Formative Research on Multimedia Learning Principles in the Instructional Design of Online Courses

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Abstract

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Formative Research on Multimedia Learning Principles in the Instructional Design of Online Courses

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With the continuing growth of online education in the United States (US) and across the world, the value of quality design and multimedia instruction is critical. The benefits gained from multimedia instruction depends on how well the design of the multimedia instructional materials align with the human cognitive learning process, and this is where the multimedia learning principles come into play. Mayer's (2001, 2009) multimedia learning principles posit that people learn better when words and images are combined instead of words only. Most of the experiments conducted focused on concise, narrated animations and computer-based as well as paper-based lessons lasting few minutes in studying the effect of individual principles on learning. Empirical studies that specifically evaluates the strengths, weaknesses or possible improvement of the principles are limited or lacking. These principles and their guidelines, like other design theories are not in a state of perfection and still has room for improvement (Reigeluth & Frick, 1999).

In this study, the multimedia learning principles for optimizing generative processing was used to design an instance of an online lesson for teaching informational content (cyberbullying). To contribute to the expansion of the knowledge base of the multimedia learning principles and its application, the researcher employed Reigeluth's

and Frick's (1999) formative research methodology. The commitment of the researcher was to search for how the guidelines for the application of the multimedia learning principles can be improved, in areas where the goal of the design theory was not achieved based on learner feedback.

The findings showed that the use of multimedia assets that allowed learners varying degrees of interactivity in the lesson was both effective and appealing. Other features that worked or were liked by learners include content accuracy and relevance and overall lesson sequence, among others. Learners felt distracted and did not like the use of emoji like or clip-arts images, preferred realistic images, and preferred having more videos to still images. The researcher concluded that it would be challenging for an instructional designer to implement the multimedia learning principles if their knowledge of the principles as well as other relevant instructional design theories are limited or not current with recent evidence. Creating a design blueprint that maps the principles to the lesson content, serving as a rubric can be beneficial in the application of the principles. Other specific improvements to application of the multimedia learning principles were identified.

Dedication

This dissertation is dedicated to my dear wife, Ethel Sefakor, and our children Nyamede Kojo and Nana Ayeyi. Their immeasurable sacrifice and support did not go unnoticed.

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Chapter 1: Introduction

Background of the Study

This study aims to test the application of an instructional design theory (Multimedia Learning Principles) and offer prescriptions for the improvement of its application using a formative research methodology – a kind of action research intended to improve design theory for designing instructional practices or processes. As Reigeluth (1999) asserts, instructional design theory "offers explicit guidance on how to better help people learn and develop" (p. 5). It is goal oriented and normative, aimed at promoting generative outcomes by offering methods and guidelines for achieving specific goals. As such they are probabilistic and prescriptive in nature and Reigeluth (1999, 2013) further points out, they are influenced by varying instructional situations (values and conditions). Using Reigeluth's and Frick's (1999) approach to formative research as a guide, the researcher intends to offer prescriptions to improve the application of an existing design theory, multimedia learning principles by Mayer (2001, 2009), or at least some subset of situations for which the design theory was intended, using learner feedback from a designed instance of an online lesson. The multimedia learning principles offers a meaningful set of methods for designing instruction in a manner that helps people learn and develop, which is consistent with Reigeluth's (1999) definition of a design theory. The learning and development encompass cognitive, emotional, social, physical, and spiritual. Instructional design theories are concerned with several aspects of instruction.

Mayer (2009) describes multimedia instruction as presentations involving both words (such as spoken text or printed text) and pictures (such as illustrations, photos,

animation, or video) with the rationale of helping people learn better (p. 3). Mayer (2009) hypothesizes that people learn better from a combination of words and pictures than from words alone (p. 4). The multimedia learning principles are essentially design based methods to help in creating multimedia instruction that improves learners understanding of presented material which can be informational or procedural content. With the continuing growth of online education in the US and across the world, the value of quality design and multimedia instruction is a critical concern (Allen & Seaman, 2017; Bailey et al., 2018; Ginder et al., 2019). The use of media elements such as words and pictures are seen in almost all instructional materials used in both traditional classrooms and in online learning spaces to promote learning. Although multimedia instruction is prevalent, the benefits gained from multimedia instructional materials is based on how it supports and aligns with the human cognitive learning process, and this is where the multimedia learning principles come into play (Mayer, 2009).

Within the online learning milieu, new theories emerge by the day as research progresses and several have successfully shaped the design of instruction, combining well-established theories such as behaviorism, cognitivism and constructivism, as well as more recently proposed theories for the digital age – connectivism, constructionism and Online Collaborative Learning (OCL) theory (Ally, 2004; Downes, 2006; Harasim, 2017; Siemens, 2004). These theories have been put into action in designing online courses employing strategies such as the use of advance organizer and content maps to prepare learners before instruction, chunking lengthy videos or having a mixture of audio and visual and or video based material in learner activities or a combination of other methods

in a bid to engage the learner. A review of the literature related to successful online learning suggests cognitive engagement as a critical factor to promote meaningful learning (Ally, 2004; Mayer, 2009; Mayer, Fennell, et al., 2004; Swan, Shea, Fredericksen, Pickett & Pelz, 2000; Webster & Hackley, 1997). Analyzing the various learning theories that impact online course design, vivid and subtle connections can be made to the multimedia learning principles and this warrants the effort to evaluate the principles using formative research methodology to identify strengths, weaknesses and possible improvements to its application. Based on results of several experiments by Richard Mayer and his colleagues testing the multimedia learning principles, learner's cognitive engagement has been found to be boosted through the application of multimedia principles (Clark & Mayer, 2003, Mayer & Chandler, 2001; Mayer & Moreno, 2003; Paas et al., 2003). However, most of the experiments took place within a laboratory setting, mostly using paper-based lessons and some computer based lessons lasting a few minutes in studying the effect of individual principles on retention and transfer (Clark & Mayer, 2003; Mayer, 2001; Mayer & Moreno, 2003).

Some have criticized instructional design for its complexity, cumbersomeness and lack of contextualization which can weaken its efficiency (Mckenney & Reeves, 2012). To address this, they emphasize the need to conduct design research in an authentic learning environment to solve real-world problems. Through this formative study, the researcher will test the applications of the multimedia learning principles in focus by applying them in the creation of a designed case / instance and the feedback gathered from learners (participants) on what parts of the theory worked and what did not work

will help inform improvement to the application of the principles. For an applied field like education, Reigeluth and Frick (1999) note that it is both vital and useful to generate and apply more design theory rather than descriptive theory. With the existing design theories not yet in a state of perfection, a continuous effort to offer detailed guidance for applying these design theories to different situations is valuable. This study intends to contribute to this effort by offering some additional guidance for applying the multimedia learning principles. Several researchers have stressed the need to employ the use of rigorous approaches to evaluate the strengths and weaknesses of design theory and offer improvements. The formative research methodology offers one of the best ways for evaluating an existing instructional design theory for improvement (Carr, 1993; McKenney & Reeves, 2012; Newman, 1990; Reigeluth & Frick, 1999).

Multimedia learning principles facilitate multimedia instruction. The central assumption of how humans learn is based on research in cognitive science which focuses on theories backing the human information-processing systems, such as Paivio's (1986) dual-coding theory, Baddelye's (1998) theory of working memory, and multimedia learning by Mayer (2001, 2009). The twelve multimedia principles by Mayer and his colleagues are categorized according the cognitive load challenge they address. To focus this study, the researcher explores instructional situations that influence how well the principles for optimizing or fostering generative processing (germane cognitive load) work for teaching informational content in an online lesson. The principles under that category are Multimedia Principle, Personalization Principle, Voice Principle, and Image Principle. A summary of the median learning effect sizes for the various multimedia

learning principles by Clark and Mayer (2016) puts the multimedia principle on top with 1.39, and they explain “if you apply the multimedia principle, you can expect an overall test score improvement of about one standard deviation greater than the same lesson without visuals” (p. 393). However, the number of experiment comparisons that resulted in this effect size is small compared to other principles, so this does not necessarily make the multimedia principle the most robust, leaving room for possible improvement.

A lesson on cyberbullying was designed with careful application of the multimedia learning principles under consideration. The lesson topic (cyberbullying) was selected out of the list of topics on the syllabus to be covered by learners in the sample Teacher Education class purposefully selected for this study. This instance was the case evaluated and revised to improve the theory and offer guidelines for possible improvement to its application. Reigeluth’s and Frick’s (1999) approach to formative research makes use of effectiveness, efficiency, and appeal as the three broad criteria for evaluating research on generalizable design knowledge. This study evaluates the application of the Multimedia Learning Principles specifically within the developed instance of an online lesson. To contribute to the expansion of the knowledge base of the multimedia learning principles and its application, the researcher considered it appropriate to employ formative research methods to identify possible ways for improving the guidelines for its applications based on specific instructional situations in an online lesson.

Statement of the Problem

The general findings of multimedia research and experiments in several domains concluded that the search for load-reducing methods of instruction through the application of the multimedia principles fostered meaningful learning without creating cognitive overload (Clark & Mayer, 2016; Mayer & Chandler, 2001; Mayer & Moreno, 2003; Paas et al., 2003). Most of the experiments conducted focused on concise, narrated animations and computer-based as well as paper-based lessons lasting few minutes in studying the effect of individual principles on retention and transfer (Mayer, 2001). There is not enough research that examines the application of the multimedia learning principles to the design of online courses that require longer time periods of participation (Clark & Mayer, 2003; Mayer & Moreno, 2003; Mayer, 2001).

Despite the evidence that support the effectiveness of applying the multimedia learning principles (Clark & Mayer, 2003, 2016; Mayer, 2009, Mayer & Chandler, 2001; Mayer & Moreno, 2003; Paas et al., 2003), empirical studies that specifically evaluate the strengths, weaknesses or possible improvement of the principles are lacking. There is limited or no specific research following the formative approach to improve the guidelines for applying the principles for optimizing generative processing with emphasis on the multimedia principle, as this study focuses on. As Reigeluth and Frick (1999) point out instructional design theories have not reached a state of perfection and research is still needed to evaluate and improve existing instructional design theories using a formative research approach. Mayer and Clark (2016), in outlining guidelines for applying the multimedia learning principles reiterate that, “we do not offer these

guidelines as a rating system, and we don't claim to have included all the important variables you should consider when evaluating e-learning alternatives" (p. 396). This confirms that there is room for improvement of design theories and their application. This is where formative research comes into the picture with its emphasis on improving rather than proving.

Purpose of the Study

Thus, the purpose of the study is to examine how the multimedia learning principles, specifically the principles for optimizing generative processing hold up when applied to the Instructional design of online courses. Using a design instance of an online informational lesson for teaching undergraduates (pre-service teachers) as a specific instantiation of the multimedia learning principles, formative data will be gathered and utilized from learner (participant) feedback. The study aims to evaluate a portion of the multimedia learning principles by answering the following questions:

1. What are the strengths and challenges of implementing multimedia learning principles in online courses from the perspective of the instructional designer?
2. What implementations of the multimedia learning principles in the design instance worked well and did not work well based on learner feedback?
3. How can the application of multimedia learning principles be improved based on learner feedback to support online learning?

The research uses formative research (Reigeluth & Frick, 1999), a qualitative approach based on a case to improve the application of multimedia learning principles.

Significance of the Study

The study can be recognized as one of the novel empirical formative evaluations of the multimedia learning principles with specific focus on the set of principles that optimize generative processing. The results of this research extends the knowledge base of the use of multimedia learning principles in online courses and provide specific insights into the application of the multimedia learning principle as well as other principles for fostering generative processing in multimedia learning (Personalization, Voice and Image principles) in an online course. The result of the study contributes to filling a gap in the current body of research as there is limited formative research on multimedia learning principles.

Delimitations and Limitations of the Study

The purpose of this study is to evaluate an instructional design theory, multimedia learning principles in designing instructional materials for online learning. The research setting, participants and the lesson developed as a design instance for evaluating the multimedia principles may affect the generalizability of the results. Participants in this study were specifically pre-service teachers at a large midwestern public university in the United States of America (US). The limitations of this study include:

1. This study was limited to investigate a lesson on cyberbullying, that was developed by the researcher applying the multimedia learning principles for fostering generative processing.
2. There are twelve multimedia learning principles which are groups based on the type of cognitive load challenge they address. Four of these principles are related

to the principles for fostering or optimizing generative processing (Multimedia Principle, Personalization Principle, Voice Principle, and Image Principle). The first three are the focus of the study and used in creating the instance for evaluation since neither an instructor / speakers' image nor virtual coach' image was used in the designed instance. Also, based on the unique design decisions made by the researcher, other principles beyond the four identified are utilized partly at some points or in combination with others. The rationale and considerations are clearly explained for the reader when this is done.

3. The study was based largely on applying the multimedia learning principles and formative research was conducted based on two iterations of the designed instance.
4. Participants were limited to college students at a large midwestern public university in the US. Also, these participants from the sample class used were predominantly Americans and did not have a general mix of international students. As such cultural dynamics or issues related the impact of cultural differences on the multimedia instruction was not considered.
5. Participants prior knowledge on the lesson content – cyberbullying used in the instance was not tested in this study but they self-reported on a likert scale in the end-of lesson survey.

Definition of Terms

Multimedia learning: Multimedia learning refers to learning from words and pictures (Mayer, 2009, p. 5).

Multimedia instruction (or multimedia instructional message or multimedia instructional presentation): This refers to the presentation of material using both words and pictures, with the intention of promoting learning (Mayer, 2009, p. 5).

Formative research: As explained by Reigeluth and Frick (1999) is a kind of developmental research or action research that is intended to improve design theory for designing instructional practices or processes. This approach utilizes three broad criteria for evaluating research on generalizable design knowledge: effectiveness, efficiency, and appeal.

It has been recommended by researchers as a way to expand the knowledge base in instructional-design theory (Reigeluth, 1989, Romiszowski, 1988).

Online learning: This is simply education that takes place over the internet. Different terms have been used to refer to online learning such as web-based learning, e-learning, distance learning, virtual learning, and internet learning. Clark and Mayer (2016) define e-learning as instruction delivered on a digital device that is intended to support learning (p. 7). Others have defined it as delivering instruction to a remote learner through the web (Khan, 1997), or presenting educational material on a computer (Carliner, 1999). This research uses the term online learning.

Online courses: Courses whose content is delivered online. These vary from fully online where most or all the course content and activities are done online to hybrid or

blended courses where usually about 30 to 70% of content is delivered online and course maintains some face-to-face meetings as well (Allen & Seaman, 2017).

Organization of the Study

This dissertation consists of five chapters. Chapter 1 explains the background of the study, includes a statement of the problem, the significance of the study, the research questions, the delimitation and limitations, and provides definitions of key terms. A review of the literature supporting the study is presented in chapter 2. Chapter 3 outlines the methodology used in this study, including an explanation of the stages involves in designing an instance, and formatively evaluating it. Chapter 4 presents the results of the data collection and finally, chapter 5 presents a discussion of the findings, its implications, and possible recommendations for future research.

Chapter 2: Literature Review

Overview

This chapter starts with an overview of the state of online learning in higher education within the United States of America (US). A review of relevant learning theories and instructional design frameworks that make online education effective, meaningful, and appealing for learners are presented. It then discusses some critical success factors for online courses and possible linkages between these "success factors" to the multimedia learning principles. Next, a review of formative research design, which is the context of the study is done, highlighting the different variants of educational design research and its importance. Finally, multimedia instruction and the multimedia learning principles are reviewed and a brief overview of the design instance for the study given.

The State of Online Education

Online education has expanded rapidly throughout the world although there remains room to extend educational opportunities to many more especially those underserved by traditional educational institutions. As a result of the confluence of technologies, the proliferation and ubiquity of computer technologies, the adoption of the internet and the heightened demand for a workforce well versed in operating as in a digital economy. According to a Western Interstate Commission for Higher Education (WICHE) Cooperative for Educational Technologies (WCET) Distance Education Enrollment report the number of students taking at least one distance education course grew from 1.6 million in 2002, to 4.6 million by 2008, and 5.8 million by 2014 (Poulin &

Straut, 2016, p. 26). In a U.S. Department of Education's National Center for Education Statistics report, the number of students who took at least some of their courses online grew by more than 350,000 a 5.7 percent from fall 2016 to fall 2017, and from 14.7 percent to 15.4 percent for student enrolled fully in online courses, while the overall postsecondary enrollment of students taking classes on brick and mortar campuses during that same period dropped by almost 90,000 students (Allen & Seaman, 2017; Ginder et al., 2019, p. 9). The National Center for Education Statistics report also highlighted remarkable nuances when online enrollments are viewed along the public and private nonprofit institutional lines. Students enrolled in a combination of some online and face-to-face courses at public institution is almost double those enrolled in fulling online courses and reverse is true in the private nonprofit institutions.

Despite the surge and high enrolment in online courses, and the promise of online education solving issues related to college prices, unequal access, flexibility and student outcomes. There is another school of thought which suggest online education has not lived up to its potential in areas such as reducing cost and improving student learning outcomes, with some faculty, academic leaders, and sections of the public remaining skeptical about its quality and value compared to face-to-face education (Protopsaltis & Baum, 2019). In what appears to be a counter claim, a report from the Action Lab at Arizona State University and Boston Consulting Group looked at how to make digital learning work in a study intended to reveal the impact of a digitally enhanced academia. The authors argue that digital learning or online learning can make high-quality education more affordable and efficient (Bailey, Vaduganathan, Henry, Laverdiere & Pugliese,

2018). The study presented success strategies from six leading universities and community colleges in the U.S., examining the multifaced roles that online learning plays from the view of practitioners who lead the field. From this general background, it is fitting to say online education is part of the new norm and a critical part of the educational landscape.

Relevant Theories that Influence Instruction

Learning theories have successfully shaped the design of instruction. Rooted in the understanding of knowledge and how people come to know or gain knowledge, which delves into schools of thought such as empiricism and rationalism (Schunck, 1991, 2012). However, the discussion under this section focuses on a review of some main learning theories without much emphasis on the historical foundations of the origins of knowledge. Three of the main theories which are behaviorism, cognitivism and constructivism are discussed, as well as other proposals that advocate for a new learning theory for the digital age.

