy, spatial and temporal contiguity, and modality. The pre-recording focus of these instructors on slide preparation highlights how this portion of video editing can be a critical element for instructors who wish to properly implement CTML design principles.

Bertha’s discussion of her PowerPoint slide creation process illuminates how slide design can impact many of the design principles. Because she creates multiple videos at a time, she has standardized her slide creation process to help accelerate her creation process. Bertha has evolved to use the wider slides instead of the standard slide size because it provides more space for her floating head which “eliminated some editing time at the end” of her process. She has also learned through experience to use a “light blue background and black text” and a Helvetica Sans Serif font with no text that is lower than 18-point font so “everything’s visible.” She used “red as the font color to highlight things” and intentionally kept few words on the slides. If she used a graphics or chart, she tried to have just one on a slide at a time. The slide creation “rules” she described evoke some of the CTML design principles. For example, her use of her floating head is an application of the embodiment principle, her use of a red font color for highlighting is an implementation of the signaling principle, and her focus on fewer words helps her to implement the redundancy principle.

**Preplanning Exception.** George presents an interesting exception to both the content preparation and the PowerPoint preparation themes of the other instructors. He does not plan ahead like the other instructors, but instead relies on moments of inspiration. George described his creation process as, “Anytime I'm somewhere in the real world and I go, a lightbulb comes on that I teach this. I'm pulling out my cell phone. I'm recording the quick video.” He said, “I won't roadmap in a video because it's too short. I'll know what concept I want to present and I'm just
going to say, Here I am. Look at this. This is why we're talking about this content. We're done.”

George’s process has far less pre-planning, yet his video still incorporated many of the CTML design principles. He is able to incorporate many CTML design principles because of the style of his video. Because he is filming short, real world situations that don’t have on-screen text in them his risk of violating any of the principles associated with on-screen text or the segmenting principle are significantly reduced. Since he is the one doing the filming and narrating, it is easy for George to address the three design principles of germane cognitive load and the signaling principle if he uses his own finger to point out elements. That leaves just the coherence and pretraining principles as elements for him to consider during the creation process. Thus, George’s particular style of video is one in which the preplanning themes may not apply.

In the theme of preparation before recording, the interviewees highlighted three sub-themes. The first was the concept of content review which could be rereading the material to cover or preparing speaking notes. The second sub-theme was the development of the visual resources which for the interviewees was primarily through PowerPoint. The final sub-theme was an exception to the preplanning concept as demonstrated by George who articulated a process of creating video as he was inspired while going about his daily life. These instructors who are best at implementing CTML design principles, highlighted how these preparation actions assist in the implementation of the principles.

**Editing.** Another major component of video creation is the editing process. The editing process can take different forms depending on an instructors’ use of techniques and tools. It can also take place at different stages in the video production process, occurring during the recording stage or after in a post-production stage. An instructor may use editing software, or they might re-record their video instead. For instance, George doesn’t typically edit, but when he does, he
will “crop an in and an out. In other words, I’ll shorten it. It’ll be in YouTube editor.” In other words, he will trim up the beginning and end of the video to focus it on the content and not the starting or ending of the recording. George does this editing right in YouTube, using the tools built in editor since his videos are already hosted on that service. Kristine uses editing to bring different video clips together in a process she calls “splicing.” If she encounters an “egregious” mistake she will remove it. Bertha had the most detailed description of an editing process among the interviewed instructors. She typically records videos on Mondays, does post-editing and publishing to YouTube on Tuesdays, and then captioning editing on Wednesday or Thursday. On Mondays she described the process as,

After I record the lectures, I um have to save them down to my desktop. I don't publish them out right away. I go and I save them. But when I save them I do go in at that point in time and clip the beginning off the front and clip the end off the back and shrink the green screen down and layer it. I always layer it over either the left or the right, depending on where graphics are on my screen. I do all of that right then in there while I'm in my little recording studio in case I identify that there's a problem... So I've learned that it's better for me to just take five minutes after I finished recording and do a little bit of that pre-editing right then in the studio.

Then on Tuesdays she described what she calls “the real editing” as

That's when I go in and I make my adjustments that I need to make to my green screen settings, because there again always need to be some adjustments made. The sizing needs to be fixed. It needs to be moved around. If I change slides and now my body is cutting off part of the words on the slides I'll shrink myself down a little bit for that period. So I
do that sort of editing and then I trim, I adjust the noise. So I make sure I cancel out as much of the backroom background noise as possible.

Her last step is to “go through the lectures” and “try to add in a few call outs, if you will, a few arrows that point to things.” Bertha has an involved step-by-step process that includes a trimming process similar to George, but her process also involves adding herself via the green-screen effect, correcting the audio, and adding signaling elements. These different editing techniques demonstrate how CTML design principles such as coherence, signaling, and embodiment can be implemented through an instructor’s editing process. In addition to general editing, there were two specific editing sub-themes that emerged including retakes and closed captioning.

Retakes. All five of the interviewed instructors reported using a re-recording process during editing to fix mistakes. Kristine appeared less likely to re-record than her peers because she reported, “if it's bad enough, I'll just re-record,” but only if it wasn’t too much work. George and Tiana indicated they engage in retakes on a regular basis during the video creation process. Tiana explained why her recording time was 30 minutes for an 11-minute video because she typically does at least two takes during the recording process as she will start over again if she messes up. George said, “on average, I probably do two or three takes just because I, there’s something I say I didn’t like and I want to be perfect and I’m George perfectionist.” He doesn’t mind doing those retakes because the video is “only a minute and a half, so it’s easy to redo it.” Tessa’s editing process highlighted that she engaged in regular re-recording, but not of the whole video, just of individual slides. When she finishes recording, she listens to the whole presentation. If she realizes that she “dropped a word here” or finds “a word on the slide is incorrect” or “if the order just doesn’t seem right” she will make adjustments and re-record.
During that process Tessa may also “cut things out” if she finds it is not working with the message she is trying to communicate. Bertha utilized a post-recording review process, something she learned to do through experience. She takes a few minutes to review her recording as soon as it was complete in a process Bertha calls “pre-editing.” That way if she identifies that there is a problem, Bertha can re-record it immediately because she still has her recording studio set-up and “the material is still fresh” in her mind. These descriptions of the retake process emphasize how the instructors are focused on providing a concise and coherent message, which are examples of meeting the coherence CTML design principle. Engaging in a review process and making corrections assists in addressing the coherence principle.

**Closed Captions.** One area of post-production editing that got particular attention from Kristine, Bertha, and Tessa and an element that assists with the accessibility of a video is the creation or correction of closed captions. All three took advantage of automatically generated closed captions from either Kaltura or YouTube. Kristine viewed the captions created by Kaltura as an extra bonus element and did not spend time editing them. She said, “I like the um the what do you call that the captioning, although it's not accurate, but I don't care. And I'm not about to go back and change it.” Whereas Bertha and Tessa used YouTube to host their videos and did spend time editing the captions. Bertha who created videos on a weekly schedule would usually “go in and fix all my closed captioning” on Wednesdays and Thursdays. She said, “I do go in and clean up all the closed captioning. In addition to correcting the spelling I also correct the punctuation. And I do put, you know, capital letters and sentences and things like that in there and sometimes put things in parentheses to clean that up to make it easier.”
For Tessa, editing closed captions is where she spent most of the hour it took her to create a video. She began by uploading the video to YouTube so that it can automatically generate a closed caption file. Then Tessa edited the captions to “make sure they make sense.” She described why this process took her a long time saying,

“Because for me it is not just about the words being spelled correctly, right. I also go through a lot of grammar. So I include like commas and all this other stuff. I go, I go a little bit deeper in terms of like my captioning then probably a lot of people do because I also teach writing classes. So the grammar is like huge for me. So um I go through and I check and I go through and I check again because I want to make sure that it's correct. So that's why it takes longer for me.”

Creating closed captioning is a post-production step in the video creation process, but one that appears to take a significant portion of the instructors’ time. How much time it consumes is dependent on how detailed an instructor wishes to be as evidenced by the gradations of editing shown by Kristine, Bertha, and Tessa.

The editing processes employed by the interviewees were varied and related to the tools and styles of video that they utilized. One instructor used a complex process to create an embodied effect using a green screen, another instructor would edit the start and ends, and another used editing for bringing clips together. All of the interviewees did employ forms of re-recording as a means of reaching their desired video and three of the instructors engaged in editing of closed captions along a gradated scale of detail. Engaging in the editing process was dependent upon the tools chosen.

**Tool Use.** The mix of tools used among the five interviewed instructors highlights the diversity of options available to instructors along with their own unique approaches to video
creation. On one end of the spectrum is Bertha who used at least six different tools to produce her video while at the other end is George who used two tools to create his video. As seen in Table 17, instructors did not report on the survey that they used all of the tools they discussed during the interviews. Certain tools such as YouTube and PowerPoint were not selected on the survey but were critical components of the instructors’ video creation process. Among the wide array of options both PowerPoint and YouTube were discussed by all five interviewees and tools were selected primarily based on their ease of use in relation to the desired tasks.

**Table 17**

*Interviewee Video Editing Data*

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Video Length</th>
<th>Editing Time (minutes)</th>
<th>Tools Used beyond a computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tessa</td>
<td>05:45</td>
<td>60</td>
<td>5 (Camtasia, Kaltura, mobile phone, PowerPoint, YouTube)</td>
</tr>
<tr>
<td>Kristine</td>
<td>11:22</td>
<td>60</td>
<td>5 (Camtasia, Kaltura, PowerPoint, YouTube, Zoom)</td>
</tr>
<tr>
<td>Bertha</td>
<td>11:07</td>
<td>40</td>
<td>6 (Camera, Green screen, Lights, Screen Flow, Yeti Microphone, YouTube)</td>
</tr>
<tr>
<td>George</td>
<td>02:20</td>
<td>5</td>
<td>2 (mobile phone and YouTube)</td>
</tr>
<tr>
<td>Tiana</td>
<td>07:40</td>
<td>30</td>
<td>4 (Kaltura, PowerPoint, YouTube, Zoom)</td>
</tr>
</tbody>
</table>

*Note.* Editing time and bolded tools are data from the survey.

*Creation Tools.* All five interviewees discussed using PowerPoint but did not report using it on the survey. Bertha, Tiana, and Kristine incorporated the tool in their video artifacts as the primary medium for delivering visual information while George and Tessa discussed using it to create other videos. Only Tessa used PowerPoint to do the actual recording “because it is easy.” She found it “easier to do than like Zoom or through something else, because then I can also rearrange the slides if it doesn't make any sense and I don't have to re-record them um again.” The other instructors used PowerPoint as their visual base and then utilized additional tools to record their use of PowerPoint. For example, Tiana used Zoom to do her recording so she could toggle between PowerPoint and other resources such as websites or the learning
management system to show students during the recording. Kristine started using Camtasia to do screen recording of her PowerPoint after being “forced into” learning the tool in order to edit her recordings to incorporate different clips such as teaching demonstrations. George did not specify how he captured his recording with PowerPoint, but one can assume it was some sort of camera because his preferred method was to record himself “standing in front of the PowerPoint slide” being projected on a “giant monitor…because at the end of day it's a much cleaner look.” Betha’s use of PowerPoint was similar to George; however, instead of being next to a monitor, she used green screen technology to superimpose herself on top of the slides which required an extensive home recording set-up.

Bertha’s use of tools was significantly more involved than the other interviewed instructors as she created her own home recording studio. The tools she used to record included “a closet” with “a piece of green cloth on the background,” a table and a chair,” “three different lights,” “a Yeti microphone,” and “a separate camera.” As part of Bertha’s recording process, she also had a specific outfit that she always wore consisting of “one gray jacket that doesn't fade out too much and one black shirt that doesn't fade out too much.” Her reference to “fade out” is in relation to editing the green screen effect. Bertha said, “I've learned through trial and error using the green screen that there are certain colors that I cannot wear and certain patterns that I cannot wear.” By wearing simple, solid colors it maximized her ability to edit out the green screen using a video editing tool called Screen Flow. Bertha would then layer her upper body with the green screen background removed onto her PowerPoint slides. Bertha utilized a plethora of equipment to create a specific video style that she wanted for her courses.