Behaviorism

The Behaviorist learning theory was shaped by early researcher of Thorndike (1913), Watson (1914), and Pavlov (1927) and later Skinner (1974) who is also regarded by many as the one founding fathers. Tyler (1949) is also a noted behaviorist. For behaviorist, learning is evidenced by the acquisition of new behavior or better still the demonstration of a change in behavior by the learner is the view of learning. The behaviorist sees the mind seen as a black box and assumes that all mental states can be simplified into observable behaviors with the understanding that all learning is based on a

stimulus-response relationship. Therefore, it focuses on observable and measurable behavior instead of mental or emotional behaviors. Behaviorism promotes competency-based education, objective based instruction as some of the main strategies with learners getting rewards or punishment for their performance based on the intended behavioral objective. This view of learning appears successful where there is a right or wrong response to the instruction presented. By its definition, the learner assumes a passive role in the learning process, the central focus being on the content.

Implications for Online Learning. Anderson (2008) discusses few suggestions for online learning centered on the ideals of behaviorism.

- Learners must have a clear expectation of lesson in terms of an explicit outcome that is deemed as successful learning.
- Tests and assessments must be integrated into the learning sequence to gauge the performance of learners in order to be able to offer feedback.
- Proper sequencing of instructional materials from simple to complex or knowledge to application in order to guide the learning process.
- Appropriate feedback must be given on time to help learner correct any wrong action where necessary.

The general criticism or arguments against behaviorism is that not all learning is observable and measuring the success of the learning process by linking it to specific observable behavioral objectives is misguided.

Cognitivism

Cognitivism emphasizes the acquisition of knowledge and internal mental processes or associations rather than overt actions. Learning involves the acquisition and reorganization of cognitive structure, facilitated by strategies such as reflective thinking, mental imagery, reciprocal teaching, use of concept maps, advanced organizer and problem solving and the learner is seen as an active participant in the learning process (Ertmer & Newby, 2013).

Cognitivists stress that learner's outward behavior is merely an outcome of their internal thinking processes, as such views the learner as an information processer and the learning process focuses on how information in collected, organized, stored and retrieved by the mind (the human information processing system). Cognitive theorists regard the learning process as a function of the processing capacity of the learner, the effort used during the process, the depth of processing and what the learner already knows (Ausubel, 1974; Craik & Lockhart, 1972). The founding works of researchers such as Jean Piaget, Vygotsky, Tolman, Gestalt, Gagne and other contributors such as David Merill, Roger Schank, Jerome Bruner, Charles Reigeluth has shaped the understanding of how the mind works and the theoretical framework immensely.

The nature of the human mind and its different type memory system is central to this school of learning. Kalat (2007) explains, information received from the senses, is sent into a sensory store prior to processing, it is kept in this store for less than 1 second or risk being lost as its transferred to working memory. A combination of factors such as how the new information was attended to, the capacity of memory determines how fast

this new information is processed and integrated with existing knowledge to be transferred for long-term storage. The strategies such as use of advanced organizers, concept maps are ways to facilitate this process (Ausubel, 1960).

Implications for Online Learning. The following are some effects:

- Based on the structure of the human memory and the rationale of cognitivism, Miller (1956) suggests information presented online in short pieces or chunking them into groups of five to nine units to allow short-term process with ease. This idea of chunking is consistent with the segmenting principle by Richard Mayer, whose work with multimedia principles looks at several methods to design multimedia instruction, in particular to help manage the human cognitive processing (Mayer, 2001). The guiding principles with the Cognitivist school of learning is how to efficiently process new information in working memory and assimilate or accommodate it in long term memory (Anderson, 2008).
- There should be specific strategies to guide retrieval of existing information from long term memory such as using an advance organizer (Ausubel, 1960; Mayer, 1979).
- The use of pre-instructional questions serves as a way of guiding the learner's mental processes and activating existing mental models through recall.
- Strategies to promote deep processing which forces learner to use higher order thinking skills must be used.
- The new information must take advantage of the dual-coding theory by presenting materials both visually and with text (Paivio, 1986). This is one of the central

assumptions of Mayer's multimedia principles, which will be expanded in other sections of this research.

- Through the right analysis of the learner, strategies must be put in place to motivate them based on the ARCS model (Keller, 1983) and focusing more on intrinsic motivation but extrinsic as well for online learners (Keller & Suzuki, 1983; Malone, 1981).
- Where applicable the use of simulations helps learners to contextualize the information and give authenticity to the cases used (Anderson, 2008).

Constructivism

Constructivism on the other hand views learning as a search for meaning. Constructivists regards learning as a process of building mental representations through a series of active cognitive processes (Mayer, 2009). Goodman (1994) refers to it as a philosophy of understanding and a theory of knowing, and Jonassen (1991) further iterates that the knowledge or reality resides internally in the learner's (knower) mind and "that the knower constructs a reality, or at least interprets it, based upon his or her apperceptions" (p. 10). Constructivist theorists suggest the goal of the learning process is for the learner to be able to make meaning and apply the information in a personal way. During the learning process, the learner observes, processes new information, interprets it and personalizes the information by integrating it into personal knowledge in a search for meaning (Cooper, 1993, Wilson, 1997). The learner is an active participant in the learning process and the mental activity of the learner is central to the knowledge construction (Cunningham, 1992). Learners construct their own meaning (Jonassen,

1991) based on the knowledge received by reorganizing new information and connecting it with existing knowledge or experiences (Ausubel, 2012, Perkins, 1993). Ertmer and Newby (2013) have suggested that such new knowledge keeps evolving and does so through social construction (Piaget, 1973, Wadsworth, 2004). It employs strategies and teaching methods such as authentic case-based learning, reflective practice, collaborative construction of knowledge, reflection, role model, among others (Ertmer & Newby, 2013). The context within which knowledge is constructive gives it authenticity and is key to the creation of understanding and meaning (Jonassen, 1991).

Mayer (2009) warns against the fallacy of constructivist teaching, where he explains the dichotomy between constructivism as a learning theory and as a teaching theory. High cognitive activity during learning (constructivism as a learning theory) is what leads to active and deep learning and not high physical or behavioral activity during learning (constructivism as a teaching theory) which is erroneously deemed as active learning. The evidence shows that when instructional methods that included worked-examples (seen as passive method) were used, compared to hands-on problem solving (active method), meaningful learning took place with students using the passive methods, suggesting high cognitive activity rather than behavioral activity during learning promotes deep learning (Cooper & Sweller, 1987; Mayer, 2001; Sweller, 1999; Sweller & Cooper, 1985).

A view of constructivism as either a theory of learning or prescription for instruction helps clarify this fallacy. It is the notion that having engagement in activity such as through discovery learning leads to active learning, rather an emphasis on

stimulating appropriate cognitive processing during learning. The misinterpretation of constructivist approach to instruction makes the assumption that exerting physical behavioral or motor activity during problem based activities or inquiry is the litmus for active learning, Mayer (2009) contends that placing the importance on active cognitive processing of information, which aligns with the view of constructivism as a learning theory, is the true litmus and a critical validation of active learning.

Constructionism, Connectivism and Online Collaborative Learning (OCL)

The rise of the web propelled many advancements in online technologies. With Web 2.0 opening the web to be a more collaborative or social network of virtual communities, both opportunities and new challenges emerged for today's learner which require new learning theories and pedagogies for this context. Continuing the discussion on relevant instructional design frameworks and learning theories that make online education effective, meaningful, and appealing for learners, the three learning theories discussed under this section focus on creating and sharing within a connected community. Closely related to constructivism is Constructionism, a learning theory that states that building knowledge occurs best through building tangible and sharable things (Ackerman, 2014).

Constructionism purports that people learn effectively through making things. The theory focuses on the learner developing positive technological fluency by learning through designing and sharing within a collaborative environment (Papert, 1996). In Seymour Papert's seminal work Mindstorms, Children Computers, and Powerful Ideas (1980), it states children can construct or create their learning experiences using

computer programming tools. This construction is explained as an extension of the constructivist theory which views learning as reconstruction rather than transmission of knowledge. The rationale of constructionism is that learning is effective when the learner constructs something meaningful which others can experience. This could be explaining an idea in their own words, or producing an instructional artifact such as a presentation, a mobile application, creating a physical product to show or explain a concept. The maker movement is a classic example of learning hinged on constructionism.

Connectivism is yet another theory proposed by Ally (2004) for the digital age of learning in a networked environment. He contends that learning theories influence design frameworks and together serve as an instructional strategy that dictates the design of courses. He analyzed theories of behaviorism, cognitivism and constructivism and maintains that to prompt higher order thinking and meaningful learning, there is a need for a new theory. The components of the theory include learner preparation, learner activities, learner interaction and learner transfer. A review of the constructs within the theory appears to blend the critical components of the three main theories discussed earlier. He advocates for instructional designers to create materials for learners based on this connectivist theory for effective online learning. The activities learners engage in during online learning must be sequenced, coordinated, and presented purposefully to achieve the objective and facilitate learning (Ally, 2002; Reigeluth & Carr-Chellman, 2009; Ritchie & Hoffman, 1997).

Another learning theory which has been advocated for the 21st century is the Online Collaborative Learning Theory (OCL) by Harasim (2017). This theory is

proposed as a framework to guide understanding and practice of education in the knowledge age which focuses on knowledge building processes. The theory emphasizes peer discourse as key to learning and stresses the core design principles of idea generation, idea organizing and intellectual convergence. It builds on constructivist learning theory by exploring and emphasizing the role of discourse (Harasim, 2017). For behaviorist and cognitivist, learning is performing new behavior or processing new information respectively, for constructivist learning is making meaning by doing, and OCL explains learning as an intellectual convergence through discourse whereas teaching is inducting learners into knowledge discourse. It situates active learning within a process of social and conceptual development based on knowledge discourse focused on innovation.

Success Factors for Online Courses and Linkages to the Multimedia Principles

The discussion of success in online courses is not a straightforward subject and has been addressed from varying angles in a bid to find quality assurance frameworks within the higher education context. Parker (2008) claims that success in online education as a measure of quality, can be a relative experience and as such individualistic. Cleary (2001) affirms this notion of quality being subjective, suggesting it is "relative to the unique perspectives and interpretations of different stakeholder groups (students, alumni, faculty, administrators, parents, oversight boards, employers, state legislatures, local governing bodies, accrediting associations, transfer institutions, and the general public"(p. 20).

The discussion will be interlaced with references to the Richard Mayer's multimedia learning principle where connections or overlaps are identified between the success factors and the multimedia principles and a framework of this relationship will be presented later in the discussion (Mayer, 2001). Generally, the factors range from the learner, student support services, faculty qualification, pedagogical innovation, tuition rates, regulatory standards, compliance and accreditation, sociocultural factors, technology, marketing and promotion, strategic vendor alliance, environmental and political factors, investment in course design and development among other factors (Bailey, Vaduganathan, Henry, Laverdiere & Pugliese, 2018; Kentnor, 2015, Volery & Lord, 2000). Some of the factors are external to the learner and higher education institution and others our integral to the service delivery of education.

Effectiveness

Webster and Hackley (1997) discuss the construct of effectiveness as an idea of success in online learning. They propose a combination of the following factors to explain the concept of effectiveness:

- Student involvement and participation,
- technology – technology self-efficacy and perceived usefulness of the technology in use,
- cognitive engagement,
- relative merits or demerits of the online delivery medium.

Dillon and Gunawardena (1995) assert that the variables of technology, instructor characteristics and student characteristic are broadly the determinants of effectiveness in

online education. The discussion of effectiveness in the next section is done broadly along the variables Dillon and Gunawardena (1995) propose, and narrowly using Webster and Hackley's (1997) dimensions of the concept of effectiveness.

Student Involvement and Participation

Wetzel, Radtke and Stern (1994), assert that in all learning student's performance is seen as a factor of success and argue that standard remains the same for both face-to-face learning and other forms of video, multimedia or e-learning. Allen (2007) expresses reservation about students' involvement and participation when it comes to online learning spaces, citing concerns similar to Lairson's (1999) on the potential to focus on expanding access and economies of scale at the expense of student involvement and participation. Addressing the creation of instructional materials, such as videos and audios for use in online instruction, Lairson (1999) warns against creating a "world of the passive listener and single speaker" (p. 188).

Still on student involvement, Protopsaltis and Baum (2019), comment on need to promote regular and substantive student-instructor interaction to ensure successful online education. They credit online education for widening the opportunity for more students to pursue higher education but stress the need to promote this interaction and participatory culture in online learning, adding that is particularly helpful to better serve learners with minimal levels of academic preparation. They emphasize that this student-instructor interaction is a naturally intrinsic feature of teaching and learning, and within the online learning environment, that nature remains a critical factor to ensure quality and success (Protopsaltis & Baum, 2019). The interaction between student and instructor has been

well documented in traditional classrooms and its importance can be reasonable relayed to the online context. The evidence also shows students perceive and have an expectation of more equitable and democratic discussion online than in face-to-face setting (Harasim, 1990, Levin, Kim & Riel, 1990; Powers & Rossman, 1985). A central point of agreement despite the concerns and fears raised by these authors and researchers, is one that emphasizes the need to maintain and strengthen student involvement and participation in online learning as a key to success (Allen, 2007; Lairson, 1999; Protopsaltis & Baum, 2019).

Technology

Technology is another factor for success in online education, the utility of the technology itself and the usability from the learner's perspective as well as the instructors' is discussed. First in terms of the belief that one has the capability to use a given technology (technology self-efficacy). This is dependent on other variables such as prior exposure or experience, access to the technology among others (Colley, Gate & Harris, 1994). A student in an online learning environment must have the basic exposure and experience to using the technologies involved to overcome this gap of technology self-efficacy that can hinder success of the overall learning process. Apart from the student, Collis (1991) addresses the instructor's implementation of the technology as a critical success factor. How comfortable or uncomfortable they are with using technology, their teaching preference and control and integration of technology are factors which can affect learning (Webster & Hackley, 1997). To this end, some institutions have made huge investments in instructional design support to help

instructors properly design for the unique challenges and opportunities of the modality (Bailey, Vaduganathan, Henry, Laverdiere & Pugliese, 2018). Other researchers found some demographic traits such as gender, students' country of origin, students' self-disciple and motivation, impacts the familiarity with technology and the effectiveness of online learning (Kay, 1992; Reinen & Plomp, 1993). The technology self-efficacy and perceived usefulness can impact the user experience in an online course, and this aligns in part with the construct of user satisfaction, a measurement scale in DeLone and McLean Information Systems (D&M IS) success model (DeLone & McLean, 2003). The original model is based on the communications research of Shannon and Weaver (1949) together with the information "influence" theory of Mason (1978) and empirical Management Information Systems (MIS) research. In their model, system quality, effectiveness or success is rated as a measure of technical success (system), semantic success (information) and use and user satisfaction (user), coupled with individual and organizational impact. The user satisfaction construct in the D&M IS success model for online learning system considers how pleased learners are with using online learning systems, how satisfied they are with information retrieval and access and their overall interaction with the online learning system.

Overlaps with Multimedia Principles. The multimedia learning principles offer prescriptive guidelines to help organize and frame words and images used in instructional materials coherently to appeal to learners and also stimulate efficient cognitive processing of materials in the mind for meaningful learning. It is consistent with the sensory-modality and presentation views of multimedia rooted in works of researchers

such as Baddeley (1999) working memory, Most of the basic multimedia principles such as coherence, Signaling, Redundancy, Spatial Contiguity are inherently meant to create both an appealing user experience with the information and also promote knowledge construction for active learning (Mayer, 2001, 2004).

The constructs within the D&M IS success model for online learning systems include: System quality, Information quality, System quality (visual), User satisfaction, Behavioral intention to use OLS, Actual OLS use. Several specific questions are addressed under each construct such as Is the information you received accurate? Is the information relevant? Is the information up to date for your purpose? Does the content meet your goals? Is the information complete? Is the content presented visually appealing (appeal of instructional materials)? Are you pleased with the user experience? Are you satisfied with the information you receive? Do you intend to use the Online learning system in future learning? Among others.

These constructs make up the D&M IS success model and is interesting to compare this with other factors of success, although the model was originally designed to serve management Information systems use, it has been updated for use in online education.

And these have points of congruence the constructs of effectiveness discussed earlier in this research (Webster & Hackley, 1997).

Cognitive Engagement, Merits, and Demerits of Online Delivery System

Student Involvement and participation factor identified by Webster and Hackley (1997) can contribute to the User satisfaction as identified under the D&M IS success

model. Also, the System quality construct in the D&M IS model in terms of visual appeal of material may align with Cognitive Engagement factor (Webster & Hackley, 1997). With the evidence in cognitive science, backed by the basic assumptions of working memory, dual-code theory showing how the human information processing system works, it is clear that the presentation format of material in learning can cause an overload of the cognitive capacity, thereby affecting our engagement and comprehension of the content (Chandler & Sweller, 1991; Mayer, 2001; Paas & Sweller, 2014; Paivio, 1986). The relative merit or demerits of the online delivery system are factors that can align with the constructs of behavioral intention of use and actual use, since the advantage of using the system may augur for a good user experience which can affect the behavioral intention.

The second aspect of technology focuses on the usefulness and its reliability to support technological advancement that allow for both synchronous and asynchronous interaction over the network in an efficient and effective manner. Others address technology's adeptness to guarantee a quality end user experience or support quality and rich design interfaces and course aesthetics (Laurel, 1990; Trevitt, 1995), this again has parallels with the system quality construct for visual appeal in the D&M IS model, and reinforces the importance of the quality of the instructional materials delivered in online learning. The import from these factors suggest that the learning experience is impacted in areas such as ease of use, navigation, cognitive load and engagement as a result of the aesthetics of content and functionality of the online learning environment.

Learning Theories that Influence Course Design

Other researchers view the discussion of success in online learning through the lens of learning theories and advocate for new theories for the digital age which will direct the design and development of instructional materials to be used in online learning (Ally, 2004; Downes, 2006; Harasim, 2017; Siemens, 2004). This proposal seeks to create a new learning theory to back the design of online learning materials that combines or adapts well-established theories such as behaviorism, cognitivism and constructivism. This proposed new theory – connectivism, is explained by Siemens (cited in Ally, 2004) as "the integration of principles explored by chaos, network, complexity and self-organization theories" (p. 19).

The challenges of the modern learner are presented as multifaceted and constantly evolving due to technological advancements include Artificial intelligence, as such Siemens (2004) calls for this new theory which has overlaps of other theories to guide the efficient processing of materials in online learning environments. Researchers have cautioned against the view of online learning as simply putting (uploading) information on the web or other digital repositories for learner to access(download) as inadequate and misleading (Ally, 2004; Ritchie & Hoffman, 1997). Thus, the connectivism theory proposes to guide the creation of online materials through a sequence of instruction and learning activities to help learners achieve the objectives and learning outcomes. There are four main elements of the model will be discussed in the next section, as a review of factors that impact success in online courses or online learning.

- Learner preparation

- Learning outcome, Advanced organizer, Content map, Prerequisites, Content map.

This component proposes that success in online courses is a factor several activities that are pre-planned to set up the learner for success. These instruction strategies to gain the learners attention, inform them of the relevance of the lesson and keep them motivated prior to and throughout the instruction, self-assess knowledge before lesson, among others. The use of advanced organizers and concept maps are few of the suggestion to help prepare to learner as they engage with the content. These activities or strategies concur with the propositions of Keller's (1983) ARCS model (Attention, Relevance, Confidence, Satisfaction) for the motivational design of instruction. The goal is to employ both extrinsic and intrinsic strategies to motivate the learner to help them achieve meaningful learning outcomes as the evidence shows (Keller & Suzuki, 1988, Malone, 1981).

Overlaps with Multimedia Principles. The role of advanced organizers in this phase to organize the structure of the lesson and help learners with varying levels of experience easily situate aspects of the learning. This helps learners recall relevant prior knowledge by activating existing cognitive structures and facilitates connections with new knowledge presented in the lesson (Ausubel, 1960; Mayer, 1979). Mayer (1979, 2001, 2009) has referenced graphic advanced organizers as models for understanding to help learner's prime relevant prior knowledge and connect it to new information. His work on graphic advanced organizers harmonizes with his research on the multimedia

effect, specifically the use of multimedia principle (which states, people learn better from words and pictures than from words alone) to foster generative processing.

The second component in the proposed model is learner activities.

- Learner activities
    - Journalizing, research, reading, listening, viewing, summarizing, practice, application.

This component suggest learners should have a mixture of learning activities that includes text only, audio, visual and or video-based materials. Here, a direct inference of the multimedia principles can be made, since this aligns with the central hypothesis of Mayer's (2001) multimedia learning principle - people learn better from words and pictures than from words alone. Other activities such as journaling to promote reflective thinking is encouraged. Learners may have enough cognitive capacity but fail to process content. Useful and timely feedback to help learner monitor their progress and make sense out of it by building the coherent mental structures through organizing and integration. The proper use of feedback through the right use of the personalization principle for example, can be helpful in such scenarios. The voice, image or multimedia principles can all be utilized to also foster such generative processing (Mayer, 2001).

- Learner interaction
    - Learner-content, learner-interface, learner-support

The first part of this component discusses the need learner interaction with content to be presented in a manner that does not overload the cognitive capacity. It recommends learning interfaces should facilitate smooth transfer to sensory store and short-term

memory for processing. The expected interaction being described is rooted in the evidence of cognitive science and how humans learn, which are the fundamental theories upon which the multimedia learning principles are built (Chandler & Sweller, 1991; Mayer, 2001; Paas & Sweller, 2014; Paivio, 1986). This corresponds with the component of cognitive engagement in Webster and Hackley (1997) framework for effectiveness in online learning. The other types of interaction prescribed under this component for successful online learning is the collaborative exchange between other learners, and with the instructor (or other agent) to form social networks and create a social presence within which learners can personalize the learning experience and meaning.

Other social constructivist researchers who address the subject of success of online education through the lens of a learning theory affirm this view of social presence and social networks as an integral part of success of online learning (Swan, Shea, Fredericksen, Pickett & Pelz, 2000). Wegerif (1998) describes this as the threshold experience, arguing that the connections felt in being part of the online learning community is a threshold every student enrolled in an online learning course, such as Open University courses must overcome in order to succeed. Scardamalia and Bereiter (1994) refer to it as “knowledge building communities” and explain students’ perception and involvement in such social interaction with other learners and instructor is impacts their performance.

- Learner transfer
    - Real-life application and personal meaning.

This final component ties it all together with the assumption that when the right preparation has taken place, the right activities have been plan and implemented, the right systems have been put in place for learner interaction, then the opportunities must be presented for the learner to transfer the knowledge to real-life situation or performance context that resemble real-life encounters. This will promote creativity and the goal of meaningful learning.

The relationships and interactions between these components do follow a linear pattern, but the individual components under each phase does not happen sequentially. Some are internal processes; others are overt strategies that are put in place to stimulate the internal response. The individual component interacts dynamically with each other as and when it occurs. Aspects of behaviorism, cognitivism and constructivist theories can be interwoven into this proposed new theory for the digital age. The suggested components of the Connectivist theory are essential for effective online learning (Siemens, 2004).

Other researchers have approached the discussion with a focus on pedagogical approaches based on a social constructivist theory as they reviewed course design factors on online learning (Swan et al., 2000) which foster successful online learning. The results of their work examining course design factors in an asynchronous online learning environment found transparent interface, frequent interaction with instructor and students, and a dynamic discussion element as critical for success.

Course Interface Design

Course interfaces in online learning environment are very critical since it is the portal of connection between learner and instructors, other learners, and the learning materials. The heuristics of the design and layout (Romiszowski, 2016), transparency (Sutton, 2001) and communication or interactive capabilities (Irani, 1998) affect learning and retention in online courses. The ability of the course interface to facilitate interactions through well-structured design, transparency and interactivity affords learners the opportunity to engage or feel a part of a collaborative online learning space which aligns with Scardamalia and Bereiter (2006) concept of "knowledge building communities."

Overlaps with Multimedia Principles. The personalization and embodiment principles of Mayer (2009) largely address similar social concerns related to keeping the learner engaged and motivated. Although the multimedia principles have focused on reducing learner cognitive load, the goal of addressing social concerns have been noted as one of the rationales in designing multimedia in order to increase the learner's motivational commitment (Mayer, Fennell, et al., 2004). Mayer (2009) discusses learning as a social event and the use of principles such as the Personalization Principle, Voice Principle and Image Principles as methods to show the implied conversation between the instructor and the learner using words in the text, the voice of instructor in the narrated animation, among other techniques. These principles for optimizing germane cognitive load such suggest that conversational style, polite wording, human voice, and virtual coaches help people learn better, keeps them engaged and bridges the social distance. Nass and Brave (2005) concur that people easily accept computers as social partners. The

application of these principles in course design of online lessons can boost the social presence between the learner and instructor, content, or other learners during the learning experience.

Summary of Success Factors

Researchers have examined the success factors from different standpoints. Webster and Hackley (1997) addressed technology, technology usage, student involvement and participation with instructor and other learners, and cognitive engagement as possible course-level critical success factors. Lin (2007) focused on a similar path of research by looking at the success of an Online Learning System using an updated DeLone and McLean model which tested constructs of system quality, information quality, system quality (visual appeal), user experience satisfaction, behavioral intention of use, actual use of online learning system.

Ally (2004) focused on learning theories as an instructional strategy in the design of courses to prompt higher order thinking and meaningful learning. He analyzed theories of behaviorism, cognitivism and constructivism and proposed the connectivist theory as a new theory for the digital age of learning in a networked environment. He advocates for instructional designers to create materials for learners based on this connectivist theory for effective online learning. The components of the theory include learner preparation, learner activities, learner interaction and learner transfer. Consistent with the learning theory construct, Swan et al. (2000) focused on three course design factors: transparent interface, frequent interaction with instructor and students, and a dynamic discussion element as critical for student's success in online learning. These were discussed as

pedagogical approaches hinged on social constructivist theory, and their study was based on students' perception of the interactions involved in the learning process.

Papp (2000) focused on what factors can make the development and implementation of distance courses a successful experience, mainly from an instructor or faculty's perspective.

Factors such as ownership of Intellectual property. Giving faculty the assurance and security of their intellectual capital by adding language that bars illegitimate use of the intellectual property is identified as the first factor. This will help gain the buy-in of faculty who provide the subject matter in most cases. Other factors take into consideration the course building process which involves the content for the course itself and making decisions regarding the suitability of the content for online delivery, the nature of assessment to use which will ensure academic integrity is upheld (Chimi & Gordon, 1997; Fischer & O'Leary, 1998). Finally, the course deployment platform. What learning platform will be selected to deploy the learning, considering the cost, technical support, reliability, security, and accessibility functionality it offers.

Selim (2007) identified four categories for e-learning success in higher education instructions as instructors, students, information technology, and university support. Elkaseh, Wong and Fung (2015) also found educational technology, computing experience, attitude, social influence, curriculum development, language, teaching and learning styles, and demographics as general critical factors from the evidence in literature.

Finally, Freeman and Urbaczewski (2019) looked beyond a single course to an entire online degree program. The critical success factors resulting from their longitudinal study covered the following constructs: Overall course quality, Overall interactivity, Overall faculty availability, Overall learning style and activities, the learning management system, Overall course availability, Advising and admissions, Faculty attitudes, Affordability, Attitudes and anxiety towards technology, Assessment diversity, Relationship of program to career services.

Linking the "Success Factors" to the Multimedia Principles

There are notable elements of congruence in these success factor identifications across the literature, and based on the purpose or justification of the identified success factors it is possible to draw linkages to some of the multimedia principle, particularly where the goal of such principles are geared towards the facilitation of those success factors directly or indirectly through a combination of other factors (Mayer, 2009; Clark & Mayer, 2016). The broad themes under the success factors are instructor, learner (student), technology, course design factors based on learning theory and instructional design theory or framework. Learning outcomes is viewed as a measure of a combination of several factors under these themes.

A prominent factor which aligns the goal of multimedia learning principles is cognitive engagement. Different factors such as course design or learner attributes discuss this feature in different ways. Some address in relation to user satisfaction based on visual displays of course content and ease of navigation, interactivity, or feedback prompts. What is clear from a synthesis of the literature is the cognitive engagement

element is a factor in addressing meaningful online learning and the multimedia learning principles are aimed at managing the learner cognitive load to improve learning.

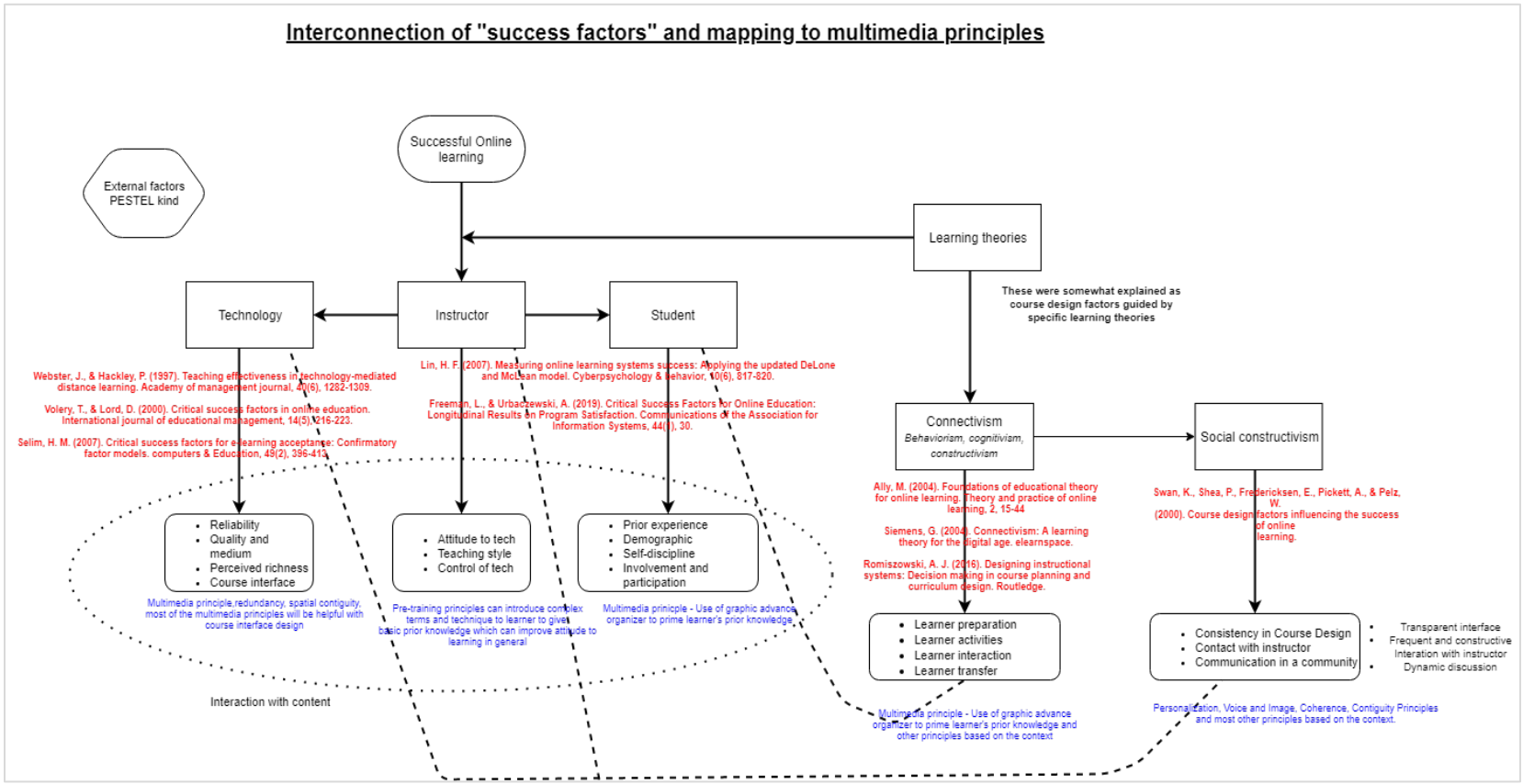
The figure below shows an interconnection of some of the reviewed literature on success factors for online learning and links to multimedia learning principles. An explanation of the shapes and elements depicted in the chart is provided by the researcher as a form of legend.

- The starting point in the chart is an oval representing the construct of Success in online learning.
- The rectangular shapes represent the identified success factors
- The rounded rectangles list some key features of the success factors
- The dashed lines show the relationships or interconnections between the success factors.
- The oval shaped dotted line indicates an interaction of those constructs with the content.
- Hexagonal shape represents other ‘external’ factors occasional mentioned which the researcher classifies as PESTEL kind
- The blue text identifies some of the possible multimedia principles which can be mapped to those success factor.
- The red text represents cited example studies for those success factors.

See full view of flow in figure 1 below.

Figure 1

An Interconnection of "Success Factors" And a Mapping to Multimedia Principles, By Researcher (2019).



Instructional Design Framework

We encounter information in many ways in our daily lives, and education and training have become part of our lives. But good instruction is not always easy to find. A professionally made video does not guarantee effective instruction. A cardinal goal of instructional design is to make instruction more effective, efficient, and engaging. Instruction is defined by Reigelulth and Carr-Chellman (2009) is "anything that is done purposely to facilitate learning" (p. 6). To design or construct instruction with a goal to facilitates learning, there are frameworks which present guidelines for achieving results, and this is where instructional design theory come to play.

Instructional design theory or framework is a set of design theories concerned with several aspects of instruction. It is goal oriented and normative, aimed at promoting generative outcomes by offering methods and guidelines for achieving specific goals. As Reigeluth and Carr-Chellman (2009) noted, it is uncommon to hear the term method, technique, strategy, guidance, and heuristic used in place of the term theory. Instructional Design theory pertain to various aspects of instruction and offer a strategy, technique, or heuristic approach to facilitate generative outcomes. Instructional design theories can be thought of as methods of instruction as they dictate specific events that facilitate learning. According to Reigelulth and Carr-Chellman (2009), an amalgamation of six major kinds of design theories or activities offer guidance about the nature of the instruction and the development process (Instructional systems design) involved (p. 8). They are:

- Instructional event - What the instruction should be like.

- Instructional analysis – what the process of gathering information for making decisions about instruction should be like.
- Instructional planning - what the process of creating the instructional plans should be like.
- Instructional building – what the process of creating the instructional resources should be like.
- Instructional implementation – what the process of preparing for implementation of the instruction should be like.
- Instructional evaluation – what the process for evaluating the instruction should be like (summative and formative).

With the exception of the instructional event theory, which describes or focuses on what the main instructional is about, the other aspects of the instructional design theory by Reigelulth and Carr-Chellman (2009), largely represent the dynamic and flexible process which many instructional design models are based on, that is the analysis, design, development, implementation, and evaluation (ADDIE) instructional systems framework (Gustafson & Branch, 2002).

Willis (1998) noted, models guided by theory have shaped instructional design over the past two decades and these design models offer a systematic approach to instructional design.

The researcher has designed the instruction for the instance as soundly as possible to ensure the instruction is effective, efficient, and engaging to facilitate or allow the formative evaluation of the multimedia learning principles.

Formative Research Methodology

Formative research methodology can be categorized as a subset / type of design-based research (DBR) and related methods. DBR is "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Wang & Hannafin, 2005, p. 6-7). The design-based research paradigm was advanced in the early 1990s by Brown (1992) and Collins (1992) as design experiments, however the literature is replete with many terminologies that describe this paradigm of research or variants of it such as development research (van den Akker, 1999), design research (Cobb, 2001; Collins et al., 2004; Edelson, 2002), educational design research (McKenney & Reeves, 2012), developmental research (Richey et al., 2003; Richey & Nelson, 1996), and formative research (Reigeluth & Frick, 1999; Walker, 1992). Table 1 below, shows different formats of design-based research and their methods adapted from Wang and Hannafin (2005).