The use of PowerPoint by all five interviewed instructors provides a possible explanation as to why full implementation of the redundancy and modality principles may be lagging.
George encapsulates the concern succinctly saying, “My slides are text heavy. I do them wrong, but I don't care because it's my textbook.” Bertha and Kristine’s video artifacts provided examples of text heavy slides that were redundantly read by the narrator and Tiana spoke of using her slides as her “PowerPoint outline” so she doesn’t lose her “train of thought.” The instructors were relying on the slides to be their notes and guidance about what to speak aloud creating situations where they would violate the redundancy and modality principles. Bertha and Tessa both discussed using the notes area of PowerPoint as a way of preparing a script and not needing to rely on the on-screen slide text; however, only Tessa reported following through. Bertha had trouble getting the notes to show up for her so she switched to typing up a long notes document that she would review before recording. If instructors are making heavy use of PowerPoint in their video work, the examples of these five instructors provide both a caution and a way forward to ensure that the redundancy and modality principles are met in future videos.

Another tool the interviewees cited but did not list on the survey was YouTube. Bertha used YouTube to host videos, create and edit closed captions, and organize her video collection. Beside his phone, YouTube was the only other tool George used to create his “field videos” since he could both host and edit through it. He justified his use of YouTube, saying “We live in the age of YouTube.” His choice also harkens back to his perception that he is in a competition for student engagement with social media. Tessa used YouTube to host her videos, but chose it primarily for the closed captioning capabilities. Kristine and Tiana used YouTube as a source for video clips to incorporate in their videos. Kristine hosted her recordings on Kaltura and Tiana loaded them directly into the learning management system, skipping the use of a streaming video service. YouTube was an integral part of the video creation process and yet it was not included in any of their survey responses. Given the ubiquitous incorporation of both PowerPoint and
YouTube in the video creation process of the five interviewed instructors and the absence of mentions in the survey data from the same individuals, it raises questions regarding what they perceive to be video creation tools versus other types of tools. Does their oversight speak to the complexity of video production that common tools such as those are not considered to be part of the process? Future research into instructor tool perceptions is warranted.

**Factors Impacting Tool Choice.** Interviewees identified two factors that influenced their tool choices, ease of use and instructional need. The ease of using a tool appears to be a primary contributing factor to the interviewed instructors’ decisions to utilize specific tools in their recording process. Tessa chose PowerPoint over Zoom because she found it easier to use. She also said, “Um, I like the editing in Kaltura as well. I find that editing to be really, really nice. I use YouTube for my videos because I found the captioning in YouTube to be more accurate than Camtasia.” Those quotes demonstrate how functions of the tools and their ease of use factored into Tessa’s decision making. Bertha had “observed from taking classes online…over seven years through seven different institutions that Kaltura seems to fail sometimes” so she decided to use YouTube instead with the implication being it was more reliable. Kristine was explicit in stating that if a tool took too much time to do something or to learn how to use it, it was “not worthwhile” to her. Tiana explained that she chose Zoom for recording over Kaltura because Kaltura was too difficult saying, “I find that Kaltura and that it might be my ignorance is more trouble than I find it to be worth.” Tiana also said when explaining how she picks tools, “if it's if it works, easily, and if it allows me to address the points that um I need to address for my students then I use it.” George referred to the ease of using his mobile phone to quickly record on three separate occasions during the interview. The instructors selected tools to use for recording because they found them easy to use.
Ease of use could be superseded by an instructional need in certain circumstances. For example, Kristine described needing to learn how to use Camtasia in order to splice videos together saying, “I was forced into it because of what I wanted to do.” In that instance she made a decision to use Camtasia to meet her instructional need rather than because it was easy to do. Tiana mentioned struggling with Kaltura in situations where she needed to capture a portion of a YouTube clip for her video, but she did use the tool even though she was reluctant to incorporate it because it facilitated an instructionally important action. Both instructors sacrificed some personal ease of use and comfort to meet instructional goals they deemed to be more important. The interviewed instructors never made mention of selecting tools because they would assist in the implementation of any of the eleven CTML design principles.

Summarizing instructors tool use, the interviewees each utilized a unique combination of tools to create their instructional video. PowerPoint was discussed and utilized by all the interviewees in some capacity, highlighting its role in helping or hindering the incorporation of the redundancy and modality CTML design principles. YouTube was an integral part of the video creation process of each instructor and yet it was not included in any of their survey responses. The interviewees made decisions about which tools to use based on ease of use and instructional need.

The video creation processes of instructors are as varied and unique as each individual instructor and the videos they create, yet similar themes emerged. All the interviewees discussed the significant time commitment of creating an individual instructional video and the time pressure they operate under during creation. Even with time pressure, most of the instructors reported preparation steps that they undertook including content review and development of PowerPoint slides while one instructor provided an example of a more spontaneous video
creation process that still incorporates CTML design principles. In addition to preparation, the interviewees engaged in varied editing processes that could be complex or simple, but often involved re-recording and editing of closed captions. A final component of the creation process was tool selection, which instructors made based on ease of use and instructional need. The decision making steps articulated by the interviewees highlight how instructor decisions can positively or negatively impact the implementation of the CTML design principles in their instructional videos.

**Student Focused (Centric)**

Instructors choose components of digital instructional video production to focus on when creating digital video for use in online courses because of the viewers of their created videos, their students. Students hold great power to influence and direct the actions of instructors over time as the instructors continue to create instructional videos. Four themes emerged from the interview data about how students impact the interviewed instructors during the video creation process. The instructors were visualizing their students and their needs as they created video, using video to create connection with students, attempting to respect their viewers, and making changes to the way they created videos based on student feedback.

**Visualizing Students to Meet Their Needs**

Students are on instructors’ minds and are being thought about as video is created. “So I say students in the case of I think about them constantly because they're my audience and I have to think about what can I do to get my content to stick with my audience” George articulated when he described his planning process. George thought about his students constantly. As Tessa works through the process of explaining an assignment, which she did in her video artifact, she is “thinking of other comments student had students had made previously about, you know,
confusion, they had it, and I'm like, Okay, I need to add this part in I need to add this part in.”

She is adjusting her narration and her script to account for previous student experiences in order to improve her final product. Kristine discussed a similar process saying, “I'm also thinking about um what all they need to know to be successful with their final project.” The “they” in the quote referred to her students. Bertha had the most detailed response of the interviewees when she described the specific conditions in which she envisions the students engaging with her video and why she is careful about what references to the slides she might make.

I try to keep in mind that for the students that might be listening to these lectures while they're at work, you know, in the dish room, you know, because these are a lot of nutrition students, they could have their ear buds in and their phone going, and they're listening to lectures while they're working. So they don't get it. They don't see it. They don't see the humor. They just hear you saying something funny.

Bertha is assuming, based on previous experiences, that some students will be listening to the video instead of watching. She is trying to “keep in mind” those students as she goes through the video creation process. One component of digital video instruction that instructors are focused on during video creation is visualizing or thinking about their future student viewers.

Creating Connection with Students

A second aspect instructors consider with regards to students is how they can create connection with their students through the video. Kristine spoke to this concept reporting that she is trying as much as possible to “let my personality come forth” and to establish a relationship with the students as they're watching the video. She explained further that the reason she tries to let her personality “come forth” is that the lack of student-to-student interaction in asynchronous learning can be “very isolating and that’s not good for students.” For her, “that’s one of the
reasons why I just believe...that the instructor should be visible in the videos.” Kristine’s belief in incorporating herself into the video, which addresses the embodiment design principle, stems from a desire to create connection with students. Tessa articulated a belief that her video also assists in connecting with her students, that her students told her “that the videos have been really helpful,” and that the videos help her with her teaching because they benefit students. Tessa views the connection to students brought about by the video as a benefit that improves her overall course. Kristine and Tessa view video as a means to creating connection with students.

**Respecting Students**

Respecting students was another component of considering students that instructors discussed about their video creation process. George wanted to respect students time with the content he put forward. He wanted to “do something that I think it’s worth your time.” Inherent in the statement is the idea that he is considering what is worthy or not of students’ time and creating with those student interests in mind. Tessa spoke this concept more directly as she expressed a desire for the videos she creates “to be beneficial to the students.” Elements of respect that she considered in the design process included video length, content interest, and slide design. She wanted to keep her videos short which was an example of the segmenting CTML design principle. She worked to ensure the content in the video was interesting and she did not have slides that were too busy which would have violated the coherence principle. She wanted to “make sure that whoever your audience is doesn’t feel burdened by watching the video.” Ultimately Tessa wanted the students to have success as she said, “I want them to be able to watch the whole thing and be like okay I grasp these concepts.”
Changing Because of Student Feedback

Student feedback informs instructor incorporation of CTML design principles and highlights a possible avenue for influencing instructors to improve their incorporation of CTML design principles. I asked Tiana “do you know where those ideas came from for you?” in reference to her use of her face in the video and her response was “student feedback.” I asked Kristine where she learned the idea of reducing her PowerPoints before recording and her response while laughing was “student feedback.” I asked Tessa if she had an interest in learning more complex editing or if she was comfortable with her process and she responded, “I'm waiting to see what the feedback is from students from their evaluations.” In all three situations the interviewee referenced that they either learned from or were waiting to decide until they received student feedback. Tiana, who creates her videos as she progresses through the course specifically asks students for feedback after the video in the first module and will adjust her creation process for the rest of the course based on their comments.

I want to make sure that you're getting out of this course what you need to. So now that we're one week deep um I need to know if I want, if I need to change on the dime here and I need the group to post in water cooler, you know, or I'll send out a Qualtrics survey um to say like are these videos, working for you, yes or no?

Tiana incorporates student feedback because she has “no idea if the quality of my video is good” and she has not seen a replication of the classroom observation for online video so she turns to student feedback. George discussed getting better at communicating concise messages “through having my students and, you know, getting that feedback and understanding what works.” Bertha changed at least two of her processes in response to student feedback.
I've even gotten you know comments over the semesters from students who say, you know, sometimes it looks like you read a lot off the screen in your PowerPoints. And so sometimes what I do is at the beginning of the semester when I record my welcome lecture to the students I'll let them know that you know it looks like there are a lot of videos, but they're very short, their content focused, and I will do my best not to look like I'm reading words off screen.

Bertha changed the way she organized her information delivery in response to student feedback. She also switched from a side-by-side style video to the green screen style “because the research that I had done showed that students preferred that.” The conversations with the five instructors highlight how students have power to improve instructional video for future students by providing feedback to instructors.

In summary and underlying the student focus is the instructors care and concern for doing right by the students in their courses. Instructors visualize their future students and their situations as they prepare and create instructional video. Creating connection through the video is a desired outcome of the instructors, particularly because of the isolating environment of online learning. Instructors also created video from an attitude of respect towards their student viewers, not wanting to burden them. Finally, instructors made changes to their creation process in response to feedback from students on what worked and didn’t work with previous video.

Learning Methods

Student feedback led to changes in instructor video creation, but also acted as a learning mechanism, teaching instructors about what was working and not working for their viewers. In addition to student feedback there are other methods, tools, techniques, and people who informed instructors and influenced their decisions when they created digital video for use in online
courses. Those other learning methods included personal experiences, research, university resources, and other people.

**Personal Experiences**

Ubiquitous among the five interviewees was a description of their personal experiences serving as learning mechanisms for the ways in which they operated with instructional video. Those experiences could be further sub-divided into teaching experiences and professional experiences as exemplified by George the TV meteorologist when he discussed how he learned how to craft the story in each of his videos saying, “what I found from both teaching and TV.” Professional experiences were only relevant among the two adjunct instructors, while the teaching experience was evident among all five interviewed instructors.