Table 1

Types of Design-Based Research and their Methods

Type and reference	Method
Design-based research Design-Based Research Collective, 2003	- Often conducted within a single setting over a long time. - Iterative cycles of design, enactment, analysis, and redesign. - Contextually dependent interventions. - Document and connect outcomes with development process and the authentic setting. - Collaboration between practitioners and researchers. - Lead to the development of knowledge that can be used in practice and can inform practitioners and other designers.
Design experiments (Collins, 1992, 1999)	- Comparison of multiple innovations. - Characterizing the messy situation. - Multiple expertise in design. - Social interaction during design. - Flexible design revision and objective evaluation. - Developing a profile as findings
Design research (Edelson, 2002)	- Designs both directly propel the development of practice and improve researchers' understanding. - Four characteristics: research driven, systematic documentation, formative evaluation, generalization. - Design generates three types of theories: domain theories, design frameworks, design methodologies; these theories go beyond the specific design context.
Developmental research (van den Akker, 1999)	- Begin with literature review, expert consultation, analysis of examples, and case studies of current practice. - Interaction and collaboration with research participants to approximate interventions

Table 1 Continued

Type and reference	Method
Developmental research (van den Akker, 1999)	- Systematic documentation, analysis, and reflection on research process and outcomes. - Using multiple research methods; formative evaluation as the key activity. - Empirical testing of interventions. - Principles as generated knowledge in the format of heuristic statements.
Developmental research (Richey, Klein, & Nelson, 2003)	- Type 1 (emphasizing specific product or program) and research Type 2 (focusing on the research process). - Begin with defining research problem and reviewing related literature. - Different participating populations in Type 1 and Type 2 developmental research during different phases. - Various forms of data collection depending on the research focus. - Employ multiple research methods, such as evaluation, field observation, document analysis, in-depth interview, expert review, case study, survey etc. - Data analysis and synthesis include descriptive data representations, quantitative and qualitative data analyses. - Reports of developmental research are long and can be published in various types of sources; websites are useful to report massive data sets.
Formative research (Reigeluth & Frick, 1999)	- Drawn from case-study research and formative evaluation. - Used to improve instructional systems and to develop and test design - theory in education. - Preferability (i.e., effectiveness, efficiency, and appeal) over validity. - Two types: (a) designed case studies and (b) naturalistic case studies.

This study follows the formative research methodology as proposed by Reigeluth and Frick (1999). This is a qualitative research method described as a kind of action research that is intended to improve design theory (or models) for designing instructional practices or processes.

Reigeluth (1989) and Romiszowski (1988) have recommended the formative research approach to expand the knowledge base in instructional-design theory.

The following steps are offered by Reigeluth and Frick (1999, p. 7) for conducting formative research to improve an existing theory based on a designed case.

1. Select a design theory.
2. Design an instance of the theory.
3. Collect and analyze formative data on the instance.
4. Revise the instance.
5. Repeat the data collection and revision cycle.
6. Offer tentative revisions for the theory.

The cases used in formative research can be designed or naturalistic, with the naturalistic cases also having two variations. With designed cases the researcher instantiates the theory or model and formatively evaluates the instance. Naturalistic cases are when the researcher takes an instance not purposefully design based on an instructional theory but its goals and context line up with the theory, and proceeds to analyze the case for elements of alignment with the theory and formatively evaluates the case for improvement. When the formative evaluation of the case is done during its application,

that is in vivo naturalistic, and if it is done after its application that is post facto naturalistic (Reigeluth & An, 2009; Reigeluth & Frick, 1999).

Previous Studies on Formative Research

In his study, Watson (2007) looked at the formative research on the Games for Activating Thematic Engagement (GATE), an instructional design theory meant to provide strategies for both the design and implementation of educational video games. The participants of his study were fifteen undergraduates in the systems analysis and design course. Lifecycle an educational video game was designed by the researcher as an instance of the GATE theory. The researcher used semi-structured interviews, a focus group interview, written participant reflections, and document analysis of the video game's design documents. Some of the key conclusions were, student did not like the idea of receiving grades during a game play, this may hamper the user experience as learners may feel compelled to perform in the long run although it can stimulate momentary or short-term engagement. Students were not apprehensive to taking a graded assignment related to the game for reflexive purposes. A focus on intrinsic rewards should be held when designing and developing educational games by applying strategies from the GATE theory. The results also explained the possibility of a single instructional designer, building an educational video game with limited resources, while making use of an available resources outside of the game to compensate for any limitations in the game's scope. The learners' feedback on the instance was positive. Learners preferability for more depth in game design did not affect the effectiveness of the existing design in the instance. Despite working with a lean budget, the study backed the design theory's

assertion of effectiveness and engagement of educational games irrespective of resource constraints. Watson's (2007) study is an example of a formative research based on a designed case.

In another designed case example, Hsu (2009) used formative research on the Goal-Based Scenarios (GBSs) to investigate strengths, weaknesses, or possible improvement of the GBS model. The GBS is an Instructional design model that offers guidelines for the design of computer simulations and the research's goal was to test and improve the methods for designing computer simulation to teach statistical concepts. The researcher used think aloud interview, semi-structured interviews, focus group interviews. Some of the strengths of a GBS found included: 1) learning goals that enabled learners to see their learning needs, 2) a sense of investment due to a mission that engaged students in the learning activity, 3) a cover story that provided a context and problems to enhance students' engagement in the program, 4) feedback that gave learners confidence and the perception of negative discrepancy that triggered further learning (Hsu, p. 129). Providing an example that demonstrates the behaviors of using GBS and seeking supports in order to increase the user's lower sense of self-efficacy while pursuing mission or assuming the role, carefully integrate other components in GBS to support hands-on activity, and showing cues or hint in negative feedback as well as recapitulating the concept in positive feedback are some of the prescriptions for improving the design theories application.

In an example which applies the in vivo naturalistic case method, Schladen (2015) conducted formative research on an instructional design theory for virtual patients (VP)

in clinical education focusing on a pressure ulcer prevention clinical reasoning case. The aim was to extend the goal-based scenarios (GBS) theory to provide guidance on the design and use of VPs to develop clinical reasoning skills in novice practitioners. The researcher noted that substantial there is evidence showing that VPs improve clinical reasoning skills but limited formal instructional design theory of VP. The GBS learning theory was tested by ten medical trainees, using a two-module multimedia VP, Matt Lane, a pressure ulcer prevention virtual patient. The study was to find out which methods of GBS was used and not used or which other methods were used which were not part of GBS. A key finding of the study was that the VP utilized all GBS methods and one other method, the Life Model which is not part of GBS, the recommendation include incorporating the Life Model along with a simplifying condition method from elaboration theory to manage complexity. This will result in an enhanced GBS theory useful in teaching patient-centered care.

In her study, Snyder (2002) set out to propose an instructional-design theory that supports a sense of community in online learning for adults in a graduate program. The following are some of the methods that the theory offers: Establish trust and rapport by devoting adequate time to build relationships established on trust early in the learning process. This helps adult learners feel at ease. Maintain consistency and predictability, a value attribute which must be held consistent across every facet of the learning community such as course interface design, lesson formats and activity schedules within the course, provide relevant and easily accessible information, use the world wide web as an extension of the learning community boundaries, among others. For each goal of this

theory, such as sharing of information, knowledge, skills, and experiences among adults with common interests and goals, though online communication, collaboration, and interaction linkages to a value such as cultivating learner centered environment and specific methods and situations are stipulated.

Formative research has been used in many fields and across disciplines to improve instructional design and systems theories and models, such as a theory for the design of computer-based simulations (Shon, 1996), an evaluation of the objectives definition process (Mowat, 2007), component display theory (Antwi, 2017), evaluation of a collaborative problem solving instructional method for a client-based globally-focused undergraduate program (Yinger, 2014), improving the guidance offered by the School System Transformation (SST) protocol, a theory to develop communication practices of leadership teams (Chen & Reigeluth, 2010), the process of creating and maintaining a Montessori school system (Wang, 1992), a theory to promote understanding (Roma, 1990; Simmons, 1991), instructional design process of virtual reality based learning (Chen, 2007), among several others. The focus of this method is to improve rather that prove since most of the instructional design theories have not reach the advanced limit of their development. It emphasizes preferability (usefulness) over validity as a research criterion. The methodology continues to be helpful for the refinement of theories and model particularly in all fields of education.

Importance of Formative Design Research

Instruction is meant to facilitate learning, and instructional design theory makes use of a set of design theories that relate to different aspects of instruction with the goal of helping people learn better. The field on instructional design is still growing. Unlike learning theory which is descriptive and identifies causal dynamics in a situation, instructional design theory is a kind of knowledge that identifies the best methods for accomplishing a specific goal in a given situation. As Reigeluth and An (2009) assert, the main research concern for design theory is preferability instead of validity, since the theory addresses usefulness in contrast to truthfulness. Reeves et al., (2005) noted, experimental research may not be the most appropriate path for developing instructional technology. Research that is exploratory/developmental (improve) as opposed to confirmatory (prove) offers ways to develop and test design theory respectively.

As Reigeluth and An (2009) state, when a design theory (or system, or technology) is matured and at the peak of its development, proving one method viability over another through for example, experimental designs is fitting, however for methods or theories that are at the nascent stages of development, such as most instructional design theories and methods, “evaluation research designs, especially formative research and other kinds of design-based research, are highly appropriate” (p. 371). Grounded theory development, design-based research, and formative research are some approaches Reigeluth and An (2009) discuss as methods to research on design theory.

The Science of Instruction

The ancient art of storytelling or use of verbal messages has been a vital way of explaining ideas to learners and handing down customs from the past. This method used words only in spoken form for instruction. Spoken words and later printed forms of word have been the main format for education for many years, and this idea is backed by the information acquisition view where teaching involves presenting information and learning involves acquiring information (Clark & Mayer, 2016). As investigation of phenomena of instruction continues to evolve. In recent times, theory-grounded approaches to instruction coupled with the proliferation and advancement of computer technology in graphics, has highlighted the potential for multimedia in instruction (Clark, 2010; Hattie, 2009; Mayer, 2011; 2014). This multimedia instruction aligns with the knowledge construction view in which the learner is actively engaged through cognitive processes. Clark and Mayer (2016) describe learning in such context as "a process of active sense-making and teaching as an attempt to foster appropriate cognitive processing in the learner "(pg. 79). Presenting words and pictures with the intention of promoting learning is described as multimedia instruction (Mayer, 2014).

A justification of the inference of learning through both behavioral changes and more importantly evidence-based research is needed to determine the instructional effectiveness. Robert Gagne (1985) defines learning as a process that leads to a change in a learner's disposition and capabilities that can be reflected in behavior. He further explains every learning situation has two parts: one external to the learner and the other internal. Discussing the relationship both external and internal parts of the learning

situation play in the process of behavior change is a central focus of learning investigation which Gagne (1985) captures as the "conditions of learning". To frame an understanding of learning and instruction, he outlines four elements of the learning event. This entails the learner or group of learners, the event, the information, and the response. The learner is recognized as having a sense organ for receiving stimulus, a brain that transforms signals from the sense organs into complex information and muscles which is used to physically orchestrate or execute responses. The events stimulate the learner's senses and the information retrieved from the learner's memory (prior knowledge) works together to finally produce the response – actions that results from these inputs and their transformation. As several researchers have asserted, learning takes place when people build mental representations from words and pictures (Mayer, 2009; van Merriënboer & Kirschner, 1997, 2017). This is both the hypothesis and goal of multimedia learning or instruction and multimedia design principles are intended to facilitate this goal.

Multimedia

Multimedia as a word or terminology carries varied connotations and can be used to capture different experiences; however, the focus of Multimedia in this research aligns with Richard Mayer's definition of the term. Multimedia is defined as presenting both words (such as spoken text or printed text) and pictures (such as illustrations, photos, animation, or video) (Mayer, 2005). Mayer identified three views or forms of presentation when dealing multimedia, the delivery media view, the presentation modes view and the sensory modalities view (Mayer, 2009). Based on the delivery media view some form of technology such as a computer screen with headsets or speakers or an

overhead project together with the teacher voice is necessary. This view focuses on the device. The presentation mode view focuses on displaying both verbal and pictorial presentation, so animations, on-screen text and other forms of printed graphic illustration will fit into this category. The representational formats used in delivering the instructional message is the focus of this view.

Finally, the sensory modalities view maintains that multimedia needs auditory and visual senses. This view focuses on the idea that the learner uses senses to receive the instructional message. Multimedia researchers have been more concerned with the presentation mode view and sensory modalities view and these have been central features of theories such as dual-code theory and multimedia learning (Mayer, 2001; Paivio, 1986; Paas & Sweller, 2014). In summing up a concise multimedia definition, Mayer (2009) asserts that the emphasis on presenting material in verbal and pictorial form which is captured in the presentation mode view and words presented as text or spoken auditory together with pictures which can be processed visually converges to support his proposition or idea that multimedia refers to using words and pictures.

Multimedia Learning

Multimedia design principles help in designing multimedia instructional messages that promote learning. Learning outcomes are assessed based on student's response to a series of problem-solving transfer questions. The research on multimedia learning situates multimedia design within a learner-centered approach instead of a technology-centered approach, since a complete focus on technology or the medium can be limiting, and fails to lead to lasting improvements in education (Clark, 1983; Cuban, 1986; Mayer,

2003). Focusing on the learner serves as a productive research strategy as it probes the investigator to study the cognitive and social process that interplay during knowledge construction (Clark, 1983, 1994). By focusing the research of multimedia design principles to a learner-centered approach, the foundation of the study is guided by Cognitivism and the quest to use words and pictures to improve learning (multimedia learning) is based on an understanding of how the human mind or human information-processing system works. (Baddeley, 1998; Chandler & Sweller, 1991; Sweller, 1999). A potential challenge resulting from combining two or more media formats in the instructional message delivery is cognitive overload. This leads us to the cognitive theory of multimedia learning which establishes the premise that multimedia designs created based on the way the human information-processing system works are more effective at enhancing learning.

Cognitive Theory of Multimedia Learning

Mayer and Moreno (2003) identify three assumptions which the cognitive theory of multimedia learning is based on. These assumptions were shaped by research in cognitive science and are as follows:

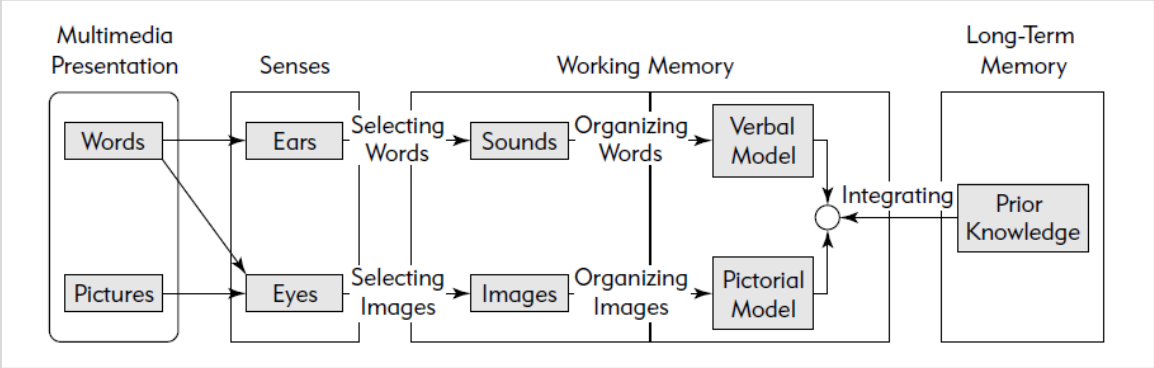
- The dual channel assumption states that humans possess separate information processing channels for verbal and visual material.
- The limited capacity channel assumption states there is only a limited amount of processing capacity available in the verbal and visual channels.
- The active processing assumption states that learning requires substantial cognitive processing in the verbal and visual channels.

Theorists such as Paivio's (1986) work on dual-coding theory and Baddeley's (1998) theory on working memory are both consistent with the main rationale conveyed by the dual channel assumption. The other two assumptions align well with the rationale of theories such as cognitive load theory, working memory theory, the generative-learning theory and the selecting-organizing-integrating theory of active learning (Baddeley, 1992; Chandler & Sweller, 1991; Wittrock, 1989; Mayer, 1999, 2002).

Figure 2 visually captures the Cognitive theory of multimedia learning, using boxes to show memory stores and arrows showing cognitive processes. There are five knowledge representations depicted in this figure. Words and pictures represent the physical representation. Sensory representation occurs in the eyes and ear of the learner experiencing the presentation and the sounds and images are shallow working memory representations the learner pays attention to. Once that memory store is full, the active cognitive processing by the learner selects relevant information and converts the sounds and images into a coherent verbal and pictorial model. Finally, the active cognitive processing connects the new model with prior knowledge stored in the long-term memory representation, through the process of integration as shown in Figure 2.

Figure 2

Cognitive Theory of Multimedia Learning. Adapted from Mayer (2005).



The capacity for mentally storing knowledge in the working memory is limited, but there is virtually unlimited capacity in the learner's storehouse of knowledge (long-term memory). The cognitive processes indicated by the arrows are:

- Selecting relevant words and images – this occurs as the learner pays attention to the auditory sensations received by the ears and the visual sensations coming through the eyes.
- Organizing words and images – this is the mental construction of a coherent verbal and pictorial model based on the relevant sounds and images.
- Integrating – this represents the cognitive processes that connect the new representation/knowledge with another knowledge. It is a merge of incoming verbal and pictorial representations with relevant prior knowledge.

This leads to an integrated learning outcome. The evidence shows that for meaningful learning to occur in a multimedia environment, the learner must engage in five kinds of processing. Selecting relevant words for processing in verbal working memory, selecting

relevant images for processing in visual working memory, organizing selected words into verbal mental model, organizing selected images into visual mental model, and integrating the verbal and visual representations (Mayer, 2005). It has been proposed that the learner may utilize prior knowledge in facilitating the selection and organizing processes (Mayer & Moreno, 2003). These five processes are all consistent with tenets active learning, and these are not intended to be demonstrated in a linear fashion (Mayer, 2001).

This overview of the cognitive theory of multimedia learning gives a clearer picture of how the mind works with information and extends our understanding of how to deal with challenges that confront learner when some cognitive resources or channels is burdened during learning. First, it is important to understand these challenges, since the multimedia learning principles are useful methods and tools, which instructional designers and learning experts can apply in different situations to address such challenges.

There are three types of demands on cognitive processing capacity (Mayer, 2011).

- Extraneous: Extraneous load or processing is the cognitive processing that does not support the instructional goal or learning outcome. Basically, wasted cognitive effort because of poor instructional design. In this case, the learner uses almost all their cognitive capacity to process extraneous material and does not have what is required to process the essential material.

- Essential processing: This is the cognitive effort needed to represent the material in working memory and depends on the inherent complexity of the learning materials. This is similar to what Sweller (1999) terms intrinsic cognitive load.
- Generative processing: Sweller (1999) identifies this as germane cognitive load and it is the effort required by learner to really understand material and is correlated to learner's motivation.

Given the constraints on the learner's cognitive capacity for processing information, it is clear the potential limits on how much processing can take place in working memory in real-time. This is what DeLeeuw and Mayer (2008) describes as the "triarchic model of cognitive load" (p. 79). As such in designing instruction, multimedia learning principles must be used with the goal of minimizing extraneous load, managing intrinsic load, and optimizing germane load in order to ensure meaningful learning outcomes.

The Multimedia Learning Principles

The twelve (12) main multimedia principles by Mayer (2009) have been listed under the three groups of cognitive load challenges which they help address.

Principles for minimizing extraneous processing

- Coherence Principle
- Signaling (or Cueing) Principle
- Redundancy Principle
- Spatial Contiguity Principle

Temporal Contiguity Principle

These principles help eliminate external distractors.

Principles for managing intrinsic load or essential processing

- Segmenting Principle
- Pre-training Principle
- Modality Principle

These principles help the learner to form mental models from the instructional material.

Principles for optimizing germane cognitive load or generative processing

- Multimedia Principle
- Personalization Principle
- Voice Principle and
- Image Principle

These help to promote the integration of new knowledge with relevant prior knowledge.

The principles are explained briefly as follows:

- Coherence Principle – People learn better when extraneous words, pictures and sounds are excluded rather than included.
- Signaling Principle – People learn better when cues that highlight the organization of the essential material are added.
- Redundancy Principle – People learn better from graphics and narration than from graphics, narration, and on-screen text.
- Spatial Contiguity Principle – People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
- Temporal Contiguity Principle – People learn better when corresponding words and pictures are presented simultaneously rather than successively.

- Segmenting Principle – People learn better when a multimedia lesson is presented in user-paced segments rather than as a continuous unit.
- Pre-Training Principle – People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.
- Modality Principle – People learn better from graphics and narrations than from animation and on-screen text.
- Multimedia Principle – People learn better from words and pictures than from words alone.
- Personalization Principle – People learn better from multimedia lessons when words are in conversational style rather than formal style.
- Voice Principle – People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.
- Image Principle – People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.

This study focuses on the principles for optimizing generative processing with emphasis on the multimedia principle. The principles under this category are listed below and briefly explored.

- Multimedia Principle
- Personalization Principle, Voice Principle, and Image Principle

Multimedia principle: People learn better from words and pictures than from words alone. When learners lack the motivation or due to other reasons, fail to engage in making meaning of the material in multimedia instruction (generative processing

underutilization) that situation calls for methods to foster generative processing. In such situation the cognitive capacity is greater than the essential and generative processing taking place. Generative processing describes the cognitive processing that helps learner to select, organize the material into coherent mental models and integrate with prior knowledge (Mayer, 2009). Mayer points out that combining words and pictures in instruction is a way to encourage learners to engage in generative processing. The multimedia principle proposes that the use of words and graphic promote learning than the use of words alone. The principle is the central tenet of the multimedia learning research which Merrill (2015) describes as "the world's most comprehensive statement of and summary of research on principles of instruction" since "virtually all instruction has become multimedia" (p. 49).

Mayer (2009) expounds on the case for combining words and pictures. The information-delivery view of learning suggests there is no informational difference between words and pictures. It views words and pictures as equal means of communicating the commodity of information to the human mind as using both in communication is redundant. He further explains, this view assumes a teacher as the deliverer of information and the learner as a memory store house, but the case for the multimedia principles is backed by the cognitive theory based on the rational that humans have a dual channel to process information, visually and auditorily and the visual and verbal representations of the information are qualitatively different under this view (Mayer, 2009).

Initial evidence of the multimedia principle favors learners with low prior knowledge (Mayer & Gallini, 1990). When it comes to applying the multimedia principle, simply adding pictures or graphics to text does not fully satisfy the goal of this design theory. Not all pictures or graphics serve the same purpose. The application of the Multimedia principle can thus be vague, as such Clark and Mayer (2016) briefly discuss different categories of the use of graphics or pictures to help instructional designers and educational practitioners understand and apply the principle.

- Decorative graphic: Graphics or illustrations may serve decorative purposes, where they entertain, provide aesthetic appeal to the reader but does not enhance the message.
- Representational graphic: Graphics which simply illustrate the appearance of an object.
- Organizational graphic: These are visuals that may be used to show qualitative relationship between content such as maps or charts.
- Relational graphic: Visuals that summarize quantitative relationships.
- Transformational graphic: Used to illustrate changes in time or over space
- Interpretive graphic: Illustrations that explain how systems work, or make intangible phenomena concrete

As Clark and Mayer (2016) assert, liking is not equal to learning. The purpose in multimedia instruction is for the principles to help learners achieve a specific learning goal, the link to an instructional purpose is key to accessing the effectiveness of the principle. It should also be noted the principles work best for novice learners or learner

who have low prior knowledge of a subject matter (Mayer, 2001), a situation Kalyuga (2005) describes as the expertise reversal effect.

Personalization Principle, Voice Principle, and Image Principles

These principles relate to the conversational style, polite wording, human voice and virtual coaches used in multimedia instruction to help people learn better.

- The personalization principle states people learn better from multimedia presentations when words are in conversational style rather than formal style.
- The voice principle states people learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.
- Image principle states people do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.

These personalization and embodiment principles appear to address social concerns related to keeping the learner engaged and motivated, which aligns with Mayer, Fennell, et al. (2004) assertion that designing multimedia in order to increase the learner's motivational commitment to active cognitive processing is one of the central factors aside designing to reduce learner's cognitive load. However cognitive factors have dominated the rationale backing the design of effective multimedia instruction (Mayer, 2005; Mayer & Moreno, 2003; Paas, Renkl, & Sweller, 2003; Sweller, 1999).

The principles for optimizing germane cognitive load or generative processing are all effective methods for boosting feeling of social presence which the learner experiences. Mayer (2009), explains learning as a social event and using these principles as methods to show the implied conversation between the instructor and the learner based

on the words in the text, the voice of instructor in the narrated animation, etc. Nass and Brave (2005) concur that people easily accept computers as social partners. The result of several studies testing the personalization principle consistently proved that people learn more deeply when words are presented in conversational, for instance with use of 'you' and 'I' rather than formal style such as the use of third person (Mayer et al., 2004; Moreno & Mayer, 2000, 2004; Wang et al., 2008). The effect being high when the personalization was not overdone, and the learner did not know the instructor. Research by Mayer and his colleagues also confirmed that machine voice used in multimedia learning led to poor performance on problem-solving transfer tests compared to the standard-accented human voice multimedia lessons (Atkinson et al., 2005; Mayer, Sobko, & Mautone, 2003). Regarding the image principle also, there was no strong consistent support for the idea of an agent's image improving learning on screen despite the potential benefits of using an agent to indicate specific parts of an illustration or formula (Atkinson, 2002).

Guidelines for Applying the Principles

In this study, the researcher applied the principles for fostering generative processing particularly the multimedia principle and through a formative research methodology find out what worked and did not work and how it can be improved. Clark and Mayer (2016) offer some suggestions on how to use graphics to promote learning and go on to provide prescriptive guidelines for applying all the principles in different situations (pp. 396 – 398). There are sixty-seven (67) guidelines covering design of games, building thinking skills, navigational options for learner control, teaching job

tasks, and all forms of online learning. These serve as a checklist for applying the principles. Twenty-eight (28) of them fall under the multimedia guidelines for all types of online learning. Eleven (11) out of the twenty-eight (28) guidelines in this checklist are linked to the principles for fostering generative processing - Multimedia Principle, Personalization Principle, Voice Principle, and Image Principle. Since neither an instructor / speaker's image nor virtual coach' image was used in the designed instance, the first three principles are concentrated on eight (8) of the guidelines. These principles were carefully applied in the creation of the design instance for this study. The researcher made a good faith effort to apply the guidelines in the design and development of the instance.

Following is the 28-item checklist (Clark & Mayer, 2016, pp. 396 – 398).

When Using Text and Graphics (Not Audio)

1. Use relevant graphics to accompany text for novices - Multimedia Principle.
2. Use animations to demonstrate procedures or to illustrate abstract ideas; Use a series of stills to illustrate processes - Multimedia Principle.
3. Use cueing devices such as color or arrows to direct attention in complex graphics or animations - Signaling Principle.
4. Use visuals that are as simple as possible to promote understanding of novices - Coherence Principle.
5. Use explanatory visuals that show relationships among content topics to build deeper understanding - Multimedia Principle.

6. Use transformational graphics (animations and stills) to show changes over time - Multimedia Principle.
7. Use interpretive graphics to explain how a system works or to illustrate abstract ideas -Multimedia Principle.
8. Place text near the corresponding graphic on the screen - Contiguity Principle.
9. Avoid covering or separating information such as feedback on a learner's question response that must be integrated for learning - Contiguity Principle.
10. Place labels on the screen rather than in legends - Contiguity Principle.
11. Avoid irrelevant graphics, stories, and excessively lengthy text - Coherence Principle.
12. To improve motivation, design relevant graphics using warm colors and human features such as eyes and facial expressions - Emotional Design Principle.
13. Write in a conversational style using first and second person - Personalization Principle.
14. Use virtual coaches (agents) that serve a relevant instructional purpose such as providing feedback, examples, and hints - Personalization Principle.
15. When using a virtual coach, design it with life-like features such as eye gazes and gestures - Embodiment Principle.
16. Break content down into small topic chunks that can be accessed at the learner's preferred rate - Segmenting Principle.
17. Teach important concepts and facts prior to procedures or processes - Pretraining Principle.

18. When teaching concepts and facts prior to procedures or processes, maintain the context of the procedure or process - Pretraining Principle.

When Using Audio and Graphics

19. Use relevant graphics explained by brief audio narration to communicate content to novice learners - Multimedia and Modality Principles.
20. Maintain information the learner needs time to process as on-screen text, such as directions to tasks, new terminology - Exception to Modality Principle.
21. Do not allow temporal separation of visuals and audio that describes the visuals - Contiguity Principle.
22. Do not present words as both on-screen text and narration when there are graphics on the screen - Redundancy Principle.
23. Avoid irrelevant videos, animations, music, sounds, stories, and lengthy narrations - Coherence Principle.
24. Script audio in a conversational style using first and second person - Personalization Principle.
25. Script virtual coaches to present instructional content such as examples and hints via audio - Modality and Personalization Principles.
26. Break content down into small topic chunks that can be accessed at the learner's preferred rate using a continue or next button - Segmenting Principle.
27. Use a continue and replay button on animations that pause the animation after short logical segments - Segmenting Principle.

28. Teach important concepts and facts prior to procedures or processes - Pretraining Principle.

Summary of Multimedia Learning Principles and Guidelines for Application

Multimedia learning is hinged on three assumptions that align with the cognitive theory of multimedia learning.

- People have separate information processing channels for verbal and visual material (dual channel assumption).
- The channels are limited in capacity. Only a limited amount of processing capacity available in the verbal and visual channels (limited capacity assumption).
- Meaningful learning occurs when learners actively select, organize, and integrate incoming visual and auditory information. Learning requires substantial cognitive processing in the verbal and visual channels (active processing assumption).

Beyond these, Mayer (2009) identifies the level of prior knowledge of the learner and the complexity and pacing of the content used in a multimedia instruction as two likely boundary factors that can influence a favorable application of the principles or otherwise. Based on the evidence and grounded theory, multimedia learning presents a powerful way deliver instruction effectively (Clark & Mayer, 2016).

Lesson Content of the Instance - Cyberbullying

The lesson went over some key definitions of bullying and different forms of it. Cyberbullying was singled out and information regarding how to identify, prevent and report cyberbullying was presented. A brief overview of social media and gaming

platforms which are avenues for cyber bullying were also covered. Below is a summary of topics covered in the lesson:

- Bullying (definition, forms, research on prevalence, risk factors and best practices in bullying prevention)
- What is cyberbullying (definition of cyberbullying, common places of occurrence, special concerns, laws and sanctions, frequency / brief statistics)
- Cyberbullying tactics
- Prevention tips
- Social Media and Gaming
- Digital Awareness (Tips for parents and teachers)
- Reporting cyberbullying

Chapter 3: Methodology

Introduction

The purpose of this study was to examine how the multimedia learning principles by Mayer (2001, 2009) apply to the design of online courses in a manner that is effective, efficient, and engaging (appeal) to foster meaningful learning using a designed instance as a case. It utilized Reigeluth's and Frick's (1999) formative research methodology to explore instructional situations (values and conditions) that influence how well the multimedia principles, specifically the principles for optimizing generative processing work for teaching informational content in an online course and in the process offer guidelines for possible improvement to its application. The degree to which principles are implemented is a function of the effectiveness, efficiency, and appeal of the method of instruction (Merrill, 2002, 2008).

Reigeluth's and Frick's (1999) approach to formative research makes use of effectiveness, efficiency, and appeal as the three broad criteria for evaluating research on generalizable design knowledge. Reigeluth further asserts that instructional design theories are not universal and may be influenced by different instructional situations (Reigeluth, 2013). Based on an evaluation of the designed instance, serving as the case this study investigated the following research questions:

1. What are the strengths and challenges of implementing multimedia learning principles in online courses from the perspective of the instructional designer?
2. What implementations of the multimedia learning principles in the design instance worked well and did not work well based on learner feedback?

3. How can the application of multimedia learning principles be improved based on learner feedback to support online learning?

The research focused more on utilizing qualitative data rather than quantitative to address the research questions. As Reigeluth and Frick (1999) noted "traditional quantitative research methods (e.g., experiments, surveys, correlational analyses) are not particularly useful for improving instructional-design theory—especially in the early stages of development. Instead, drawing from formative evaluation and case-study research methodologies in developing formative research methods" (p. 634). Using formative research methodology is a way of improving prescriptive instructional design theory. The researcher used a formative research methodology to answer the research questions in this study.

Richard Mayer's research in multimedia learning principles have been evaluated in several fields and with different instructional content and findings concluded that the search for load-reducing methods of instruction through the application of the multimedia principles fostered meaningful learning without creating cognitive overload (Clark & Mayer, 2003, Mayer & Chandler, 2001; Mayer & Moreno, 2003; Paas, Tuovinen, et al., 2003). However, most of the experiments conducted focused on concise, narrated animations and paper-based lessons lasting few minutes in studying the effect of individual principles on retention and transfer (Clark & Mayer, 2003; Mayer, 2001; Mayer & Moreno, 2003).

Role of the Researcher

The researcher is an international graduate student from Ghana, West Africa currently in the instructional technology program at a large midwestern public university in the United States. The researcher has a bachelor's degree in Computer Science and two master's degrees one in Information and Telecommunications Systems and the other in Business Administration (Corporate Strategy). Before his master's degree, he worked as an education technology (Edtech) professional and pioneered an elementary school in Ghana.

The researcher most recent experience is working as an instructional designer for the college of health sciences of a public university in the United States during his graduate career. The characteristics of the learners enrolled in the online courses he builds run the gamut of today's typical online learner, from college freshmen to matured professional aiming to get a degree close to their retirement age. With such a varied pool of learners come a heightened challenge of designing instruction to meet learners need whiles staying aligned to the instructional objective. The researcher understands that learner's attention in online learning spaces must be focused on the relevant material, cognizant of the distractions surrounding online learners. This viewpoint is one the researcher may have carried into this project. However, as Patton (2014) cautions, data from the findings are all results and a good researcher must understand and accept this despite their personal stake. The researcher's role in the data gathering process must be done objectively and with care.

The researcher anticipates discovering some strengths of applying design principles, and possible improvements to the instructional design guidelines. The researcher assumes learner's feedback of their experience with the designed instance may offer helpful prescription to improve the guidelines for applying the design principles. Finally, the researcher was not the instructor of the class from which participants were chosen for the study, as such he did not have any existing relationship with the participants. However, the class instructor worked well with the researcher by introducing the researcher to the class prior to and during the instance experimentation. The instructor of the class was present to help facilitate the researcher-participant relationship or interactions and make it smoother if necessary.

Formative Research Methodology

Formative research is the methodology utilized within this study. It is a type of qualitative research procedure to evaluate the improve instructional design theory. As several researchers have asserted, formative research methodologies are one of the best ways for evaluating an existing instructional design theory for improvement (Carr, 1993; McKenney & Reeves, 2012; Newman, 1990; Reigeluth & Frick, 1999). The central ideal of this method as Reigeluth (1989) states is the results of an evaluation of any instruction built strictly to the guidelines or a theory gives us a testing ground for that theory's effectiveness. "Any weaknesses that are found in the application may reflect weaknesses in the theory, and any improvements identified for the application may reflect ways to improve the theory" (Reigeluth & Frick, 1999, p. 636). Field testing or usability testing, also termed formative evaluation has natural similarities with this method. As Reigeluth

& Frick (1999) point out, it involves asking question like “What is working?”, “What needs to be improved?”, and “How can it be improved?” (p. 4), however the guiding questions for formative research are, “What methods worked well?” “What did not work well?” and “What improvements can be made to the theory?” In order to apply formative research methodology to multimedia learning principles in an online course, a specific designed case of an online course was developed following guidelines from the multimedia principles as closely as possible. This single case serves as an application of the instructional design theory, in this case the multimedia learning principle, and is referred to as the instance or case for the study. As such the formative research uses a case study (designed case). When the goal of an inquiry is to answer, “a how or why question”, such as how to improve a design theory, single case studies are useful (Yin, 1984, p. 20).

Binding the Case

An important aspect of research involving a case study is defining the case. This helps clarify the exact context of the study. Miles and Huberman (1994) explain a case as “a phenomenon of some sort occurring in a bounded context”. Thus, the case is, “your unit of analysis” (p. 25). To avoid the likelihood of the researcher extending the inquiry beyond the scope of the study, Yin (2003) and Stake (1995) recommend placing boundaries. Several researchers have suggested different ways to bind a case such as by time and place (Creswell, 2003); time and activity (Stake, 1995); definition and context (Miles & Huberman, 1994); instructional conditions (Reigeluth & An, 2009; Reigeluth & Carr-Chellman, 2009).