**Professional Experiences.** George and Bertha, who are adjunct instructors, cited their professional experiences as learning mechanisms for components of their digital video creation processes. George had multiple direct and indirect references to his ten-year on-air TV experience as guiding his current video creation and use practices. His inclusion of himself, the use of pointing, the way he created his field videos, his emphasis on images, and even the way he talked were all “because of my TV background.” George’s professional experience was a significant asset in the video creation process and is likely a contributing factor to his significant use of many of the CTML design principles. Instructors may find much to learn from those TV professionals who are regularly on camera, a sentiment echoed in Bertha’s statement,

“I never wanted to be a TV personality in the first place, and here I am.” Now we’re all TV personalities, you know, none of us you know, this is that was not the career we chose for ourselves. We chose to be educators and now all of a sudden you know, we're
learning how to do hair and makeup and clothing and green screens and lighting and audio and you know what does your voice sound like and so it's challenging.”

Even though Bertha acknowledged that there are things to learn from TV personalities such as George, she also highlights how other professional experiences can impact video creation processes. Bertha “used to record the menu every day for a company” and learned how to speak “using a certain tone...with a slow speech pronouncing everything very particularly and carefully.” She used this tone and cadence when she first started recording. Bertha also acknowledged that she learned how to do components of her video creation process through a “kind of just an amalgam of everything that I’ve been doing for the past 25 years.” George and Bertha learned techniques they employed in the video creation process from their professional experiences outside of teaching.

**Teaching Experiences.** Another set of personal experiences that instructors learned from regarding their video creation and use processes is their teaching experience. Tessa summed up learning through experience saying, “as I just kind of keep going through the process, I keep finding things I want to change. Areas I want to improve.” She is improving and adapting as she continues to engage in the video process. This sentiment of learning through teaching experience was echoed by Bertha, Tiana, Kristine, and George. Bertha described that learning experience as “it’s been trial and error. I’ve learned through trial and error.” Tiana demonstrated the gradual improvement process in describing “if it's like the second or the third time I'm teaching a course, then I have a little bit more knowledge about the sites that I want to see, the resources that I have in my back pocket.” Tiana can create her videos in a more efficient manner when she knows what resources to draw on from her previous teaching experience. When I asked Kristine how
she had learned to do the reduction of her PowerPoints, her response was “it was experience.”
All of the interviewed instructors learned what to do through the process of teaching with video.

**Research**

Professional and teaching experiences were one way in which instructors learned how to create and use digital video in online courses, but they also uncovered information through research. George and Tessa reported that they learned from research literature. For example, Tessa said in reference to why she made her videos shorter, “all the studies out there saying, you know don’t create a one hour (chuckles) you know, presentation.” George adamantly supported his use of finger pointing by saying, “I know there are studies that will echo what I just said.” Tiana and Bertha utilized information they discovered via the internet. For example, Bertha “went online and read about this” and Tiana indicated she learned from “stuff I trip across” as she engaged in her regular work. Information uncovered through intentional research or other reading contributed towards instructors’ video making decisions.

**University Resources**

A third set of learning resources that assisted instructors with their video creation processes came from the university at which they worked. Those resources included initiatives, conferences, and learning aids. For example, Bertha based her video length decision on a combination of her own previous student experience and the University’s learning aid that indicated the preferred video length of no more than 15 minutes. Tessa cited information she had learned from a University sponsored conference where she was introduced to sources on how to create video. Tiana was participating in an initiative on course design that she was “hoping will give me the feedback that I need to either confirm or grow in my teaching abilities through not only my modules...but my video presentations to.” Tiana also cited faculty colleagues who
shared tips they received from the university as another source of learning about how to create video. Interviewed faculty identified university resources as a source of information that supported their video creation processes and decision making.

**Other People**

A final learning theme to emerge from the interviewed instructors was the significance of learning from other people such as teachers, family, and university staff. Learning from other teachers was a common theme among all the interviewees. Kristine “did reach out to the other professors who are teaching the same course” for input. Tessa knew “that there’s some people who use Adobe Spark” to create video and so she wanted to learn more about that tool for future use. George shared advice he had gotten from another teacher and Tiana referenced learning about Educreations from her kid’s teachers. Bertha based her decision on video length in part on an encounter with an instructor “who did really short lectures, like two to three minutes long, that were topic focused.” The influence of the other instructors varied in terms of the nature of the knowledge, but all the interviewees reported learning from other instructors. Bertha and to some extent Tiana also indicated learning from family members. Tiana’s impact came via her kids and their teachers, but Bertha received feedback from her husband in two areas. One was on her speaking cadence and the other was on the use of Camtasia. A final individual who assisted some of the instructors with their learning about video use was their instructional designer. Kristine’s assigned instructional designer had the responsibility to assist her in learning new tools, including video editing software, a fact she reported in her interview. George and Tiana also indicated that they learned more about video and video creation from the one-minute videos distributed by their instructional designer. George said, “It’s your idea of that one-minute concept” and Tiana said, “So sometimes, like a faculty colleague gets paired with you will send
your tips that you send to faculty that like introduce them to new materials.” Thus, the interviewees learned about video creation and processes from a number of different individuals with whom they interacted.

In summary, instructors reported learning about video creation from personal experiences, research, university resources, and other people. Personal experiences broke down into professional experiences that adjuncts had outside of teaching and teaching experiences that all the instructors engaged in. Learning via research included professional literature and regular day to day reading. The university resources that assisted in the development of instructor video creation processes were learning aids, conferences, and initiatives. Finally, other people like faculty, family, and instructional designers contributed knowledge that assisted instructors in the development of their video creation processes.

Chapter Summary

The purpose of this study was to describe higher education online instructors’ implementation of the 11 Cognitive Theory of Multimedia Learning (CTML) design principles in digital instructional video created for online learning courses. In this chapter, I described the findings derived from an explanatory sequential mixed methods design and data collected from an initial survey, five interviews, and five video artifacts. After analyzing the data according to the steps outlined in Chapter III, I found that instructors robustly implemented the coherence, modality, voice, and personalization principles, but lagged in implementing the signaling, redundancy, and segmenting principles with the remaining principles falling between the two extremes. The five interviewees highlighted numerous examples of strategies, creation methods, and video creation decisions that illuminate which CTML design principles are a focus during video creation and why instructors choose components of digital instructional video production
to focus on. In the final chapter, I will connect the study findings to my theoretical framework and the broader research literature, provide implications for educational practice, and offer my suggestions for future research.
Chapter 5: Discussion

“I never wanted to be a TV personality in the first place, and here I am. Now we’re all TV personalities” - Bertha

Bertha’s quote captures both the promise and peril that the COVID-19 pandemic forced upon higher education instructors. It is the peril of instructors forced into teaching through a video screen in ways that were perhaps uncomfortable and unfamiliar, while at the same time the promise of continuing to educate students when not in physical presence with one another. The quote displays the promise of new means of conveying information coupled with the peril of possible pitfalls of inexperience or ignorance as to how best to convey information through video. Given the forced migration of teaching into video formats brought on by the pandemic, this study sought to reveal the extent to which higher education instructors with previous online teaching training were aware of and implemented video design principles derived from the Cognitive Theory of Multimedia Learning (CMTL). In this final chapter, I will summarize the study, connect the findings with the theoretical framework, discuss the results, suggest areas of future research, and offer my implications for future educational practice.

Summary of the Study

This mixed methods study investigated higher education online instructors' implementation of 11 design principles of the Cognitive Theory of Multimedia Learning (CTML) at a large, regional mid-Atlantic public university in the United States of America. Within this setting, I collected data from 55 consenting instructors via a survey and used the results to generate a CTML design principle implementation score for each instructor. I identified the five instructors who had the highest self-reported CTML design principle implementation scores for a follow up interview and also collected a single video artifact from
each interviewee for further corroborating evidence of their design principle implementation. I triangulated quantitative and qualitative data to answer the research question: *To what extent are higher education instructors who create digital instructional video for online learning applying the 11 multimedia design principles of the Cognitive Theory of Multimedia Learning?* and four sub-questions:

1. Which Cognitive Theory of Multimedia Learning (CTML) design principles are higher education online instructors incorporating into self-made digital instructional videos? *(quantitative)*

2. Why do higher education online instructors choose components of digital instructional video production to focus on when creating digital video for use in online courses? *(qualitative)*

3. Which CTML design principles appear in higher education online instructors self-selected “best” self-made instructional video? *(quantitative and qualitative)*

4. To what extent are CTML design principles an area of focus for higher education online instructors as they create digital instructional video? *(quantitative and qualitative)*

Using SPSS, I calculated descriptive statistics on instructor implementation of each individual design principle and combined scale scores as well as correlations between the principles and collected demographic data. According to the principle implementation scoring scales, the sample participants implemented CTML design principles in videos they created between 58.7% and 70.9% of the time. As seen in Figure 8 in Chapter 4, instructors robustly implemented the coherence, modality, voice, and personalization principles, but had less robust implementation of the signaling, redundancy, and segmenting principles with the remaining four
principles falling between the two extremes. I identified 14 statistically significant correlations between the CTML design principles using a Spearman’s Rho calculation out of a total of 66 possibilities.

After completing the interviews, I used hypothesis coding to identify examples or descriptions of CTML design principle implementation from the interview transcripts and video artifacts. Then I synthesized the codes into themes which could assist in explaining why the five interviewees were implementing or not implementing specific CTML design principles. With each principle, the themes from the interviewees served different informative roles. In some instances, the identified themes helped explain why all instructors implemented a principle at a certain rate. In other situations, the identified themes provided examples of techniques the interviewees incorporated that led them to have better results than the overall group of instructors. These roles varied depending on the data collected during the interview process.

An example of how the themes provided supporting explanations for principles implementation rates are found with the voice and personalization principles. According to the survey, the voice and personalization principles had robust implementation among instructors, however the survey data didn’t explain why. Themes from the interviewees indicated that instructors were serving as the video narrators for their videos because they saw their voice and presence in the video as a relationship building tool with the students. The interviewees described using words such as “you,” “we,” “me,” and “I” because they were focused on being in a conversation with their student viewers and found the normal method of talking easy to incorporate in their videos.

Themes from the interviewees also served to identify methods that other instructors could incorporate to improve their implementation of certain principles. According to the survey data,
instructors as a whole were lagging in their implementation of the signaling principle, however the interviewees reported strong signaling implementation. The interviewees discussed methods for incorporating various signaling techniques such as vocal signals, using shapes and color, finger pointing, and mouse circling. Therefore, these signaling methods provide practical examples other instructors can draw on when creating future videos.

Additionally, some themes assisted in explaining why a CTML principle had poor implementation. According to the survey, 60% of instructors reported reading on-screen text more of the time or all of the time which goes against the redundancy principle. The interviewees highlighted some techniques that could help instructors improve their implementation of the redundancy principle such as creating visual designs that eliminate or reduce on-screen text and building up video creation experience, but they also identified the need to reinforce a key concept as a contributing factor in redundant on-screen text narration. The distinction between the interviewees who minimized on-screen text and were able to meet the redundancy principle versus those who had significant on-screen text which they were then more likely to read aloud points to a possible solution that can assist instructors in meeting this principle. Minimizing on-screen text will likely reduce the likelihood on violating the redundancy principle.

In addition to examining instructor implementation of the CTML design principles individually, I also investigated their video creation processes. From the survey data, an instructor’s average video had a lecture instructional style, took an hour and 48 minutes to create and was likely built using Camtasia, Kaltura, or Zoom meeting software. The interviewees elaborated that they were under time pressure to create instructional videos in part because of the varied steps they undertook during the process. For most of the interviewees those steps included preparation which involved reviewing content to be covered and preparing PowerPoint slides for
use in the video. The interviewees also engaged in video editing to add in signaling elements, bring video segments together, rerecord segments, and modify closed captions.