This research binds the designed instance using instructional conditions, boundaries suggested for the development of instructional design theories (Reigeluth & An, 2009; Reigeluth & Carr-Chellman, 2009). These tend to align or overlap with other means of binding based on context, time, place and activity. Instructional conditions ultimately affect the instructional choices made and is part of instructional situations, which encompass all aspects of an instructional context that are useful for deciding when and when not to use an instructional method or the context within which an instructional method is applied. To some extent, the word context has a similar meaning to instructional conditions. The four main kinds of instructional conditions (Reigeluth & An, 2009; Reigeluth & Carr-Chellman, 2009), by which the design instance is bounded are:

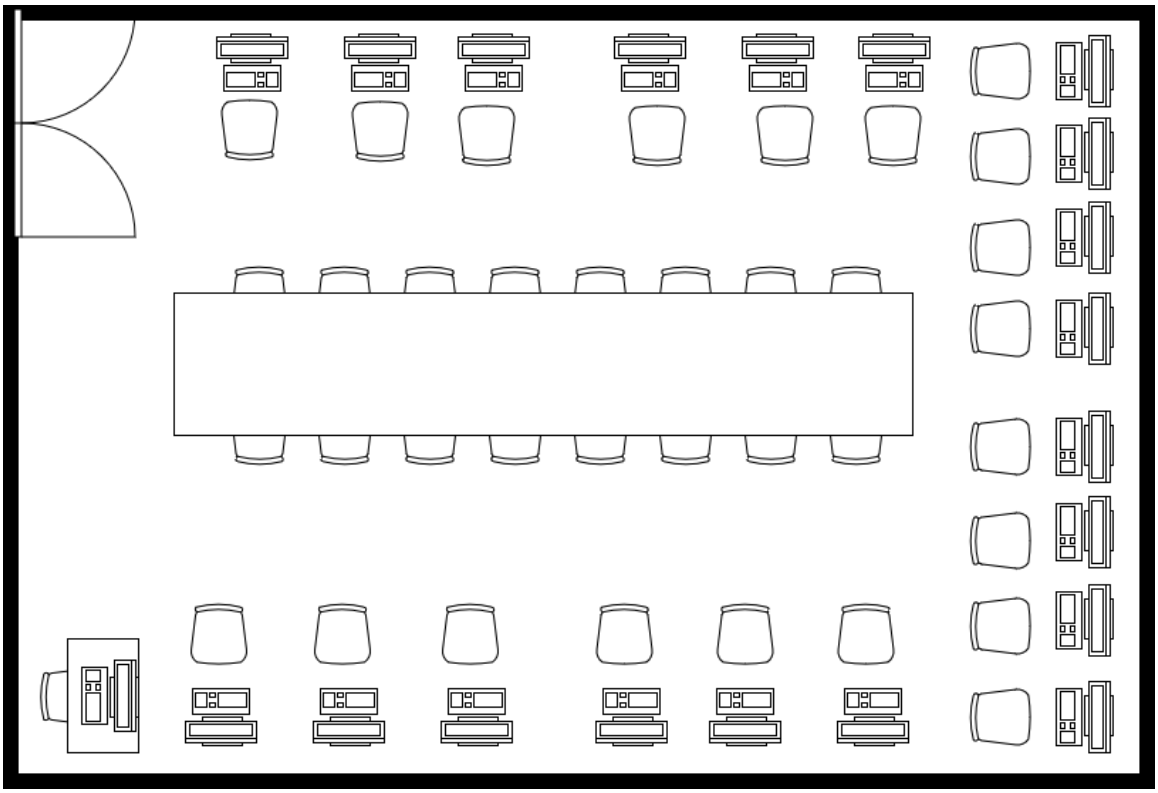
- Content: Informational lesson. The content of the cyberbullying lesson can be classified as an informational lesson. In terms of instructional taxonomies, the kind of learning such an informational lesson presents falls under the cognitive domain of learning when categorized under Bloom's (1956) taxonomy. It may require a combination of verbal information and intellectual skills when translating it from Bloom to Gagne's (1985) types of learning or an 'information-about' and 'kind-of' component skill lesson (Merrill, 2012).
    - The principles for optimizing generative processing was considered when applying the multimedia learning principles. In developing the online lesson for the case / instance, the category of multimedia learning principles that focus on optimizing generative processing will be the

focus. These principles are Multimedia Principle, Personalization Principle, Voice Principle, and Image Principle. A careful application of the first three principles for optimizing generative processing except for the image principle was used in the creation of the designed instance for this study in order to explore it further for improvement. Since neither an instructor / speaker's image nor virtual coach' image was used in the designed instance, the image principle was not applicable. Also, according to Mayer (2001, 2009) the principle has proven not to necessarily support learning.

- Learner: The participants representing the learners were undergraduate students (pre-service teachers) enrolled in a hybrid Teacher Education Program of the College of Education at a large public university in the Midwest.
- Learning environment: The instruction was delivered online via a securely hosted webpage. Learners accessed the instruction using desktop computers in a large computer laboratory. A layout of the room is depicted in figure 3 below to give a better sense of the environment participants worked in while going through the instance.

Figure 3

Room Layout of the Computer Lab where Research was Conducted. Researcher (2019)

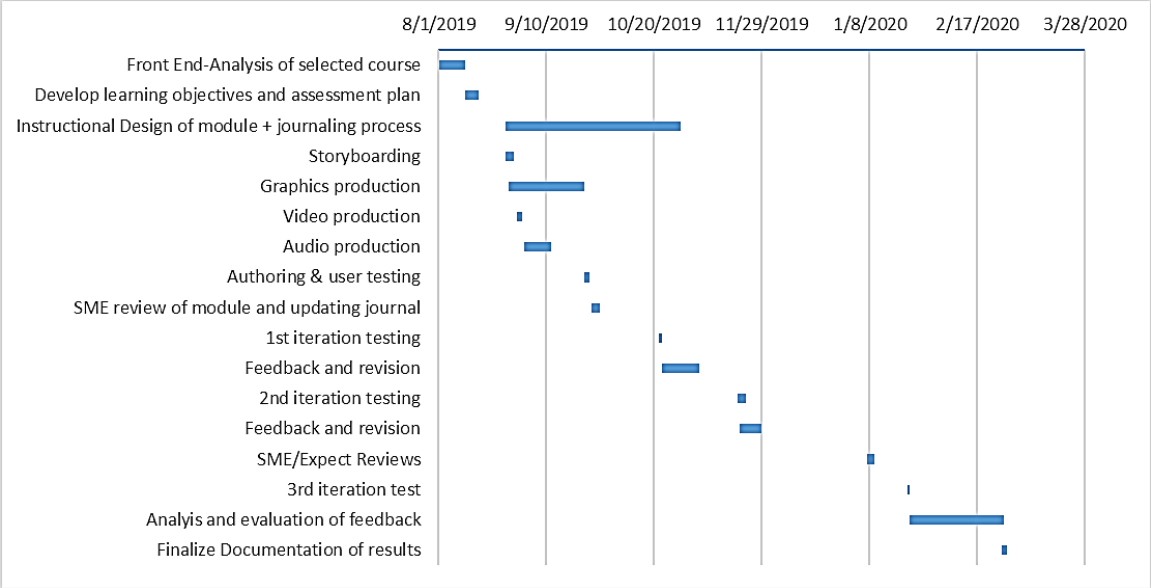


- Instructional development constraints: This boundary factor addresses the resource availability that the researcher (instructional designer) in the process was bound by during the process of designing, developing, and implementing the instruction. This includes money, calendar time, and person hours.

The overall process for creation of the instance from analysis, development, design, implementation, and evaluation was expected to span about seven months. A Gantt chart of the activities is seen in figure 4 below.

Figure 4

Gantt Chart Showing the Timeline for Development of the Design Instance



The calendar hours for the development of the instance and the entire research project has been determined based on unique obligations of the researcher such as work time and commitments, and the deadlines set in the academic calendar for research work within the university. The instance development and revisions spanned seven months, and the entire process of the research study was anticipated to be completed within a nine-month period.

The researcher did not receive any funding for this project and made use of personal funds to cover any costs incurred because of the project. However, it would be interesting to compute the overall cost of development of the instance given the total person hours exerted on all the iterations and the average market rate for instructional design, which is currently $30.63 (PayScale, 2019), in order to extrapolate analysis about

the efficiency elements of the overall instruction. Compared with the intended learning outcomes, learning experts and instructional designers may question whether the effort is worth it. Are the benefits of multimedia instruction sufficient to warrant the investment of time, cost of resources? The development of the instance and its successive iterations is bound by these constrains and the researcher as well is bound by the instructional development constraints.

Based on how the researcher manipulates the situations, case studies for formative research have three versions. It can be a designed case or two variants of a naturalistic case (Reigeluth & Frick, 1999, p. 637).

- Designed cases: the theory is intentionally instantiated for the study typically by the researcher.
- Naturalistic cases: an instance that was not purposefully designed based on the theory but shares a similar function with the theory or model is selected for analysis and conformity or difference to the theory and assessed formatively for possible refinement. It has two types depending on when the observation takes place.
    - In vivo: the formative evaluation of the instance takes place during its application.
    - Post facto: the formative evaluation of the instantiation is done after its application.

A study may either set out to create a new theory or improve an existing one, and either paths lends itself to variation in the methodology.

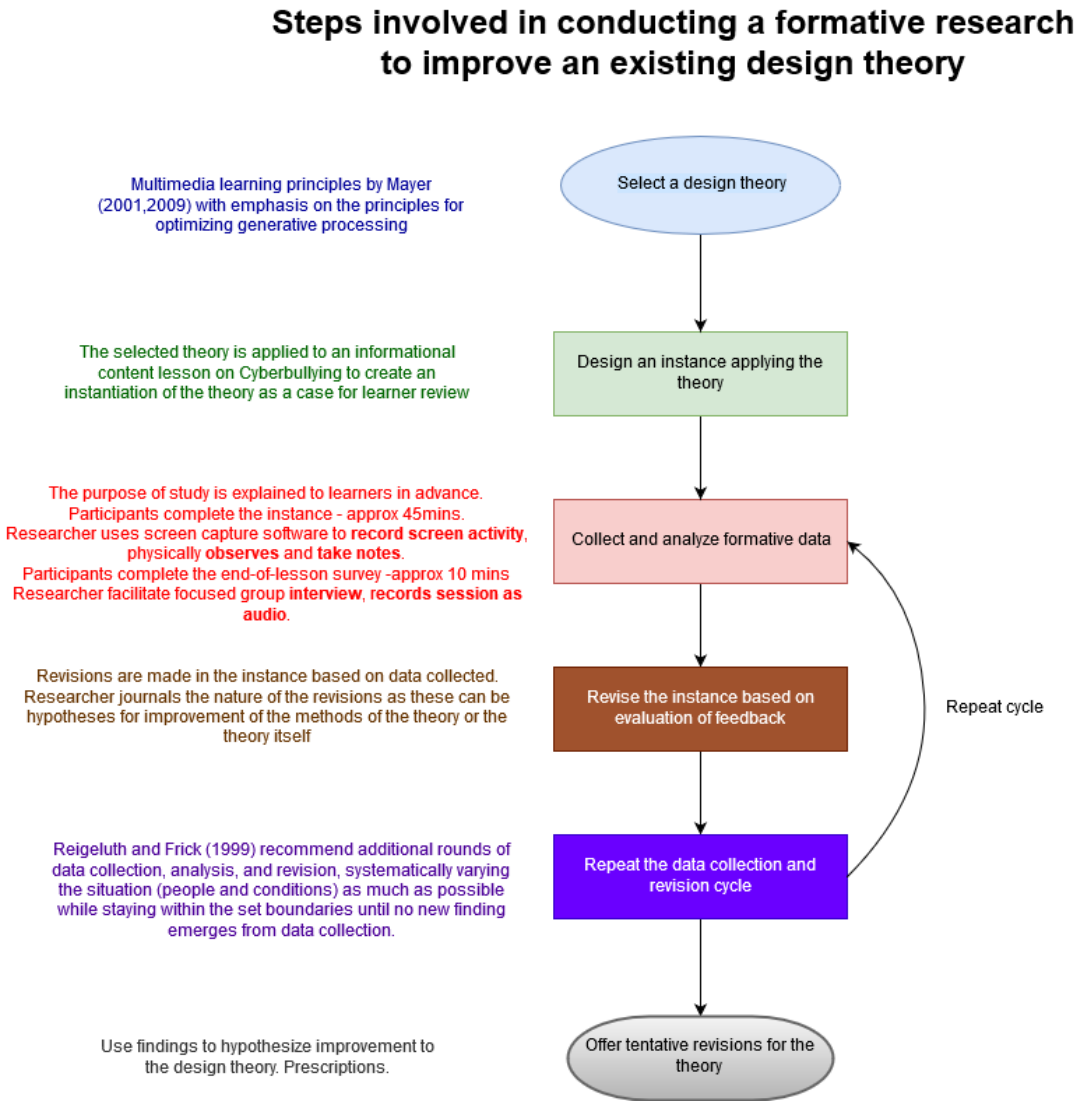
The study employs the use of a designed case. The goal is to examine the application of the multimedia learning principles for meaningful learning in an informational content based online course. The researcher is interested in knowing what prescriptions will work best when designing online instruction that requires many hours of participation. By using a case the researcher can gain an in-depth understanding of the design theory in action, allowing the researcher the affordance of gaining exploratory and descriptive evidence from the instance or case (Yin, 2017).

Study Design Process

The implementation of the study followed the processes detailed by Reigeluth and Frick (1999) for conducting formative research. Figure 5 is a flow chart of the research methodology implementation and the next section explains the process at each stage.

Figure 5

Steps involved in conducting a formative research



The methodological concerns will focus on the following processes outlined by Reigeluth and Frick (1999) for conducting formative research (p. 7).

1. Select a design theory

2. Design an instance of the theory.
3. Collect and analyze formative data on the instance.
4. Revise the instance.
5. Repeat the data collection and revision cycle.
6. Offer tentative revisions for the theory.

This type of formative research where an existing instruction design theory is selected for improvement based on a designed case is the most common of the three kinds. A detail of the implementation is discussed in the next section.

Select a Design Theory

The first step in the process proposed by Reigeluth and Frick (1999) is to choose an existing design theory (or model) which you intend to improve. For this study, the researcher's goal is to examine and improve the application of the principles for optimizing germane cognitive load, category of Richard Mayer's multimedia learning principles, while taking into consideration varying technological constraints and specific learning objectives.

Mayer and Clark (2016) offers guidelines which serve as a checklist of research-based features that should guide the decision considerations of designers creating instruction for online learning. However, most of their experiments involved very brief narrated animations or paper-based lessons (Clark & Mayer, 2003, 2016; Mayer, 2001). The commitment of the researcher was to search for how the guidelines for the application of the multimedia principles under consideration can be improved, in areas where the goal of the design theory was not achieved based on learner feedback.

Design an Instance of the Theory

An online lesson on cyberbullying served as the instance for the study. The researcher carefully applied the prescriptions for implementing the multimedia learning principles designed under consideration as a major design framework for designing the online lesson to introduce the subject of bullying to the pre-service teachers who served as the learners. As Reigeluth and Frick (1999) state that the design of the instance can be done either by an expert in the theory or by the researcher, preferably with the help of a Subject Matter Expert (SME). They stress a conscious attempt to match the design instance closely to the instructional theory by following its prescriptions and avoiding methods not called for by the theory. This is an issue of construct validity. Table 2 below shows a framework of the applicable guidelines drawn from Clark's and Mayer's (2016) guidelines for applying the multimedia principles for all forms of online learning used in the cyberbullying module (design instance).

Table 2

Framework of Cyberbullying module based on Multimedia principle guidelines

Guidelines for applying the principle	**Principle in action within the instance.**
Use relevant graphics to accompany text for novices - Multimedia Principle	- Representational and explanatory image of concept of bullying in first scene, most likely to be bullied scene. - Cyberbullying prevention tips scene. - All graphics not merely decorative.
Use animations to demonstrate procedures or to illustrate abstract ideas; Use a series of stills to illustrate processes - Multimedia	Short video / animation (Brandy Vella news clip) illustrates an example of Cyberbullying and tactics used.
Use explanatory visuals that show relationships among content topics to build deeper understanding - Multimedia Principle	- Relational chart showing occurrence of bullying and cyberbully trends in 2017. - Signaling used to focus on overall bullying also.
Use transformational graphics (animations and stills) to show changes over time - Multimedia Principle	Not applied. No specific content in this informational lesson offered a transition of an activity or state over time. Best suited for procedural content.
Use interpretive graphics to explain how a system works or to illustrate abstract ideas - Multimedia Principle	- Use of interactive graphic using markers with blend of audio, image, and video clips to interpret circle of bullying. - Spatial contiguity also applied with placement and layout of multimedia
Write in a conversational style using first and second person - Personalization Principle	- Presenting lesson objectives introductory scene and throughout instruction text.

Table 2 Continued

Guidelines for applying the principle	**Principle in action within the instance.**
Use virtual coaches (agents) that serve a relevant instructional purpose such as providing feedback, examples, and hints - Personalization Principle	Not applied. Virtual coaches not used in the instance. Also due to the counter effect of use of virtual coaches not aiding learning (Mayer, 2009).
When using a virtual coach, design it with life-like features such as eye gazes and gestures - Embodiment Principle.	Not applied. Virtual coaches not used in the instance.
Use relevant graphics explained by brief audio narration to communicate content to novice learners - Multimedia and Modality Principles	- Use of interactive graphic using markers with blend of audio, image, and video clips to interpret circle of bullying. Change in perspective slide. - Ohio antibullying laws scene. - Brandy Vella news clip narration with graphics.
Script audio in a conversational style using first and second person – Voice Principle.	- Informal / conversational tone use. Ohio antibullying laws scene narration.
Script virtual coaches to present instructional content such as examples and hints via audio—Modality and Personalization Principles	Not applied. Virtual coaches not used in the instance.

Instance Development. In this study, the design and development of the instance were completed before implementation. The design process of the instances, its implementation and testing and proposed revision was envisaged to span about seven months, August 2019 to February 2020. In developing the online module which served as the instance for the study, the researcher worked with the course instructor and a subject matter expert in the domain of instruction in order to ensure construct validity and establish what Yin (1984) describes as "operational measures for the concepts being studied" (p. 37). The subject librarian for educational studies was consulted to gather expert insight on collating the right instructional materials to address the selected lesson topic – cyberbullying. The subject matter expert as well as the course instructor recommended relevant literature about bullying and cyberbullying which guided the researchers content curation decisions for the lesson on cyberbullying. The content was mainly in text-only format and in the public domain through the National Center on Safe Supportive Learning Environments (NCSSLE) resources for classroom training and resources from stopbullying.gov a one-stop access to U.S Government information on bullying topics. The content was however revised through the consultative and collaborative work of the researcher with the course instructor and the subject matter expert for use in the creation of the instance for this study. This instance was designed with an intentional application of the multimedia learning principles – the principles for optimizing generative processing or germane cognitive load (Clark & Mayer, 2016; Mayer, 2001, 2009).