The interviewed instructors created videos with a student focus, keeping student needs in mind as they went through their creative processes. Sometimes the instructors visualized their students and the settings they would be in when they watched the finished video product while other considerations included using the video as a tool for building relationships with their students. The instructors made video creation decisions out of respect for student needs and also made changes to their process based on student feedback.

Finally, instructors learned the skills they employed in the video creation process through multiple avenues. Interviewed instructors’ personal life experiences, including both non-teaching professional experiences and teaching experiences, contributed to their video creation decision making. The instructors utilized research to assist in decision making and university provided resources and guidance. They also learned from other people including other teachers, family, and university staff.

**Application of Theoretical Framework to Findings**

The theoretical framework for this study combined the broad flexibility of the Constructivist Learning Theory with the specific focus of the Cognitive Theory of Multimedia Learning to illuminate the relationships and interactions between an instructor and the video they create (See Figure 1). Constructivism was the lens I used to analyze the impact of instructors’ lived experiences on the creative process and editing decisions while the cognitive theory of multimedia learning explained why instructor implementation of the design principles would lead to effective learning videos for students. The findings identified in Chapter IV have direct and obvious connections to the theories applied in this study.
Constructivism

The central tenet of constructivist learning theory is that an individual constructs knowledge through a process of integrating new information with previous learning (Bada & Olusegun, 2015). Thus, according to this theory, both the process of creation and the video end product would be unique manifestations of the individual creator. The data from this study supports that assertion as the interviewees described video creation processes and created video artifacts that were each unique and distinct. Moreover, each individual interviewee used a different combination of video creation tools in an individualized manner to arrive at their specific end products and each incorporated the CTML design principles in ways customized to their own experiences. The instructors’ diversity in technique, conventions, and production styles reinforced the concept of educational video as a meta-genre (Winslett, 2014). Their stories demonstrate that there are many trails for instructors to follow to arrive at full implementation of the CTML design principles in videos that they create.

As I stated in Chapter II, in constructivist learning theory there are two primary assumptions: (a) individuals must use their previous knowledge in the knowledge construction process (Merriam & Caffarella, 1999) and (b) the learning process is active (Bada & Olusegun, 2015) with social interactions a component of the active process (Tam, 2000). Each interviewee demonstrated the two primary assumptions in connection with their application of various CTML design principles. For example, Tiana drew on previous classroom knowledge when she chose to use vocal signaling in her video and she incorporated shapes and colors as signaling tools after an active interaction of seeing other teachers do so. A second example was Bertha’s decision to switch from making a single 40-minute video per unit to six to eight shorter videos per unit, improving her application of the segmenting principle. Tessa provided a third example, when she
began narrating her videos after a combination of research on video use and student feedback motivated her to implement the modality principle. She drew on her previous knowledge, incorporated new understandings, and was active in her decision making to adjust her method to more fully implement the CTM design principle. In each of these examples and others discussed in Chapter IV, the interviewees demonstrated “the complex interplay among learners’ [instructors] existing knowledge, the social context, and the problems to be solved” (Tam, 2000, p. 52).

Another component of Constructivist learning theory is the three-stage process Piaget (1977) identified: (1) assimilation, (2) accommodation, and (3) equilibration. Various elements of the interviewees CTML design principle incorporation demonstrated the three-stage process, and one example was Kristine’s evolution in her application of the embodiment principle. She acknowledged the awkwardness of seeing herself on camera when she first started recording, an example of disequilibrium. As she continued to create video and gained experience incorporating herself into the video product, she engaged in accommodation becoming more comfortable with seeing herself on camera. Finally, she reached a point of equilibration where she no longer had a problem being on camera and now posits “that the instructor should be visible in the videos.” As this example has demonstrated, Kristine experienced the three-stage process described in constructivist learning theory as she learned to meet the embodiment design principle in the videos she creates for her online courses.

**Cognitive Theory of Multimedia Learning**

Connecting the results of this study with the Cognitive Theory of Multimedia Learning was a straightforward task, as the 11 design principles are a direct offshoot of the theory itself and their application by instructors was the focus of the study. The principles were the
connective tissue throughout the entire process, and the elements around which I organized
everything in the study. Data from the study illustrated that instructors are applying some of the
principles robustly and the overall application of the design principles appears to be better than
50%. However, the study data has evidence that the instructors do not know the specifics of the
underlying CTML research. Out of all collected data, there was only one explicit reference to the
CTML design principles in a response to the survey question about the instructional strategies
used in the video. None of the five interviewees specifically mentioned a design principle,
CTML research, the key theorists, or either of the three types of cognitive load. Thus, the
qualitative findings add important contextual examples of how instructors implement the design
principles in practice settings, creating a bridge between the experimental laboratory-based
findings and real-world settings.

*Technology Adoption Model*

In addition to the primary theoretical framework I utilized in this study, I also referenced
additional subtheories to assist in explaining instructor decision-making as it related to the tool
and editing decisions. One subtheory was the Unified Theory of Acceptance and Use of
Technology (UTAUT) which identifies determinants such as performance expectancy which was
closely related to the study theme of instructional need and effort expectancy which is similar to
the study theme of ease of use as predictors of instructor technology use (Venkatesh et al., 2003).
Tiana encapsulated both determinants when she explained how she picks tools, “If it works,
easily, and if it allows me to address the points that, I need to address for my students then I use
it.” Her comment about a tool allowing her to “address the points” represents performance
expectancy and her comment about “if it works, easily” demonstrated effort expectancy. The
third determinant of UTAUT is social influence or “the degree to which an individual perceives
that important others believe he or she should use the new system” (Venkatesh et al., 2003, p. 451) and the interviewees student focus or centrism when creating their videos represents this concept. George provided another detailed example of this determinant and his student focus when he justified his use of short video segments as a means of winning the competition for student attention with social media. In those examples, the instructors are making decisions based on the influence of how the important others or students will perceive their choices. The final determinant is facilitating conditions or the organizational and technical infrastructure that supports the use of the technology. The survey results on tool use indicated that the top three tools instructors used for video creation were Camtasia, Kaltura, and Zoom Meeting which also happen to be the three primary video creation tools the university provided and supported. Factoring in the significant references to PowerPoint, which is another university-supported tool, I assert that instructors were picking tools based in part upon the technical infrastructure that was available and supported in their specific contexts. Given these examples along with other evidence in Chapter IV, the UTAUT theory provides an additional lens for interrogating the video creation decisions of instructors.

**Complex Instructor Decision Making**

A second subtheory situated under the broader constructivist learning theory is the considerable complexity involved with instructors and their decision making as it relates to video creation. As I discussed in Chapter II, Oleson & Hora (2014) identified seven concepts that influence instructor decision making and numerous examples from this study connect to those seven concepts. While all seven decision-making concepts were not present for each interviewee, there were multiple examples of each concept among the interviewees. I have identified one pertinent example from the study for each of the seven concepts in Table 18. Thus, the examples
from the study appear to confirm and add further support to the findings of Oleson & Hora (2014).

Table 18

Examples of Instructor Decision Making Concepts

<table>
<thead>
<tr>
<th>Concept</th>
<th>Example from Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructors relied on previous related experiences as an instructor to inform decisions</td>
<td>Tiana does not read aloud on-screen text in her videos because she wouldn’t do that in her face-to-face classroom.</td>
</tr>
<tr>
<td>Prior classroom trial and error experiences</td>
<td>Bertha described how she has developed her video creation process as “it’s been trial and error. I’ve learned through trial and error.”</td>
</tr>
<tr>
<td>Professional development</td>
<td>Tessa cited information she had learned from a University sponsored conference where she was introduced to sources on how to create video.</td>
</tr>
<tr>
<td>Reflections on peer and student feedback</td>
<td>Kristine learned the idea of reducing her PowerPoints before recording from “student feedback.”</td>
</tr>
<tr>
<td>Interactions with other instructors</td>
<td>Kristine “did reach out to the other professors who are teaching the same course” for input.</td>
</tr>
<tr>
<td>Own student experiences</td>
<td>Bertha based her decision on video length partly on an encounter with a former teacher during her undergraduate program “who did really short lectures, like two to three minutes long, that were topic focused.”</td>
</tr>
<tr>
<td>Experiences from research</td>
<td>George used the finger pointing signaling technique because he was aware of studies supporting its effectiveness.</td>
</tr>
</tbody>
</table>

Note. Oleson & Hora’s (2014) seven concepts that influence instructor decision making

Ecological Model

A third subtheory, the ecological model of university faculty members’ knowledge and beliefs about technology (Shelton, 2018), provided some additional clarification on instructor decision making processes and how they relate to larger contexts. The model posits that...
instructors are influenced by series of different contexts starting with their self-identity and emanating out through department, institution, higher education, and finally to society itself. Within the findings of this study were echoes of those various influences; however, the connections are less obvious and prevalent than those of the complex instructor decision-making concepts. As seen in Table 19, there are individual examples from the study that relate to the different ecological contexts with the exception of the higher education sector where I was unable to identify a specific example. Given these examples, the study findings extend and confirm the use of the ecological model as a frame for analyzing instructor decision making.

Table 19

Examples of Ecological Contexts

<table>
<thead>
<tr>
<th>Ecological Context</th>
<th>Study Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self</td>
<td>George had what he called a personal belief that it was inappropriate to use music with teaching or teaching of weather.</td>
</tr>
<tr>
<td>Departmental</td>
<td>Kristine “did reach out to the other professors who are teaching the same course” for input.</td>
</tr>
<tr>
<td>Subject / Discipline</td>
<td>Bertha, who teaches nutrition courses, reported “[It is not] appropriate for the subject that I teach for me to use any music.”</td>
</tr>
<tr>
<td>Institutional</td>
<td>Tessa cited information she had learned from a University sponsored conference where she was introduced to sources on how to create video.</td>
</tr>
<tr>
<td>Professional</td>
<td>George’s “TV background” contributed to his inclusion of himself, use of pointing, emphasis on images, and way of talking in his videos.</td>
</tr>
<tr>
<td>Higher Education Sector</td>
<td>No examples identified.</td>
</tr>
<tr>
<td>Society and Culture</td>
<td>Tiana learned to insert shapes and colors for signaling from watching K-12 teachers use it in videos her child watched during remote learning of the COVID-19 pandemic.</td>
</tr>
</tbody>
</table>

*Note.* Ecological contexts from Shelton (2014).

Discussion of Results
Working from the connections between the results and the theoretical framework, in this section I will discuss how the results answered each of the four subresearch questions and how those findings relate to the broader literature. This section mirrors the organizational structure of each individual CTML design principle in Chapter IV. The first question is addressed via the survey data, the second question by the qualitative interviews, the third question by the triangulation of findings with the video artifacts, and the fourth question by all of the data taken together collectively.

**CTML Design Principles Incorporated by Instructors**

The first sub-research question was quantitative in nature and sought to identify which CTML design principles instructors were incorporating into their videos. The sample for this study reflected the best possible outcome regarding CTML design principle incorporation because it included instructors who had already received training to teach online, reporting on their “best” self-made digital instructional video. Within those conditions and under the most optimistic assumptions, instructors are only implementing the CTML design principles 70.9% of the time. Less optimistic assumptions indicate CTML design principle implementation among the instructors most likely to know the principles could be closer to 58.7%. The data from either set of assumptions reveals that instructors have moderate principle incorporation, with plenty of room for future improvement. Broadly speaking these findings extend the current research literature on CTML design principle incorporation by adding practical context to the primarily experimental- and laboratory-based investigations of the principles (Rudolph, 2017). I have not identified any prior investigations of higher education online instructors’ incorporation of these principles prior to this study so the findings add to the larger body of knowledge regarding CTML.
Examining the design principles individually, this study found that instructors implemented the voice principle the most often with 97.9% incorporation while embodiment had the lowest implementation with 50% of instructors not incorporating the principle. The remaining principles fell between those extremes with the personalization, modality, and coherence principles having higher implementation and the signaling, redundancy, and segmenting joining embodiment with less robust implementation among instructors. Comparing these results to a similar study of primary and secondary (K-12) teachers’ implementation of the design principles found similar results regarding the personalization, voice, and redundancy principles but divergence among the remaining principles (Allison, 2015). Primary and secondary teachers reported less than 50% implementation for spatial contiguity, temporal contiguity, coherence, and segmentation as well as robust implementation for signaling and pre-training (Allison, 2015). Given the differences in population, context, and design between the two studies it is difficult to draw further comparisons.