Following Clark's and Mayer's (2016) guidelines for application of multimedia principles, relevant text, and graphics (images and videos) were added to communicate and demonstrate the informational content of the lesson accordingly. The methods offered by the design theory, the instructional situations that affect their application and measures of strengths and weaknesses are the focal concepts in formative research (Reigeluth & Frick, 1999).

Using the first designed instance, a pilot study was conducted in October 2019 and a second pilot in November 2019. A summary of the feedback pointed out some problems encountered in the instance such as unclear user guidance and typos in aspect of the lesson. A few also complained about text size not being large enough or images not bold or having an easy feature to enlarge it. Revisions were made to these identified errors and a second pilot test was conducted in November 2019. Learner feedback from the second pilot was analyzed, together with expert review of the instance to inform modification for the third and final iteration (See Appendix A).

A summary of the feedback showed that aspects of the lesson sequence under the cyberbullying section was confusing to some learners, there were a few omissions spotted in the knowledge checks as well, such as adding the statement 'select all that apply' to multiple answer questions. One participant also cautioned about the display of some real-life examples of bullying without a viewer or reader discretion notice could trigger some emotional trauma for learners who may have had prior experience. These were fixed and the revised instance was republished online for the final run. For the final testing, there was no revisions to the design instance during its implementation.

Collect and Analyze Formative Data on the Instance

One of the rigors of qualitative case study is utilizing systematic processes of gathering multiple sources of evidence such as through observations, documents, and interviews to gain a complete picture of the context. This is a major strength of this design and an opportunity to use different sources of evidence through triangulation (Yin, 2003). Triangulation enhances the credibility of the research; it helps confirm data by comparing the data gathered from different sources and explores ways to verify the finding. It also ensures data is complete (Casey & Murphy, 2009; Redferm & Norman, 1994).

Instrumentation. The following techniques were used to collect data from formative evaluation: observations, end-of-lesson survey, focus group interview, document analysis (time log and screen capture), and journaling. The end-of-lesson survey included eleven Likert-scale type questions and eight open-ended questions. The open-ended questions were structured in a manner to afford the researcher (interviewer) the opportunity to gain the critical inquiry about the aspects of the instance which applied the multimedia principle. These questions also served as a guide in facilitating the focus group interview. The focused group interviews were a platform for participants to share their experiences after finishing the lesson. Giving respondents room to share thoughts is a good way to elicit in-depth information (Patton, 2002). The researcher documented his experience throughout the project lifecycle as it relates to the challenges associated with implementation of the multimedia principles from an instructional designer's perspective.

Data Collection Procedures. The following techniques were helpful in collecting the formative data: observations, end-of-lesson survey, end of lesson tests, focus group interview, document analysis. First the purpose of the study was explained to the participants to prepare them. The researcher explained to the participants that they are testing an instructional design theory, and any problems encountered will be due to weaknesses in the method or its application, and not deficiencies on their part. There could be the possibility of problem arising due to technical difficulties as the researcher encountered in an implementation the pilot instance. They were encouraged to be very critical.

As participants went through the online lesson or instance, the researcher observed and took notes. Using an open source screen video recording and streaming software, Open Broadcaster Software (OBS) studio, installed on every computer, the researcher recorded the screen activity of every participant while going through the lesson. Observations were conducted to identify factors that helped or hindered the learning experience of participants without any presumptions, and to note down any technical difficulties in order to address them during the study (Glesne, 2006). This, coupled with the other data collection techniques such as screen capture and recordings helped the researcher gain a tacit understanding of design theory in action, as well as the participants reaction during the lesson and made judgements about the value of the elements of the theory. As Maxwell (2012) asserts, “observation provides a direct and powerful way of learning about people’s behavior and the context in which this occurs”

(p. 139). The goal was to identify and improve or remove any problems encountered in the instance, which is related to the methods prescribed by the design theory.

After going through the online lesson, participants completed an end-of-lesson survey which included questions based on the lesson content and the learners' experience of the different aspects of the lesson. After this, they were asked to discuss factors that helped or hindered their learning experience as they engaged the instruction during the focus group interview session, this helped gain rich qualitative data about the presentation of multimedia content and what aspects of the presentation enhanced or hampered their learning. Probing the reactions and thinking of participants helped the researcher gain insight into which multimedia principles work best and deduce improvements. As Reigeluth and Frick (1999) assert, questions asked in formative research must be to find out what part of the implementation of the instance work well, does not work well and ways to improve the weaknesses. The response to these questions guided the evaluation of aspects of the design theory under review to find out what helped or hindered learning. These were open-ended questions, used flexibly and responsively. Before the focus group interview, participants were prepared to be more open and comfortable with providing data. They were reminded of the purpose of the study and the procedures involved and the fact that their comments are vital to help the researcher deduce strengths, weaknesses, and possible improvements to the design theory. Weaknesses they encounter are not a reflection of their weakness but possibly the approach. The purpose of the focus group interview session was to allow participants the opportunity to reflect and evaluate the implementation of the design instance. As data

collection and analysis continued in an iterative manner, each participant denotes a data point which is a unique iteration of data collection. Results from participants were confirmed with prior findings until no new information is revealed or prior findings are confirmed. All spoken comments were recorded to establish completion of data to ensure accuracy (Guba & Lincoln, 1981).

The results of the focus group interview were corroborated with the observation for similarities and to gain an in-depth insight into the context under investigation. Screen capture and time log of each participant's attempt while going through the instance was taken. This document served as another data source that was supported with other information gained through different sources such as interviews and observation notes to check for consistency. The end of lesson test entailed both retention and transfer tests. The retention tests helped assess how much of the instruction can be remembered whiles the transfer test will require the learners to apply what was learned in new situations. As Mayer (1999) points out, "when the goal of instruction is constructivist learning, multiple measures of learning are warranted, including both retention and transfer" (p. 147). The screen captures also generated a time log of each participant's lesson completion time. This was helpful in measuring time on task to check the efficiency construct of the instance. Notes from the observation, focus group interview and the end-of-lesson survey helped address the effectiveness and appeal of the instance.

Data Analysis. Ideally, the analysis will be conducted during the data collection process, as Coffey and Atkinson (1996) warn, "We should never collect data without substantial analysis going on simultaneously" (p. 2), and this must be systematically planned. Following the suggested strategies for qualitative data analysis (Emerson et al., 2011), reading of the interview transcript, observational notes, or documents were done first in the analysis process. Listening to recordings, rewriting, or reorganizing draft notes were all opportunities for analysis. Some analytic options available included; the use of memos, categorizing strategies (coding and thematic analysis guided by the focus of formative research – what works well and what does not) and connecting strategies to reduce data, display data and draw conclusion (Miles & Huberman, 1984). Due to the nature of the study (formative research), the guiding research questions which served as a form of structural code or categorizing technique in arriving at themes. The themes were hand coded and further analytic strategies considered included frequency counts.

These activities were employed to facilitate the analyses of data gathered through the observation, focused group interview, end-of-lesson survey, time log of participants activity during lesson and screen recording data. A combination of deductive and inductive methods was utilized. The researcher watched out for tentative categories or relationships that emerged through this initial process. In the first cycle coding, the researcher considered attribute coding, descriptive coding (observation notes, documents), initial coding (focused group interview transcripts).

Maxwell (2012) comments on the general use of coding which has led many to assume the activity is equal to qualitative analysis. He further stresses the importance of

other fundamental activities in data analyses such as "reading and thinking about your interview transcripts and observation notes, writing memos, developing coding categories and applying these to your data, analyzing narrative structure and contextual relationships, and creating matrices and other displays" (p. 142).

The researcher remained open during initial data collection and in the process of reviewing data from different sources (such as focus group interview transcripts, documents, etc.), choose which coding method(s) may be most appropriate and most likely to yield a substantive analysis. An approach Saldaña (2013) describes as pragmatic eclecticism.

Revise the Instance

The next step is to revise the instance of the design theory based on the data gathered so far (Reigeluth & Frick, 1999). The pilot version served as the first instance used to gather data. Learner feedback was analyzed and used to revise the instance in the study.

Repeat the Data Collection and Revision Cycle

Reigeluth and Frick (1999) recommend several rounds of data collection, analysis, and revisions to confirm earlier findings may enhance the external validity (generalizability) of the design theory. In the iterations following revision, participants experienced the improved versions of the instance. It is likely that not all the participants who underwent the first version will be available or willing to try the revised instance. The researcher had to test the revised instance with another group of participants who were available to evaluate the revised instance and were from the same program as the

first group. The researcher had two revisions of the instance used in this project within the project timeline, the pilot version which was reviewed by senior instructional design experts and a revised iteration.

Offer Tentative Revisions of the Theory

Based on the results of the two improved iterations, the researcher hypothesized improvements to the guidelines for applying the instructional design theory. These can serve as prescriptive suggestions for further review of the design theory.

The use of "experts" or "external" colleagues help support the credibility of findings (Reigeluth & Frick, 1999). An independent senior instructional design expert reviewed the instances and the feedback received was be incorporated into the revision of the instance.

Methodological Issues

Qualitative research is seen as lacking rigor pertinent to truly scientific work and these allegations about methodological concerns are addressed by Reigeluth and Frick (1999).

Construct Validity

Yin (1984) explains purpose of construct validity is "establishing correct operational measures for the concepts being studied" (p.37). In formative research, the focal point is on the prescriptions offered by the theory and how different context influence its outcome. According to Reigeluth and Frick (1999), "the concepts of interest in formative research are the methods offered by the design theory" (p.647). For this study, the guidelines for applying the universal multimedia principles form the concept of

interest, and any instructional situationalities that affect its use and the outcome measures of meaningful learning.

To assure construct validity, the operationalization of the methods and analysis of each situation in which the design instance of the theory is tested was reviewed by experts in the theory. The researcher had an independent senior instructional designer, and two instructional design professors who were also the instructors of the two groups of Teacher Education classes who reviewed the instances. The expert reviewers who are all learning specialists reviewed different stages and aspects of the instance to ensure there is no omission of elements of the theory or addition of elements not included in the theory. These two factors of omission and commission of elements of the theory weaken construct validity (McKenney & Reeves, 2012; Reigeluth & Frick, 1999).

Expert measurements of specific goals of the design instance, reviewed by another expert will help validate the suitability of the instance to be used in evaluating the design theory (multimedia principle). As Merrill (2002) noted, the degree to which principles are implemented is a function of the effectiveness, efficiency, and appeal of method of instruction. So using the data from screen capture and time log as a measure of the prudent use of time and resources will address the efficiency indicator or construct, the outcome of transfer and retention test scores will address the effectiveness indicator (attainment of learning goals as measured by test results), and the appeal (preferability, aesthetic feel and comfort of design) will be addressed using the results and analysis of the survey and follow-up interview.

Following the recommendation of Yin (2009) to increase construct validity, data were gathered through multiple sources of evidence such as through observations, documents, survey results and interviews. A chain of evidence was be established through the different data sources which will enhance the triangulation of qualitative research (Patton, 2002). The ensure operationalization of the methods to the design theory, valid content must be used in creating the instance. At different stages and aspects of the instance development and revision, the researcher worked with the instructors of the hybrid residential Teacher Education Program and a Subject Matter Expert (SME), who was the subject librarian for the subject area used in the lesson to ensure validity of instructional materials. This will assure construct validity.

Ensuring Trustworthiness and Credibility of Data Collection and Analysis Procedures

In discussing thoroughness, Reigeluth and Frick (1999) link the validity and reliability to the concept of credibility and dependability. As data collection and analysis continued in an iterative manner, reliability or consistency across participants was maintained to determine point of "saturation", where no new information is revealed (Creswell, 2007; Reigeluth & An, 2009; Reigeluth & Frick, 1999; Small, 2009). Completeness and accuracy of data are the factors which influence sound data collection and analysis (Reigeluth & Frick, 1999). Through techniques such as triangulation and member checking accuracy of data can be assured. The data gathered from multiple sources was analyzed independently and triangulated to confirm meaning and consistency utilizing methods such as descriptive analysis, content analysis, inductive and deductive analysis to analyze information from the data sources.

Participants

The participants were pre-service teachers enrolled in a hybrid residential Teacher Education Program of the College of Education at a large public university in the Midwest. The researcher consulted faculty teaching a hybrid course in the program for permission after discussing the nature of the study with that instructor. Upon agreement, a class was purposefully selected and students in the class were briefed about the project and were given a chance to volunteer as participants. Twelve volunteers were recruited for the study. The purpose of the study was explained to the participants to address ethical concerns.

Table 3 below shows the demographic information of participants for the study.

Table 3

Demographic information of participants for the study

Participant	Major	Level
Participant 1	BS6177 Middle Child Math & Science	Senior
Participant 2	BS6854 Early Childhood	Senior
Participant 3	BS6306 Integrated Language Arts	Sophomore
Participant 4	BS6177 Middle Child Math & Science	Sophomore
Participant 5	BS6309 Integrated Science	Freshman
Participant 6	BS6468 Child and Family Studies	Sophomore
Participant 7	BS6316 Mild-Moderate Educ. Needs	Junior
Participant 8	BS6235 Spanish	Senior
Participant 9	BS6854 Early Childhood	Senior
Participant 10	BS6306 Integrated Language Arts	Junior
Participant 11	BS6317 Moderate-Intensive Educ. Needs	Sophomore
Participant 12	ND8837 Pre Early Childhood	Freshman

Pilot

A first version of the instance was designed and tested on October 22, 2019 between 6:45pm and 8:00 pm as the first pilot study. This helped the researcher test to see firsthand how the data collection procedure worked out and to test the online lesson as well as software and equipment used in the learning environment for the study. Eleven pre-service teachers enrolled in the undergraduate teacher education program were recruited to evaluate the cyberbullying lesson. Each participant sat at a computer in the lab. After the researcher briefed the participants about the purpose of the study and encouraged them to be critical and honest about their learning experience in the end, the

researcher had to move from computer to computer to launch the software and hit record and then leave the participants to start the lesson. This resulted in a few delays as some computers started running updates upon restarting and it took a while to get set up. There were a few technical glitches as some of the headphones in the lab that were not working properly but this could not be fixed so some participants had to go through the lesson without the benefit of hearing the audio element using headphones but listening through the system speakers or not listening at all where they felt the sound would also disturb others. This was evident in some of the feedback which required learners to comment on the usefulness of some narrations or audio elements in the instance. One participant commented “I personally did not use it, but I think it is still smart. I do not have headphones”.

Overall, participants spent an average of 60 minutes on both the lesson and completing the end of lesson survey. Aside the operational delays the researcher faced in running the recording software on the computers and technical challenges with the headphones, the results of the feedback highlighted concerns about ambiguous or unclear instructions in some tests within the lesson. These were due to typographical errors or instructions that were not clearly understandable, also readability of some text and images due to their size was noted. Learner feedback from the review revealed that the application of multimedia elements within the instance helped learners to comprehend and recall the content. The aspects of the lesson which used the multimedia learning principles were noticeable to most learners and drew them in emotionally. One participant commented “This was emotional and made me want to help victims of

bullying," others felt the images were useful cues and help their recall during the tests. Another student explained, "Yes, I noticed the image. It provided a useful visual for understanding the content of the comprehension questions that followed." The lesson kept most of them engaged as one student commented "I loved how interactive it is. I am exhausted and had a long day but still paid much more attention than I thought I would be able to."

The feedback was factored into corrections or revision of the instance for the second iteration which was used in a second pilot test on November 20, 2019. As Reigeluth and Frick (1999) recommend, during the revision cycle of data collection systematically varying the situation (learner and conditions) is helpful, and if this is done extensively over multiple iterations it enhances the external validity within the boundaries of the theory. The researcher conducted the second pilot study with fifteen participants from a different section of the same teacher education program.

The video data of about nine hundred minutes from the second pilot was analyzed and data points corroborated with first pilot results. The video data generally showed most learners quickly clicking through sections of the lesson until they encountered a question for which they were not sure about the response. Participants would then go back to review content. Learner feedback brought up some comments. There were still a few typographical errors, there was no clearly stated objective at the start of the lesson, although there was information that inferred it, specific illustrations used in the instance were pointed out to be duplicated, and lastly a subject matter omission was pointed out. Information that was not up to date was given in the instance. An example of a social

media mobile application was cited under the section on cyberbullying which was no longer an active application. This application (Vine) had been acquired by another company (Twitter) and was no longer available. Feedback from the expert review was also considered in the revision of the instance, this was documented as part of the insights regarding the strengths or weakness of the design theory, where applicable.

With formative research of this kind, improvement or refinements to the instance can keep going, and since the literature basically does not have a clear criterion for when to stop, and considering other factors, the researcher planned to have at least 2 iterations of the instance within the research project lifecycle. The 2 instances revised during the pilot phases was considered part of the iterations. The third iteration, which was not modified during its implementation is discussed in this study.

Summary

This chapter discussed the methodology of formative research that was used to test and improve the multimedia principle in an online lesson instance. By working with the course instructors and subject matter expert, the researcher (instructional designer), developed the online lesson for the instance following sound instructional design to ensure the product promotes efficient, effective, and engaging learning. The steps involved in the formative research process and methodological issues to ensure rigor and validity of the study were addressed.

Chapter 4: Findings

This chapter presents the findings of the study. The goal of this study was to evaluate the multimedia learning principles as implemented in a design instance of an online course to identify prescriptions to improve its application guidelines or possible improvement to the design theory. The instance was designed to teach an informational lesson on cyberbullying. The terms instance, module and lesson may be used interchangeably in this chapter. While explaining the instance to participants during the data collection, the researcher used these different terms, as such learners feedback occasionally reflected the varied usage of the terms when referencing the instance.

The results were derived from learner's evaluation of the design instance and is organized or categorized based on the guidelines for implementing the multimedia learning principles (Mayer & Clark, 2016). These guidelines served as a strategy for the implementation of the multimedia learning principles in the design instance for this study.