**Instructors Video Production Component Focus**

The second subresearch question was qualitative in nature and sought to address why instructors choose production components to focus on when creating digital video. Production components are the elements that make up a video which are primarily reflected in the implementation or absence of the CTML design principles although it can contain other elements as well. Researchers have not thoroughly investigated instructor decision making regarding video use for education and when researchers have conducted investigations the focus has been on students rather than instructors (Kay, 2012; Pan et al., 2012; Winslett, 2014). Thus, the following selected examples from the broader findings of this study extends current understanding of
instructor decision-making on video use for education. Two factors influenced the incorporation of certain production components: (a) students and (b) the personal impact on the instructor.

There is a consistent theme throughout the study findings found in each CTML design principle that students motivated or influenced interviewee production choices. For example, Tiana discussed wanting her video to be “meaningful and serve a purpose” so as to help her students meet their course objectives and thus implemented the coherence principle during video creation. Another example was Kristine’s implementation of the temporal contiguity principle through inclusion of visuals to go along with narrated explanations because she believed that was what students wanted. Tessa demonstrated a third example applying the redundancy principle when she reported that she didn’t use a lot of words with her PowerPoints to keep from distracting her students. Finally, George demonstrated his student focus with an example from his implementation of the embodiment principles when he discussed including his face with the content because he knew it would help students remember the information. In the examples from each interviewee, their interest in supporting their students played a role in their decision to implement a CTML design principle. The student focus appeared consistently throughout the interviewees’ discussions of principle implementation.

The second factor influencing the incorporation of production components was the personal impact on the instructor. Personal impact is a mix of instructor time demands and how decisions would impact how others perceived them. For example, Tessa made a decision to use PowerPoint for her video recording “because it is easy” implying that she didn’t want to invest the time into learning another tool. However, she also indicated that she was worried about how she would appear on camera and using PowerPoint would allow her to remain off camera. Both time and perception then played a role in Tessa’s incorporation of the embodiment principle and
may have impacted other principles such as redundancy. Another example of this combination was Tiana engaging in two to three retakes of her 11-minute-long video because she would make a mistake during recording. She was attempting to balance her desire to appear mistake-free with the time it would take to complete the recording. A final example of how instructors attempted to balance time demands and how others perceived them was from Bertha and her evolution on her implementation of the redundancy principle. When she first started creating video, she read aloud on-screen text because she was didn’t want to make a mistake and have students perceive her as unprofessional. As she gained video creation experience and developed a creation process, she was able to create a situation where she was less reliant on reading on-screen text. These examples from the study findings regarding time pressure on instructors confirm and provide additional explanation of previous findings related to academic clinicians and video production (Norman, 2017). The findings of this study also help to identify the space in which these phenomena operates (Hora, 2012).

**CTML Design Principle Appearance in Instructors’ Self-Selected “Best” Videos**

The third subresearch question combined quantitative and qualitative data to address which CTML design principles appeared in instructors self-selected “best” instructional video. The study findings sought to extend current knowledge of instructor use of CTML design principles via rich descriptions of local practice in actual instructional settings to benefit educators and educational practitioners (Hora & Holden, 2013). Analysis of the video artifacts in combination with the survey results from the five interviewees allowed me to triangulate the data to confirm or contradict the greater survey results. Among the five interviewees, there was clear evidence that the principles of coherence, signaling, temporal contiguity, segmenting, personalization, embodiment, and voice principles were applied robustly in the video artifacts.
The interviewees mostly met the redundancy principle as they all kept redundant reading under 20% of their total video length; however, only George fully implemented the principle with no redundant reading of on-screen text. Two principles had inconclusive results. The spatial contiguity principle was inconclusive due to three interviewees not having images and text together onscreen while the other two interviewees did meet the principle by having text and images together on screen. Interviewee application of the pretraining principle is also inconclusive. Two instructors had evidence of the pretraining principle and a third instructor insinuated its presence. The remaining two instructors had no evidence confirming or denying the existence of the pretraining principle. While the survey results appear to indicate that the modality principle is being applied robustly, the evidence from the video artifacts of the five interviewees undercuts the validity of those findings. Only George’s video, which had no on-screen text could be considered as fully applying the modality principle. Two of the interviewees had 100% of their video with text-based information while another had 82%. Given the strong mismatch between data sources the application of this principle remains unclear. The five interviewees implementation of these principles extends the understanding of instructors’ practical implementations in online courses (Rudolph, 2017).

The Extent of Instructors Focus on CTML Design Principles

The final sub-research question combined quantitative and qualitative data to determine the extent to which CTML design principles are an area of focus for instructors. While it appears that instructors are incorporating more than half of the CTML principles, their use is not occurring because instructors are focusing on the principles specifically. The evidence points to instructors incorporating the principles based on personal experiences and preferences and not from knowledge of the specific CTML principles. The signaling principle provides an example
of this idea. The five interviewees robustly applied the signaling principle in their video artifacts and mentioned it during their interviews; however, they were unable to accurately articulate their own usage of the principle via the survey data. George, who was in the best position to actually know the research based on his professional TV experiences, could not articulate the specific concept. Tiana also provided evidence of the lack of specific knowledge of the principles when she articulated a need to have someone who understand distance education and video review her videos and provide feedback on what did well and what could be improved. If she had the knowledge of the CTML principle she would be able to analyze her own videos. The instructors may know to apply the concept, but they don’t appear to know why it is effective. These findings provide additional support for the idea that more research is needed on how faculty learn to implement technologies like digital video into their instruction (Belt & Lowenthal, 2020) and instructors need additional research-backed training on video creation.

**Directions for Future Research**

One of my primary motivations for conducting a study of this nature was to begin the process of mapping out instructor implementations of the 11 CTML design principles and video creation processes more broadly. I attempted to begin defining boundaries in which a research agenda could begin to take shape. With the study of digital instructional video and learning still new and few studies focused solely on instructors and their video creation processes, their remains a great many areas of future research in the field (Bétrancourt & Benetos, 2018; Chorianopoulos, 2018; Kay, 2012).

First, there is a need to further refine the survey instrument to better capture the diverse possibilities for incorporating the CTML design principles. An accurate and efficient instrument would have great value in assisting individuals with evaluating their incorporation of CTML
design principles into video artifacts. Even though the survey I used in this study was based on previously used instruments, had four experts test it for content validity, and had demonstrated reliability, I still found components of collected data that could be interpreted from multiple perspectives. For example, it is possible that instructors reported on the survey that they did not apply a CTML design principle because it was not applicable. George demonstrated this with the spatial contiguity principle when he indicated he didn’t have related words and images appearing together on screen because he didn’t use any onscreen text. The survey in its current form had no way to discern that distinction which was a weakness of the design as implemented and adds support for refining the instrument before future use. There is also evidence that some instructors may have been thinking about their video creation work holistically instead of specifically about their “best” video which may have led to variations in the scale scores. Again, further refinement of the language and questions could help to focus the collected data. Video creators and learners would benefit from the guidance a refined and efficient tool capable of collecting more accurate data on CTML design principle implementation could provide.

Second, this study looked at each principle individually and primarily in isolation from the others leaving open questions about how the principles interact with each other. The 14 identified statistically significant correlations between the CTML design principles are worthy of future investigation to determine how implementation of certain principles may positively or negatively impact the implementation of other design principles. While there are plenty of examples of controlled experiments investigating one or two of the principles in isolation, there are no studies that look at the learning impact of videos created that apply all of the principles together (Adesope & Nesbit, 2012; Ari et al., 2014; Ginns et al., 2013; Gunnell, 2017; Kutbay & Akpinar, 2020; Pi et al., 2019; Rey et al., 2019; Shah, 2020; Wang & Crooks, 2015). For
example, Tessa discussed speaking on-screen text as a means of emphasizing key vocabulary, a form of signaling. She also had a course structure that prevented the implementation of pretraining or providing key terms and definitions for viewers prior to the video. Thus, Tessa was implementing the signaling principle at the expense of the redundancy principle. If she had followed the pretraining principle, she may not have had the need to redundantly read as a form of signaling to the video viewers. Another example of interactions between the principles occurred with the redundancy, modality, and coherence principles and the use of PowerPoint in videos. In an ideal application of the three principles, limited text is included in a video, it is not read aloud by the narrator, and it is crucial for the video learning objective. It is unclear if violations of one of the principles lead to violations of the other principles. Thus, future studies should investigate how all the principles collectively support or undermine one another rather than individual studies of their effectiveness.

Third, engaging in the exploration of each individual principle raised new questions about how to measure and investigate certain principles. For example, screen capture recordings that show the default computer tool bars and screen layouts could be violating the coherence principle. According to a strict interpretation of the principle, the computer tool bars should be excluded from a video to meet the coherence principle. Yet, video viewers may be ignoring those elements because they are a normal part of viewing a computer screen and thus not impacting the coherence principle. Another example is the pretraining principle and the timing of when a pretraining activity occurs prior to video viewing. I have not identified any research discussing if varying the timing between a pretraining activity and viewing a video impacts the pretraining principle’s effectiveness. Investigating the varied methods of signaling implemented by the interviewees raised questions about what exactly constitutes a signaling method, especially given
that the signal has to stand out to the viewer to be effective. Future investigations into any of
these specific principle related questions would assist in further refining the boundary conditions
of each principle.

The qualitative data is not transferable to larger populations; however, I do believe the
themes identified indicate areas in need of future investigation. This study asked instructors to
focus on their “best” instructional video when completing the survey as a means of trying to
define an upper boundary to CTML design principle incorporation. However, that raises a
question about how instructors perceive the quality of their videos in comparison to one another.
Without research exploring what facets instructors’ value in video production, it is possible they
selected videos that didn’t have CTML design principles over ones that did because the
principles are not valued. Further research into areas of video value would be beneficial in
supporting or debunking this possibility. Another area of further research is in instructor
perceptions of video creation tools and specifically what tools they consider to be part of the
video creation process. Given the number of mentions of PowerPoint in the qualitative data, but
its small selection rate in the survey there appears to be a perception among instructors that it is
not a video creation tool. This highlights an interesting question that further research could help
to illuminate.

Finally, I see a need to replicate this study in different higher education instructional
settings and under non-pandemic conditions. Other higher education institutions have different
contexts such as tools, training, and institutional support which could impact future results. It
would be beneficial to the larger education field to see how the results may change under
different contextual conditions. Considering that this study took place entirely during the
COVID-19 pandemic when many social interactions were via videos and digital screens and
daily life routines were up-ended, it would also be beneficial to replicate this study when the pandemic restrictions have been lifted to see how CTML design principle implementation may shift. Ultimately, given the lack of research focused on instructors, any replication that explores how instructors implement the CTML design principles will assist in advancing the field.

**Implications for Educational Practice**

Based on the study findings, instructors might consider the following practical recommendations as they create video for use in online courses. The findings are organized into five practical application categories which are a mix of specific principles and overarching ideas:

1. Be a Video Star
2. Add Some Signals
3. Check Your Text
4. Account for Time
5. It’s not the tool, but how you use it

Implementing these five practices would lead to improved implementation of the Cognitive Theory of Multimedia Learning design principles and thus may very likely improve student learning outcomes.

**Be a Video Star**

The survey and interview data indicated that instructors are taking an active role in their videos serving as narrators using a personalized style of talking helping them meet both the voice and personalization CTML design principles. The interviewees were all physically present in their “best” video in some form; however, the survey data indicated that the application of the embodiment principle is only at 50%, meaning half of instructors are not physically present in their videos. Since research indicates students tend to watch videos incorporating embodiment longer because they find them more engaging (Chen & Thomas, 2020) and a small meta-analysis demonstrated a median effect size in favor of student learning gains (Mayer, 2019), instructors should consider incorporating some form of physical presence in their future videos. Adding implementation of the embodiment principle to the already robust incorporation of the other two
design principles would mean that instructors are fully addressing germane cognitive load. Thus, it is recommended that instructors continue to serve as the star of their instructional video show.

**Add Some Signals**

For instructors who are reluctant to incorporate their full presence into an instructional video the use of finger pointing could serve as a compromise, an example George demonstrated as a means of signaling important information. Adding that type of embodiment would also address a second key finding of this study, the lack of signaling cues. The survey data indicated that somewhere between 24% and 47.9% of instructors are not incorporating the signaling principle into their videos. Two different meta-studies have reported positive effect sizes on learning outcomes when signaling is utilized (Alpizar et al., 2020; Schneider et al., 2018). The interviewees demonstrated a plethora of signaling techniques including the aforementioned finger pointing, outlining key ideas with color or shapes, underlining, cursor movements or vocal cues demonstrating the ease by which instructors could incorporate signals. Incorporating some forms of signaling such as adding shapes or color does require an instructor to engage in video editing. Tiana reported inserting shapes into her PowerPoint presentation or highlighting some key text prior to recording. Bertha added callouts or arrows using her editing tool after she completed recording. In both instances the instructors were engaged in a reflective practice, considering the message for their viewers, and making adjustments to their work which is an example of the student centric them. Given the many options for signaling, the relative ease of incorporating them, and the impact on learning, this appears to be an easy method for instructors to incorporate and improve the learning impact of their instructional videos.
Check Your Text

If instructors engage in a reflective editing practice for adding signals, they may also consider examining the amount of text they are displaying on screen and seek to reduce or eliminate text entirely in favor of more visuals. Taking the extra time to reduce on-screen text would benefit the 60% of instructors who reported violating the redundancy principle by reading aloud on-screen text most of the time or all of time. The interviewees were not immune from this concern, as George succinctly encapsulated it saying, “My slides are text heavy. I do them wrong.” Bertha and Kristine’s video artifacts provided examples of text heavy slides that were redundantly read by the narrator and Tiana spoke of using her slides as her “PowerPoint outline” so she doesn’t lose her “train of thought.” Those examples indicate that the instructors were relying on the slides to be their notes and guidance about what to speak aloud creating situations where they were violating the redundancy and modality principles. Instructors should follow George’s field video example and create videos with no on-screen words. If no text is present, it is impossible for the instructor to read it aloud and violate the principle.

If instructors still feel that some words are necessary than follow the advice of Bertha and try “to keep as few words on the slides as possible while still giving them the necessary information that they [students] need.” Bertha looked for punctuation and used that as an indicator to go back and edit the text down “into a short powerful phrase.” Shift to a visual focus, which is more in line with how our brains learn, by including no more than ten words at a time (Costa, 2020). Moving to the use of more visuals and less text also helps ensure instructors are meeting the modality principle which states words should be presented via audio narration rather than as text on the screen (Mayer, 2019). One of the techniques the interviewees utilized to help address the temporal contiguity principle, displaying a content-related image and then discussing
it is another technique that can assist instructors in addressing these principles. In addition, taking advantage of automatically generated closed captioning and then editing it for clarity, as Kristine, Bertha, and Tessa did would create textual information associated with a video for viewers to access. Instructors who take a little extra time to check their text and incorporate more visuals will set their video up to successfully meet numerous CTML design principles and thus lead to better learning outcomes for their student viewers.

**Account for Time**

Instructors who do take the time to check their on-screen text would also engage in the fourth recommendation which is to take just enough time to create video that addresses the CTML design principles and no more. As the interviewees articulated, it is a balancing act between spending too little and too much time on video creation. In addition, an instructor must weigh varying time requirements for creating different types of video. Using the data from this study, consider the average instructor. This average instructor will create 14 videos for their online course using Camtasia with an average creation time per video of 108 minutes (1 hour 48 minutes) meaning they will spend 25 hours and 12 minutes creating video for a single course. The videos they create will all have an average length of 15:43 which means their students could spend up to 3 hours and 45 minutes watching video. For every minute of video, average instructor will spend seven minutes creating it. If average instructor could reduce the length of their videos to 10:00 minutes, they could save a full workday (8 hours and 52 minutes) of creation time which would help to reduce the time pressure the interviewees reported. Further reduction in video length while also reducing creation time, would assist instructors in better meeting the segmenting CTML design principle.
There are a number of suggestions that emerged from the interviewees on simple ways to create video more efficiently including identifying creation formulas and processes that will help them implement the CTML design principles. For starters, instructors can follow the lead of the interviewees and identify a self-imposed video length time limit and stick to it when creating video. Instructors could also create a standard PowerPoint template that they use across all of their videos as Bertha did. They could think about presenting information using George’s effective presentation style of a thesis, three points with supporting information, and ending with the thesis again or his field video format of describing his location, telling the viewers to look at some aspect in the camera’s view, explaining why it is important, and ending with a concluding statement. George also recommended making “content that is sustainable” so videos wouldn’t have to be remade each time a course was taught. Given the unique processes that each interviewee identified, instructors will need to determine the specific processes that work best for their situations.

While employing efficient processes can assist instructors with saving time, findings from the study indicate that it remains important for them to engage in certain time-consuming video creation practices. All five of the interviewees engaged in review processes where they reviewed what they had done and improved it through both addition of elements like signals or retakes and reduction of distractions. These editing steps were instrumental in addressing CTML design principles such as signaling and coherence and should not be avoided. For example, incorporating and editing Closed Captions, while time consuming address accessibility issues. Ultimately, instructors should be prepared to invest time into video creation, while also taking steps to be as efficient as possible.
**It is Not the Tool, It is How You Use It**

The final recommendation to emerge from the study is that how tools are used is far more important to the incorporation of CTML design principles than the tool itself. All five interviewees who had the highest CTML implementation scores, used a different combination of tools to create their video demonstrating that the tool matters less than how it is used. The top three tools instructors reported using were all options provided and supported by the university reflecting that instructors used what was available to them. This suggests that other instructors can do the same by identifying available tool options and selecting the one they are most comfortable with to use for video creation.

An instructor does not need to be a video creation tool technical expert in order to implement the CTML design principles. Tessa, who expressed a lack of technical skills and made decisions on tool use based on her limited knowledge was one of the top five instructors implementing CTML design principles. She understood her limits and worked with PowerPoint, a tool she was comfortable with, to create video that implemented most of the principles. George’s process of creating field videos also highlights the ease by which an instructor can create an instructional video using just their smartphone and YouTube. To assist in finding the right tool and using how to implement it, instructors should take advantage of the learning resource highlighted by the interviewees such as research, university provided resources and most importantly other people. Instructors’ decisions are the primary factor determining CTML design principle implementation.

**Chapter Summary**

As the global COVID-19 pandemic has demonstrated, video will continue to play an important role in educational settings, making it necessary for instructors to know how to
effectively utilize the medium. Derived from research on the Cognitive Theory of Multimedia Learning, the 11 design principles provide instructors with research supported guidance on how to create and use video to improve student learning. This study revealed the extent to which higher education instructors with previous online teaching training applied the design principles in their self-selected “best” instructional video using a combination of quantitative and qualitative data. Instructors are implementing the CTML design principles more often than they are not, but certain principles like redundancy are still lagging. The factors of students and personal impact influence instructor video design decisions and implementation of CTML design principles is driven more by instructors’ personal experiences and preferences rather than knowledge of the design principles. Given these findings, I recommend that instructors continue to be video stars, incorporate more signals in their videos, check their on-screen text to ensure they are using as little as possible, account for the time it takes to create video, and remember it is not the tool, but how they use it that matters for student learning.
References

https://doi.org/10.1037/a0026147


https://doi.org/10.1007/s11423-020-09748-7


https://doi.org/10.1016/j.compedu.2014.04.002


https://doi.org/10.18844/wjet.v10i1.3186


https://doi.org/10.1016/j.chb.2018.08.035


http://udlguidelines.cast.org


*International Review of Research in Open and Distributed Learning, 19*(1). https://doi.org/10.19173/irrodl.v19i1.2920


https://doi.org/10.1007/s11423-020-09757-6


https://doi.org/10.1016/j.tate.2016.12.005


[https://doi.org/10.12968/ijtr.2009.16.1.37935](https://doi.org/10.12968/ijtr.2009.16.1.37935)


relationships and academic achievement. *Journal of Educational Psychology, 108*(3), 342-352. [https://doi.org/10.1037/edu0000042](https://doi.org/10.1037/edu0000042)

Ginns, P. (2006). Integrating information: A meta-analysis of the spatial contiguity and temporal contiguity effects. *Learning and Instruction, 16*(6), 511-525. [https://doi.org/10.1016/j.learninstruc.2006.10.001](https://doi.org/10.1016/j.learninstruc.2006.10.001)


Humboldt Institut for Internet & Society Discussion Paper Series, 2.

https://dx.doi.org/10.2139/ssrn.2577882


http://www.qualitative-research.net/index.php/fqs/article/view/2655/4079


https://doi.org/10.1002/acp.1345


https://doi.org/10.1353/rhe.2012.0001


Lattuca, L. R., & Pollard, J. R. (2016). Towards a conceptualization of faculty decision-making about curricular and instructional change. In L. Leišytė and U. Wilkesmann (Eds.), *Organizing academic work in higher education: Teaching, learning and identifies* (pp. 89-108).


https://doi.org/10.1080/0142159x.2017.1322190


Reuters. (2006, July 16). YouTube serves up 100 million videos a day online. *USA Today.*


https://doi.org/10.1007/s10648-018-9456-4


https://doi.org/10.1016/j.edurev.2015.12.003


https://doi.org/10.1016/j.edurev.2017.11.001


https://doi.org/10.1186/s40594-019-0161-8


dissertation, Old Dominion University]. ODU Digital Commons.

https://digitalcommons.odu.edu/stemps_etds/110


https://doi.org/10.1007/s12528-018-9168-2


https://doi.org/10.1080/23796529.2009.11674657


https://doi.org/10.1007/s10648-020-09522-4


https://doi.org/10.1016/b978-0-12-800649-8.00009-2

https://repository.uchastings.edu/cgi/viewcontent.cgi?article=2260&context=faculty_scholarship


Appendices

Appendix A: Institutional Review Board (IRB) Approval

TO: Thomas Pantazes and Heather Schugar
FROM: Nicole M. Cattano, Ph.D.
Co-Chair, WCU Institutional Review Board (IRB)
DATE: 7/6/2020

Project Title: Online instructors Use of the Cognitive Theory of Multimedia Learning Design Principles: A Mixed Methods Investigation
Date of Approval: 7/6/2020

☑ Expedited Approval
This protocol has been approved under the new updated 45 CFR 46 common rule that went in to effect January 21, 2019. As a result, this project will not require continuing review. Any revisions to this protocol that are needed will require approval by the WCU IRB. Upon completion of the project, you are expected to submit appropriate closure documentation. Please see www.wcupa.edu/research/irb.aspx for more information.

Any adverse reaction by a research subject is to be reported immediately through the Office of Research and Sponsored Programs via email at irb@wcupa.edu.

Signature:

Co-Chair of WCU IRB

Protocol ID # 20200706E
This Protocol ID number must be used in all communications about this project with the IRB.

WCU Institutional Review Board (IRB)
IORG#: IORG0004242
IRB#: IRB00005030
FWA#: FWA00014155
Appendix B: Informed Consent Form

Note. The consent form was delivered via the Qualtrics Survey tool.


Investigator(s):

Thomas Pantazes
- Researcher
- Phone: [redacted]
- Email: tpantazes@wcupa.edu

Dr. Heather Schugar
- Faculty Sponsor
- Phone: [redacted]
- Email: hschugar@wcupa.edu

You are being asked to take part in a research project run through West Chester University of Pennsylvania. The University requires that you give your signed agreement to take part in this project.

The researchers listed above will explain to you in detail

· the purpose of this project,
· the procedures to be used,
· the expected length of your participation,
· the potential benefits,
· and possible risks of taking part in the study.

You may ask them any questions, to help you understand the project.

A basic explanation of the project is written below. Please read this explanation. Discuss it with the researchers listed above if you have any questions.
If you decide to take part in the project, please complete this digital survey.

If you don’t want to be a part of this study, it won’t affect any care you may receive or any of your studies from [redacted]. If you choose to be a part of this study, you have the right to change your mind and stop being a part of the study at any time.

**Project Overview:**

Participation in this research project is voluntary. It is being done by Thomas Pantazes as part of his Doctoral Dissertation.

The intent of the study is to identify what elements of video creation instructors focus on when creating video for online courses. It seeks to explore how instructors apply eleven multimedia design principles of the Cognitive Theory of Multimedia Learning (CTML).

Your participation will take about 15 to 20 minutes to take a survey with 17 questions. If you take the survey, you may be asked to participate in one follow-up interview. Up to five people will be selected for one-on-one interviews. The interview will take approximately 30 to 60 minutes. It will be recorded on Zoom. If you are selected for an interview, you will also be asked to:

- share one video you created and
- review the interview transcript to confirm its accuracy.

If you would like to take part, West Chester University requires that you agree and sign this consent form.

1. **What is the purpose of this study?**
   - The intent of the study is to identify what elements of video creation instructors focus on when creating video for online courses. It seeks to explore how
instructors apply eleven multimedia design principles of the Cognitive Theory of Multimedia Learning (CTML).

2. **If you decide to be a part of this study, you will be asked to do the following:**
   - Take a survey through Qualtrics.
   - The survey will take 15 to 20 minutes of your time.
   - You may be asked to participate in a 30 to 60-minute interview with Thomas Pantazes.
   - If you are interviewed, you will also be asked to
     - Share a video you made for your course with the researcher
     - Check the interview transcript for accuracy. This step may take 30 more minutes of your time.

3. **Are there any experimental medical treatments?**
   - No

4. **Is there any risk to me?**
   - Possible risks or sources of discomfort include:
     - There is a tiny risk of a loss of privacy if digital data is hacked or stolen.
     This risk is being lowered by:
       - using the University’s regular password reset process
       - following information security standards
       - using code names in place of actual names when data is exported
       - using pseudonyms on interview transcripts
     - If there is a breach, the researcher will contact you. They will follow the rules of the University’s Information Services department.
• There is a risk that you will recognize your video creation process does not follow research standards. The University has resources from the Office of Research and the Digital Media Center that can assist you. If you experience discomfort, you may be directed to those resources.

• Thomas Pantazes is a staff member at University. You may be worried that your relationship with him could be impacted by your choice to participate in the study. Thomas Pantazes will not know you responded to the survey, unless you are selected for an interview. Only Heather Schugar will see all the survey responses. With Heather Schugar, she will not know who was asked to participate in the survey. She will only see the who completed the survey or withdrew from the study.

• If you become upset and wish to speak with someone, you may speak with Heather Schugar

• If you experience discomfort, you have the right to withdraw at any time.

5. Is there any benefit to me?

• There is no direct benefit to you.

• Other benefits may include:
  • This research will help to outline how online instructors create video for online courses. This area has not been studied. It will provide evidence about educators use of research-based design principles. This study will inform online teaching practice. It will inform the field of instructional design. It will lead to improved teaching practice and student learning.

6. How will you protect my privacy?
• Your records will be private. Only Thomas Pantazes, Heather Schugar, and the IRB will have access to your name and responses.

• Your name will **not** be used in any reports.

• Any survey data taken from Qualtrics for analysis will use code names instead of actual names.

• Pseudonyms will be used in the interview transcripts.

• Records will be stored in password protected computer files.

• The interview sessions will be recorded.
  
  • Recordings will be created using the Zoom Cloud recording feature of Zoom Meeting and an iPhone voice memo application. Both of those tools are password protected.
  
  • Zoom Cloud recording captures both audio and video. Only the audio recording will be used for this study.
  
  • The video recording will be deleted as soon as the audio file has been secured in a password protected computer file.

• Thomas Pantazes will **not** know you responded to the survey, unless you are selected for an interview. Only Heather Schugar will see all the survey responses. She will only see the who completed the survey or withdrew from the study.

• If you share a video with the researcher, it will not be shared with anyone else besides Heather Schugar and the IRB. If a photograph of a portion of the video is
used in the final report, the researcher will ensure no identifying information is included. For example, faces will be blurred.

- Records will be destroyed Three Years After Study Completion

7. **Do I get paid to take part in this study?**

- No

8. **Who do I contact in case of research related injury?**

- For any questions with this study, contact:
  - **Primary Investigator:** Thomas Pantazes at [redacted] or tpantazes@wcupa.edu
  - **Faculty Sponsor:** Dr. Heather Schugar at [redacted] or hschugar@wcupa.edu
  - If you have any questions about your rights as a subject or participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Institutional Review Board through the ORSP at 610-436-3557.

9. **What will you do with my Identifiable Information?**

- Your information will not be used or distributed for future research studies.

For any questions about your rights in this research study, contact the ORSP at 610-436-3557.

Would you like to:

- Agree to participate in the research project. (You will be sent to the consent form).
- Withdraw from the research project. (You will be sent to the withdrawal form).
- Not participate in the research project (The survey ends.)

*(page break)*

*(Withdrawal form if withdraw is selected)*

Please submit your name and email to complete the withdrawal process.

First Name:

Last Name:
Email:

Today’s date:

(survey ends)

Typing your name in the box below indicates that you have read this form and understand the statements in the form. You know that if you are uncomfortable with this study, you can stop at any time. You know that it is not possible to know all possible risks in a study, and you think that reasonable safety measures have been taken to decrease any risk.

Type your full name:

Today’s Date:

Type your email:

Type your department:

You will now be directed to survey.

(page break)
Appendix C: Survey Instrument

*Note.* Anything typed into this document in parentheses and italics is notation to help you understand how the survey functions. It was not be in the actual survey which was administered via the Qualtrics survey tool.

Please do not consider remote instruction that occurred at the end of the Spring 2020 semester when addressing these questions. Remote instruction is defined as any course that was being taught in a face to face or blended mode prior to spring break that was forced to switch to online instruction.

1.) How interested were you to teach your first online course?
   a. Strongly Interested
   b. Somewhat interested
   c. Neutral
   d. Somewhat uninterested
   e. Strongly uninterested

2.) How many online course sections have you taught prior to the Fall 2020 semester? Remember, please do not include any courses that were forced to move to remote instruction at the end of the Spring 2020 semester when answering this question.

* (Open response area accepting only numbers)

3.) Provide the course code and name for online courses you are teaching during the Fall 2020 semester. (ex. EDU-111: Introduction to Education)

Online Course 1 *(open response area)*

Online Course 2 *(open response area)*

Online Course 3 *(open response area)*

Online Course 4 *(open response area)*

Online Course 5 *(open response area)*

Online Course 6 *(open response area)*

*(page break)*
4.) *(This question will only display rows for courses entered in question 3. The course information will pull directly from what the participant enters in question 3.)*

For each course listed below indicate if you are using or plan to use video during the Fall 2020 semester. *(options are yes or no for each course)*

- Online Course 1 Name from Question 3
- Online Course 2 Name from Question 3
- Online Course 3 Name from Question 3
- Online Course 4 Name from Question 3
- Online Course 5 Name from Question 3
- Online Course 6 Name from Question 3

*(page break)*

5. *(For any courses that are marked with “Yes” in question 4, the following will display. Where you see “EDU 111” is information that the survey taker has input into question 3. This sequence of questions will repeat for each course mentioned in question 3 that has a Yes marked.)*

How many videos are you using in EDU 111 that someone other than yourself made? *(Enter your answers as a number.)*

How many videos are you using in EDU 111 that you made? *(Enter your answer as a number.)*

*(page break)*

*(The survey will end if someone has indicated they are not using any videos that they created.)*

Consider the instructional videos you have created and are using in one of your online courses during the Fall 2020 semester. Of those instructional videos, which one stands out to you as your best? With that video in mind, answer the following questions: *(You are encouraged to pull up the video for reference as you answer the questions.)*

6. How long is the video? *(Enter your answer in minutes and seconds. Example: 4:37)* *(open ended response)*
7. Continuing to keep in mind your best instructional video from this semester, answer the following questions:

(These questions are all yes/no)

7a. Does the video contain audio narration?
7b. Can you be seen in the video at any time?
7c. Does the video include music?
7d. Does your video include cues (highlighting, arrows, etc.) to draw attention to important information in the video?
7e. Are related words and images presented near each other in the video?
7f. Does the video contain decorative visuals or video that are not essential for learning?
7g. Were students taught general concepts or key vocabulary found in the video prior to viewing the video?

(page break)

8. Approximately what percentage of the video contains text appearing on the screen that is read by the video narrator? (drop-down selection)
   - 0%
   - 10%
   - 20%
   - 30%
   - 40%
   - 50%
   - 60%
   - 70%
   - 80%
   - 90%
   - 100%

9. Approximately what percentage of the video contains audio narration spoken at the same time as related images are appearing on the screen? (drop-down selection)
   - 0%
   - 10%
   - 20%
   - 30%
10. Does the video narrator have a human voice, a computerized voice, or both voice types?
   - Human
   - Computer
   - Both

11. Is the narration personalized (i.e. uses terms like “you” and “I”) as opposed to third-person narration?
   - Yes
   - No

12.) Continuing to keep in mind your best instructional video from this semester, indicate your level of agreement or disagreement for each statement.

(The following questions all use this scale)

- None of the time (0%)
- Some of the time
- Half the time (45 to 55%)
- Most of the time
- All of the time (100%)

12a. The video contains music.

12b. The video contains audio narration.

12c. Visual or auditory elements that are not essential to the learning are included in the video to add interest.
12d. Cues (such as changes in voice, highlighting, arrows, etc.) are used in the video to draw attention to important information.

12.e Text is included on the screen at the same time that a narrator is speaking it.

12.f Text is included on the same screen as the picture or footage for which it applies.

12g. The video narration occurs at the same time as related images or video footage.

12h. General concepts and/or key vocabulary are taught prior to students viewing the video.

12i. A human narrator was at least partially present (visible) in the video.

12j. The voice of the narrator is personalized, such as using terms like “you” and “I” as opposed to third-person narration.

(page break)

13.) Approximately how much time did it take you to create this video? (enter your answer in hours and minutes ex. 4:37 is four hours and 37 minutes) (open ended response)

14.) What tools did you use to create the video? (Select all that apply)
• Camtasia
• Kaltura Capture
• Zoom Meeting
• Swivl
• Mediasite
• iMovie
• Quicktime
• Adobe Premier
• Adobe Rush
• Screencast.com
• SnagIt
• Mobile Device (phone or tablet)
• Digital video camera
• Recording Booth
  One Button Studio
• Other (open response)

15.) What is the instructional technique or techniques used in the video? (Demonstration, presentation, announcement, etc.)
(open ended response)
16.) Are you willing to share this video with the researcher for analysis? *(yes/no)*

*(page break)*

17.) Will you be making any instructional videos for your online courses during the Fall 2020 semester? *(yes / maybe / no)*

Thank you for taking the survey.

If you would like to learn more about creating instructional video, please contact [redacted].

[redacted]
Appendix D: Interview Guide

Interview Guide


Research questions:

(2) Why do higher education online instructors choose components of digital instructional video production to focus on when creating digital video for use in online courses? (qualitative)

(3) Which CTML design principles appear in higher education online instructors self-selected “best” self-made instructional video? (quantitative and qualitative)

(4) To what extent are CTML design principles an area of focus for higher education online instructors as they create digital instructional video? (quantitative and qualitative)

Welcome and Establish Rapport:

Thank you for taking some time out of your busy schedule to meet with me. I appreciate your willingness to engage with me. My plan for today is to address consent and permissions and then dive into a conversation around digital video. Does this sound ok to you?

Permission to Record:

[NAME]. Thank you for agreeing to participate in my dissertation research, Online Instructors Use of the Cognitive Theory of Multimedia Learning Design Principles: A Mixed Methods Investigation. Do I have your permission to record this session?

(Activate Recording Equipment)

Permission (again) to Participate:

Do I have your consent to conduct this interview? A verbal, “yes” will be considered your consent to participate.

(Pause) - Thank you.

As a reminder, you are free to withdraw your consent or participation at any time.

Participants Rights:

The recording will remain in password protected settings. I am recording through Zoom and also with my iPhone voice memo app as a back-up. Once Zoom has finished processing the
recording, I will transcribe our session using a pseudonym for your name. When the transcription is complete, I will retain a copy of only the audio file in my university provided and password protected Microsoft One Drive account. I will delete the recording materials from Zoom and my iPhone at that time. I will also send you the completed transcript for you to review.

Let’s get started.

1. (Grand tour question) Take me through your process for creating (an instructional video) from initial idea to finished product. (It would be great if you could use the video you were thinking about when filling out the survey, but if you have another video in mind that works too.

2. How do you decide what to include in your instructional video? (themselves, footage, pictures, words, music, etc.)

3. What is your thought process about including yourself in the video? (how much?) Explain why or elaborate on your feelings. (ARE THEY READING ONSCREEN TEXT?)

4. How do you use this video in the context of your course? What happens before and after the video in the course? (ASK about PRETRAINING)

5. Do you use an editing process? (y/n) Can you describe your editing process for me? (IS THERE ANY SIGNALLING COMING THROUGH?)

6. How long did it take you to create the video? Where in your process did you spend most of that time? Why do you think that was the case?

7. Where did you learn to (do that/incorporate that concept?) (these ideas will be pulled from the survey data on design principles)

8. In your opinion, what makes an instructional video good (effective?)?

9. What tools do you use to make the video? Can you describe for me, why you use those tools?

10. As you go through the video creation process what are you keeping at the top of your mind?

11. What part of your video creation process are you most proud of? Why?

12. Where in your video creation skills set do you see a need to improve?
13. (Conclusion) Is there anything else about creating instructional videos that you would like to add to what you have already said?

14. In the survey you completed you indicated your willingness to share your video with me. Are you still willing to do so? (yes/no)

    Yes – great thank you. Are you able to share a copy of that video with me now? I’ll be in touch about gaining access to it. Thank you for participating in today’s interview.

    No – move on.

Here are the next steps. I will wait to get a copy of the recording from Zoom. Once I have that recording, I will prepare a verbatim transcript. That means it will include pauses, ums, and elements that are not grammatically correct. That is normal.

I will replace your name with a pseudonym in the transcript. Do you have a pseudonym you would like me to use?

Once I have the transcript, I will move a copy of the audio file to a secure storage area and then delete the original recordings in Zoom and off of my iPhone. I will then send you the transcript for your review. This process is called member checking. You will review the transcript and let me know if there are any changes or adjustments you would like me to make. Does that sound ok to you?

Thank you so much for participating today.

(end recording)

1. Coherence: The video only included what was needed to meet the video's objective and nothing else. Will code negative examples.

2. Signaling: Used highlighting for important information.

3. Redundancy: None of the on-screen text was read aloud by the narrator. Will code negative examples.

4. Spatial Contiguity: All related words and images appeared together.

5. Temporal Contiguity: Images appeared as they were being discussed by the narrator.


7. Modality: Most information was presented via audio narration rather than as text on the screen. Will code negative examples.

8. Segmenting: The video was under 6 minutes.

9. Personalization: A conversation talking style was used.

10. Embodiment: Natural human gestures were used in the video.

11. Voice: A human voice was used for the narrator.
Appendix F: Post Interview Member Check Email

(Participant Name):

Thank you for participating in the interview with me. I appreciate your willingness to share about your experiences.

I have attached the verbatim interview transcript for your review. Because this was a natural conversation, you will find pauses and incorrect grammatical statements. This is normal. Remember your name has been replaced with a pseudonym.

Please review the transcript. Let me know if it is accurate. If you would like to make a change, please mark it on the document using track changes, highlighting, or a different text color. Please return the updated document to me.

(If participant has not yet shared a video, the following will also be included.)

In the survey you indicated you were willing to share a video with me. If you are still willing to do so, could you please direct me to the video?

Thank you again for participating in my Doctoral Dissertation.

Regards,
Tom Pantazes
## Appendix G: Online Courses Taught During Semester per Instructor

<table>
<thead>
<tr>
<th>Online Course(s) Taught During Semester</th>
<th>Number of Instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>
| **Total**                              | **131**               | **55**
### Appendix H: Number of Participating Instructors by Department and College

<table>
<thead>
<tr>
<th>College / Department</th>
<th>Instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>College of Business</strong></td>
<td>15</td>
</tr>
<tr>
<td>Economics &amp; Finance</td>
<td>1</td>
</tr>
<tr>
<td>Public Policy &amp; Administration</td>
<td>3</td>
</tr>
<tr>
<td>Management</td>
<td>8</td>
</tr>
<tr>
<td>Marketing</td>
<td>3</td>
</tr>
<tr>
<td><strong>College of Humanities</strong></td>
<td>7</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
</tr>
<tr>
<td>Languages and Cultures</td>
<td>4 *</td>
</tr>
<tr>
<td>Women’s &amp; Gender Studies</td>
<td>2</td>
</tr>
<tr>
<td><strong>College of Social Work &amp; Education</strong></td>
<td>9</td>
</tr>
<tr>
<td>Early and Middle Grades Education</td>
<td>1</td>
</tr>
<tr>
<td>Educational Foundations &amp; Policy Studies</td>
<td>1 *</td>
</tr>
<tr>
<td>Social Work</td>
<td>1</td>
</tr>
<tr>
<td>Literacy</td>
<td>1</td>
</tr>
<tr>
<td>Special Education</td>
<td>5</td>
</tr>
<tr>
<td><strong>College of Health</strong></td>
<td>14</td>
</tr>
<tr>
<td>Communication Sciences and Disorders</td>
<td>2</td>
</tr>
<tr>
<td>Health</td>
<td>3</td>
</tr>
<tr>
<td>Kinesiology</td>
<td>1</td>
</tr>
<tr>
<td>Nursing</td>
<td>5 *</td>
</tr>
<tr>
<td>Nutrition</td>
<td>3 *</td>
</tr>
<tr>
<td><strong>College of Science</strong></td>
<td>7</td>
</tr>
<tr>
<td>Earth and Space Sciences</td>
<td>1 *</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1</td>
</tr>
<tr>
<td>Political Science</td>
<td>2</td>
</tr>
<tr>
<td>Psychology</td>
<td>1</td>
</tr>
<tr>
<td>Sociology</td>
<td>2</td>
</tr>
<tr>
<td><strong>University College</strong></td>
<td>3</td>
</tr>
<tr>
<td>Music Education</td>
<td>2</td>
</tr>
<tr>
<td>Exploratory Studies</td>
<td>1</td>
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</tbody>
</table>

*Note: Departments with an instructor selected for an interview are marked with an *
Appendix I: Cognitive Theory of Multimedia Learning Design Principle Implementation

<table>
<thead>
<tr>
<th>CTML Design Principle</th>
<th>Principle Implementation as Measured via Likert Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indicated CTML Design Principle Application via Yes or No Question</td>
</tr>
<tr>
<td>Coherence (No Music)</td>
<td>90%</td>
</tr>
<tr>
<td>Coherence (No Extras)</td>
<td>73.5%</td>
</tr>
<tr>
<td>Signaling</td>
<td>52.1%</td>
</tr>
<tr>
<td>Redundancy</td>
<td>-</td>
</tr>
<tr>
<td>Spatial Contiguity</td>
<td>79.6%</td>
</tr>
<tr>
<td>Temporal Contiguity</td>
<td>-</td>
</tr>
<tr>
<td>Pretraining</td>
<td>67.3%</td>
</tr>
<tr>
<td>Modality</td>
<td>97.91%</td>
</tr>
<tr>
<td>Segmenting</td>
<td>-</td>
</tr>
<tr>
<td>Personalization</td>
<td>93.6%</td>
</tr>
<tr>
<td>Embodiment</td>
<td>51%</td>
</tr>
<tr>
<td>Voice</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note.* Segmenting split at the 6 minute and 15-minute video length marks. Voice is fully human and half was both human and computerized.

**Redundancy Principle**

<table>
<thead>
<tr>
<th>Level</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>12.24</td>
<td>22.45</td>
<td>10.2</td>
<td>12.24</td>
<td>-</td>
<td>12.24</td>
<td>4.08</td>
<td>2.04</td>
<td>2.04</td>
<td>12.24</td>
<td>10.2</td>
</tr>
<tr>
<td>n</td>
<td>6</td>
<td>11</td>
<td>5</td>
<td>6</td>
<td>-</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>5</td>
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</table>

*Note.* Scale progresses from full redundancy principle implementation on the left to no implementation on the right.
**Temporal Contiguity Principle**

<table>
<thead>
<tr>
<th>Level</th>
<th>100%</th>
<th>90%</th>
<th>80%</th>
<th>70%</th>
<th>60%</th>
<th>50%</th>
<th>40%</th>
<th>30%</th>
<th>20%</th>
<th>10%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>32.65</td>
<td>22.45</td>
<td>10.2</td>
<td>10.2</td>
<td>-</td>
<td>4.08</td>
<td>2.04</td>
<td>-</td>
<td>2.04</td>
<td>4.08</td>
<td>12.24</td>
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<tr>
<td>n</td>
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<td>11</td>
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<td>-</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

*Note.* Scale progresses from full temporal contiguity principle implementation on the left to no implementation on the right.
Appendix J: Spearman’s Rho Correlation Coefficients Between Design Principles

Spearman's rho correlation coefficients between CTML design principles

<table>
<thead>
<tr>
<th>CTML design principles</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Coherence (No Music)</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B. Coherence (No Extras)</td>
<td>.268</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C. Signaling</td>
<td>-.038</td>
<td>-.137</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>D. Redundancy</td>
<td>-.343*</td>
<td>-.310*</td>
<td>-.151</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E. Spatial Contiguity</td>
<td>.326*</td>
<td>.169</td>
<td>.275</td>
<td>-.721**</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>F. Temporal Contiguity</td>
<td>.246</td>
<td>.387**</td>
<td>.346*</td>
<td>-.451**</td>
<td>.586**</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>G. Pretraining</td>
<td>.112</td>
<td>.039</td>
<td>.062</td>
<td>-.235</td>
<td>.305*</td>
<td>.301*</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>H. Modality</td>
<td>.271</td>
<td>.030</td>
<td>.005</td>
<td>-.280*</td>
<td>.247</td>
<td>.199</td>
<td>.032</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>I. Personalization</td>
<td>.266</td>
<td>.169</td>
<td>.064</td>
<td>.207</td>
<td>.033</td>
<td>.141</td>
<td>.055</td>
<td>.060</td>
<td>1.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>J. Embodiment</td>
<td>-.078</td>
<td>.280*</td>
<td>.008</td>
<td>.324*</td>
<td>-.159</td>
<td>-.003</td>
<td>.119</td>
<td>-.139</td>
<td>.360*</td>
<td>1.000</td>
<td>-</td>
</tr>
<tr>
<td>K. Segmenting</td>
<td>.124</td>
<td>.156</td>
<td>-.093</td>
<td>-.001</td>
<td>-.117</td>
<td>.179</td>
<td>.127</td>
<td>-.078</td>
<td>-.133</td>
<td>-.019</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*p < .05. **p < .01.