Guidelines or strategies include:

- Use relevant graphics to accompany text for novices (multimedia)
- Use animations to demonstrate procedures or to illustrate abstract ideas; Use a series of stills to illustrate processes (Multimedia)
- Use explanatory visuals that show relationships among content topics to build deeper understanding
- Use interpretive graphics to explain how a system works or to illustrate abstract ideas

- Use relevant graphics explained by brief audio narration to communicate content to novice learners (Multimedia & modality)
- Personalization
    - Voice - Script audio in a conversational style using first and second person,
    - Text - write in a conversational style using first and second person.

The chapter first presents the strengths and challenges of implementing these principles from an instructional designers point of view which is related to the first research question, followed by a section on learners evaluation of what they liked or what worked and what did not work as they went through the designed instance which is aligned to the second research question. The recommendation for improvement which relates to the third research questions is presented in the subsequent chapter. The research questions guiding this study were:

1. What are the strengths and challenges of implementing multimedia learning principles in online courses from the perspective of the instructional designer?
2. What implementations of the multimedia learning principles in the design instance worked well and did not work well based on learner feedback?
3. How can the application of multimedia learning principles be improved based on learner feedback to support online learning?

Strengths and Challenges

This section presents the strengths and challenges associated with implementing the multimedia principles from the instructional designers' perspective.

The researcher self-reported these strengths and challenges associated with implementing the design principles in an online course through reflection on his thought and work processes. This was journaled going through the entire design and development phases associated with the developing of the instance and the implementation of the project. It must also be noted that these identified strengths and challenges may extent to encompass the implementation of design theories in general or the foundational work of instructional designers. It will be valuable for an instructional designer of quality to have these as a background as to ensure sound design.

Strengths

A Rubric that Maps Design Principles to Instruction

The designer's ability to master the design principles is a key advantage. Knowing the principles is essential however keeping an abbreviated version as guide during development is helpful. This serves as a design blueprint for applying the principles and it mapped to key aspects of the lesson content. The designer created a guiding rubric based on the multimedia principles which was kept close while creating the storyboard for the instance and during development for quick referencing. The rubric essentially outlines the main principles and maps it to areas in the instruction where the content yields to their application. This practice was found to be helpful to the designer during the creation of the instance.

Access to Advance Design and Development Technology

One other benefit the researcher notes as a strength for applying the multimedia learning principles is the access to eLearning and multimedia production applications. Advance technology at the disposal of the designer facilitated the creation of digital multimedia assets. Intuitive systems with varying levels of functionality are available today that make it relatively easier and faster to create instructional materials from scratch or by employing existing templates and modifying them for ones needs. The researcher used Articulate 360 design suite as the program or development technology for creation of the instance used in this study.

Community of Practice

The researcher found having access to a community of practice as another strength for designer in translating design principles into action. The researcher as a designer gained insight from the perspective of other researchers, practitioners, and advisors who are experts or passionate learners in the domain of innovative learning design and technology. The shared repertoire of resources and experience available to designers in such communities helps each designer to grow their confidence and improve their performance in applying instructional design theories effectively in their projects. The researcher benefited from productive engagement with professionals within the domain of instructional design throughout his graduate career and for the purpose of this study in a way that shaped his competence in applying the design principles. This was through continuous communication with instructional technology faculty, members of the

instructional technology scholars association, and professionals in instructional technology.

Clearly Identifying the Instructional Goal

Another strength the designer noted was when the lesson objective is clearly identified, and instruction is created based on that. Taking time to derive the instructional goal from a performance analysis or needs assessment sets the designer up for success in implementing and applying design theory. The learning objectives inform the content analysis which also helps to determine the type of media to be selected and used in the instruction. Having a clear learning objective thus guides the designer in performing a good content analysis and deciding what combinations of multimedia to use and then apply the principles.

Performing Evaluation and Revision

Another strength the researcher noted was the ability to listen and draw from learner feedback received after a series of evaluations were conducted based on draft versions of the instance which applies the principles. Through one-to-one evaluations draft versions of the instance was reviewed by comparable intended learners and instructional technology faculty advisors.

Having access to these experts and engaging with them meaningfully is important, particularly in areas of reviewing the design instance. “Even if it is just having one expert or professional designer review the instance, it serves as a nice trustworthiness thing but also some expert validation as well” (J. Strycker, personal communication, October 3, 2019).

This formative evaluation as well as the pilot trials helped the designer create and improve instructional processes and materials for the instance. Conducting different types of evaluations such as one-to-one or small groups are ways to help the designer improve the implementation of the design principles.

Challenges

The following outlines some challenges noted by the researcher.

Knowledge of the Multimedia Learning Principles and Making Design Decisions

It can be challenging for the designer if she or he has limited knowledge in the multimedia learning principles or any other design principle for that matter. Demonstrating competence of the knowledge areas (Multimedia Learning principles) is important since you can only apply what you know, and with several factors to be considered the design decision is not always a binary one. The design decisions in the case of the instance for this study was comprehensive and interrelated, knowledge of one multimedia principle can affect the use of another. The designer must be cognizant of this in order not to violate one design principle while applying another.

The application of one principle might have other repercussion. For instance, the researcher decided to present some instructions as a narration instead of text to help explain a specific graphic, the intent of the researcher (designer) in such a case was to apply the redundancy principle which states people learn better from graphics and narration than from graphics, narration and on-screen text. If the graphic had a corresponding animation that could replace it, the decision to use narration and graphic as opposed to on-screen text and animation would then be an attempt to apply the modality

principle. Whether the decision is intended to apply redundancy or modality, this would necessitate another decision. If narration must be done the designer must keep in mind at least two other principles - the voice and personalization principles. Voice principle because the evidence currently states that human friendly voice used in narration supports learning better than a computer generated voice and even when using a human voice, the personalization principle must be upheld to create engaging instruction which is conversational and not formal.

After having the knowledge, there are many components and knowledge areas that intersect during an instructional design project and demonstrating competence in balancing priorities and make the best decision through a consultative approach with subject matter experts is another potential challenging area that needs to be undertaken with care.

Cost of Resources

Other challenges may arise related to cost implications based on the resources available to the designer. The designer may have additional questions to consider in the process. For example, will there be a professional voice talent doing the narration or would the designer or subject matter expert do the narration on their own? This simply goes to explain how the interdependence of principles or knowledge areas is critical and can be challenging to the instructional designer in making sound design decisions.

Staying Current with Research and Skills

The researcher noted the value and challenge of staying abreast with research in the field of the design theory. The knowledge of design principles and competency in

applying them can be gained through practicing experience which may be considered informal training as well as learned through formal training. A designer with substantial years of experience may have picked up a process of making design decisions along the way unconsciously, and these principles will still inform their practice. A new designer may have to consciously make such decisions and ensure it is in conformity to the evidence. There is a need to be well-informed with current state of literature to make evidence-based design decision is a challenge for the designer.

Intent Versus Implementation

Another challenge the researcher experienced with applying of the design principles not specific to this research but likely to be a general challenge designer face is that knowledge does not always translate to implementation due to constraints. Based on the knowledge of principles in a designers' "toolbox", a designer sets out with a desire or intent to apply them, however there is a gap between the desire and actual implementation of design principles. The work culture, the power dynamics at play within the team working with the instructional designer, and resource availability are few of the constraints that may impact the outcome of the final product.

Short or Tight Deadlines

The production time expended on designing and developing instruction has a correlation to the outcome of the instructional product. When this time is limited, it poses a challenge to how well designers can apply design principles thoroughly. It can be time consuming to come up with quality instruction, whether the designer is handling all the different components such as Instructional design, graphics and animation, videography,

script writing, etc. or working with a team of media experts to pull the different components together. This calls for effective project management skills on the part of the designer to be able to plan and execute projects effectively and efficiently. As noted in the researcher's journal in the middle of October 2019, there was a change in plans after assessing the time and cost (of purchasing specific software) needed to create specific digital multimedia assets for some sections of the instance. Although there was an initial consideration to include more customized animations, the researcher reckoned it would take too much time and could potentially delay the delivering of the final instance based on timelines set.

Loosing Focus of the Learner in a Bid to Apply Principles

Another challenge a designer may face is when their focus is glued on applying the multimedia principles to the extent that they lose sight of the intended learner and their needs. This unfortunate event is likely when the designer is engrossed in the idea of applying all the design theories possible. If a good learner assessment is not done and principles are applied to instructional materials without a consideration of the learner attributes such as prior knowledge, ease of use with technology, etc., there could be a case of well-designed instruction which remains unbeneficial to the learner. Since these multimedia principles are more helpful to novice learners, not every section of the lesson will require the use of multimedia to provide learner guidance.

What Worked and Did Not Work?

Implementations of the multimedia learning principles in the design instance that worked well and did not work well based on learner feedback.

Learners evaluation of the design instance is presented to address this second research questions. The design instance was critiqued by twelve participants with the researcher as a participant observer. Data were gathered through end of lesson survey, end of lesson test, follow up focus group interview, and document analysis. The design instance was improved through two iterations of pilot testing before the study began. The final version of the instance used and described in this study was not revised during its implementation.

Feedback based on End of lesson survey

This section describes how the guidelines of the design principle (multimedia learning principles) was implemented in the instance for this study and presents an evaluation based on a qualitative report of participants learning experience during the lesson, highlighting what worked and did not work well as related to the research questions.

Guideline 1

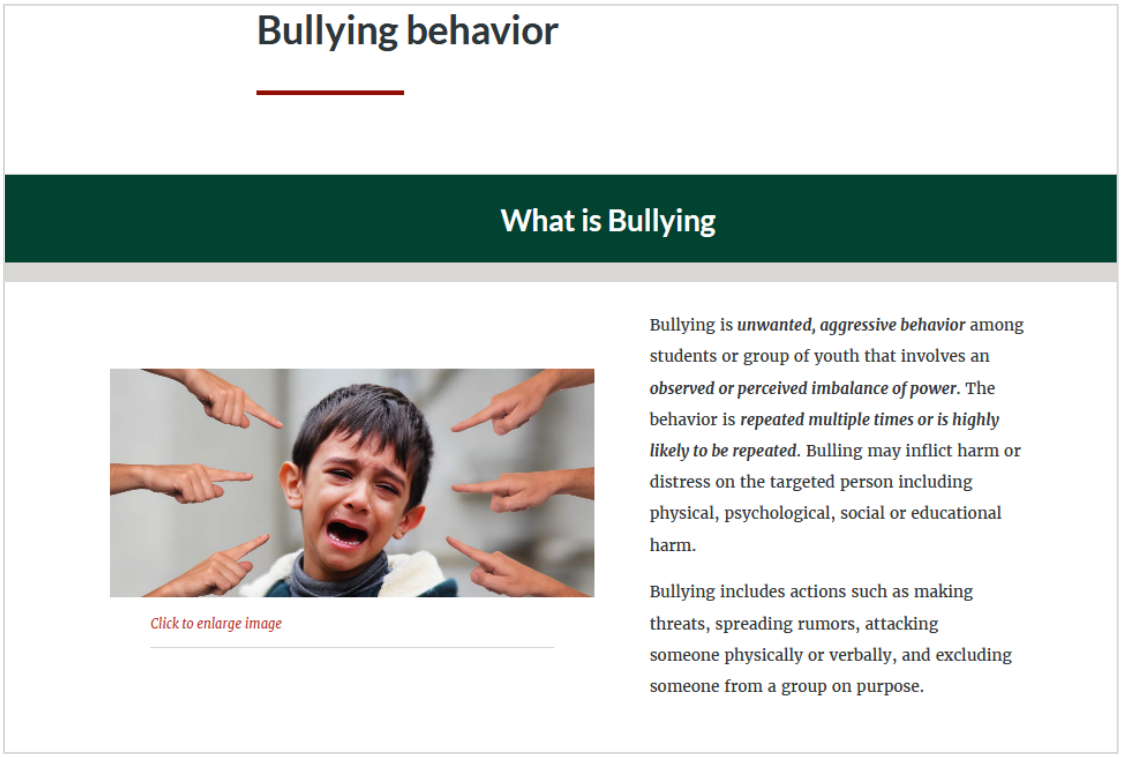
Use relevant graphics to accompany text for novices (Multimedia)

The first guideline for implementation of the multimedia learning principles is to use relevant graphics which includes static illustrations, charts, graphs, pictures, and dynamic graphics such as videos or animations alongside text (printed text or spoken words) to convey information meaningfully to learners particularly novice learners.

What worked and did not work well? Within the instance this guideline was applied in several scenes. In the introductory sections a graphic showing a boy being bullied with many fingers pointing at him is used next to the text explaining bullying.

Figure 6

Screenshot of Section of Instance Showing Representational Image of Bullying



The designer (researcher) used this image which qualifies as a representational and explanatory image to explain the concept of bullying. Carefully selecting graphic based on their instructional usefulness and presenting it together with words supports learning. When participants were asked whether this graphic was noticeable and what their thoughts were on it, what did they like or not like or how well it worked, most expressed how well the images conveyed meaning, and gave a better perspective to the concept of bullying which they read about. Participant 5 noted, “This evoked pathos very well. It made me intrigued to learn more about the issue to prevent it” Similarly, participant 2 stated, “It made me feel really sad for the kid” Participant 4 also noted, “This made me

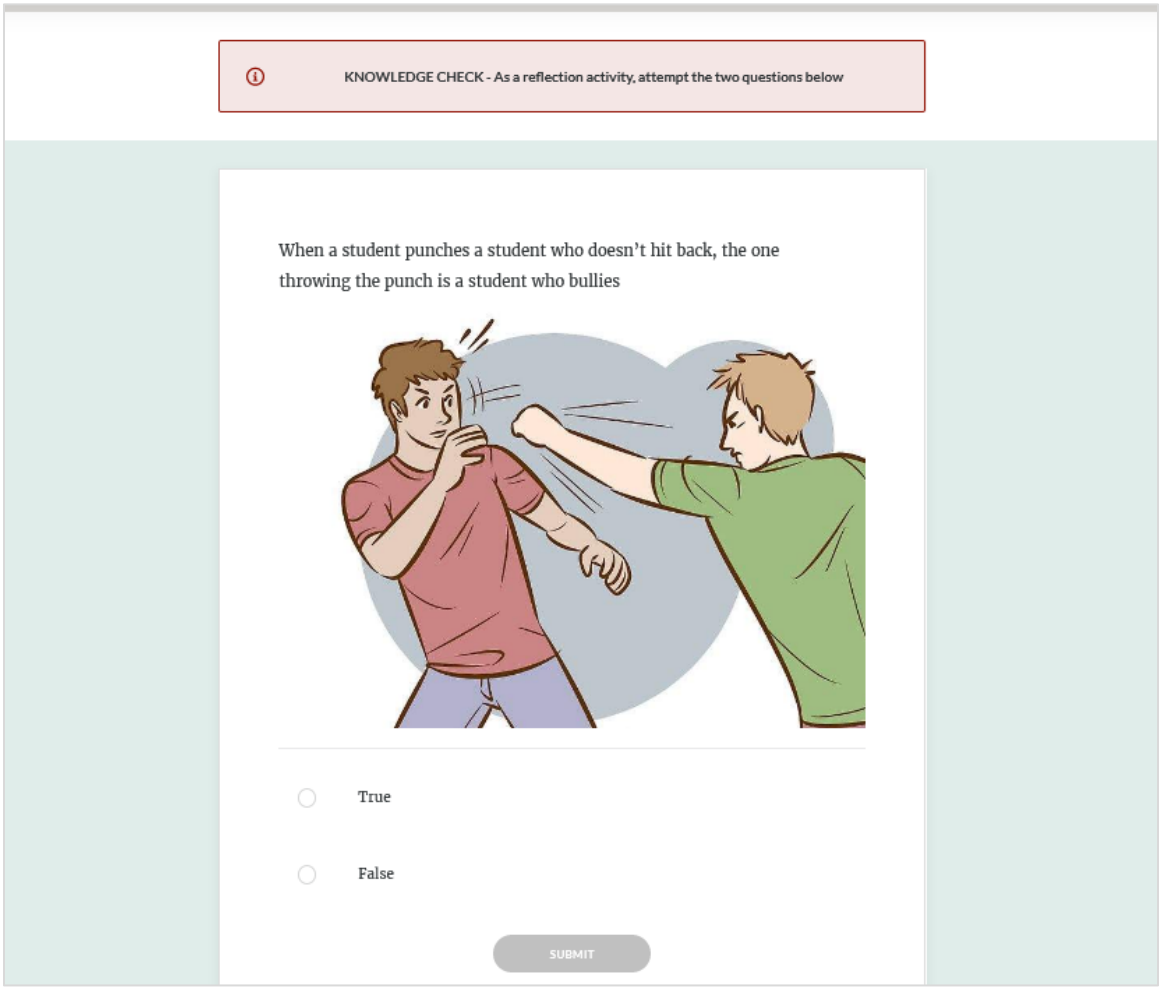
genuinely very upset. I was thinking about the students in my 1st grade classroom being bullied." Participant 11 shared similar thoughts, "Yes. I thought it was sad and an illustration of bullying." A concurrent view was shared by participant 8 who said, "I thought that it was a somewhat accurate portrayal of bullying. The child being bullied is crying and uncomfortable, and it seems that there are multiple students taunting him, leading it to be a repeated situation."

The sentiments expressed generally pointed to how well the concept or subject of bullying was meaningfully communicated to the point of evoking empathy in the learner using the accompanying graphics. However, some learners (Participants 1, 10, 12) were critical of the graphic, describing it as being exaggerated. Participant 10 stated, "It was definitely sad to look at but it seems as if the hands were photo shopped in, so the child wasn't actually crying because of the reason." Participant 12 had a similar viewpoint, "Honestly, I thought that this photo was corny and didn't actually capture the complete essence of bullying."

Another application of the first guideline was the use representational images within the knowledge check activities throughout the module. Knowledge checks consists of questions the designer embedded throughout the lesson sequence to elicit feedback of information presented to the learner, indirectly reinforce the concepts being presented and allow the students to integrate new knowledge by actively thinking about questions and attempting to respond.

Figure 7

Screenshot of Use of a Representational Image Within the Knowledge Checks Section of Instance



The knowledge check activities or in lesson practice tests were presented in a variety of ways using drag and drop tasks, multiple choice questions, short answers, sorting activities which cover the span of the taxonomy from lower order thinking skills to higher order thinking skills and were aligned to the overall learning objective. The variety of activities was a design decision the researcher made to create some degree of

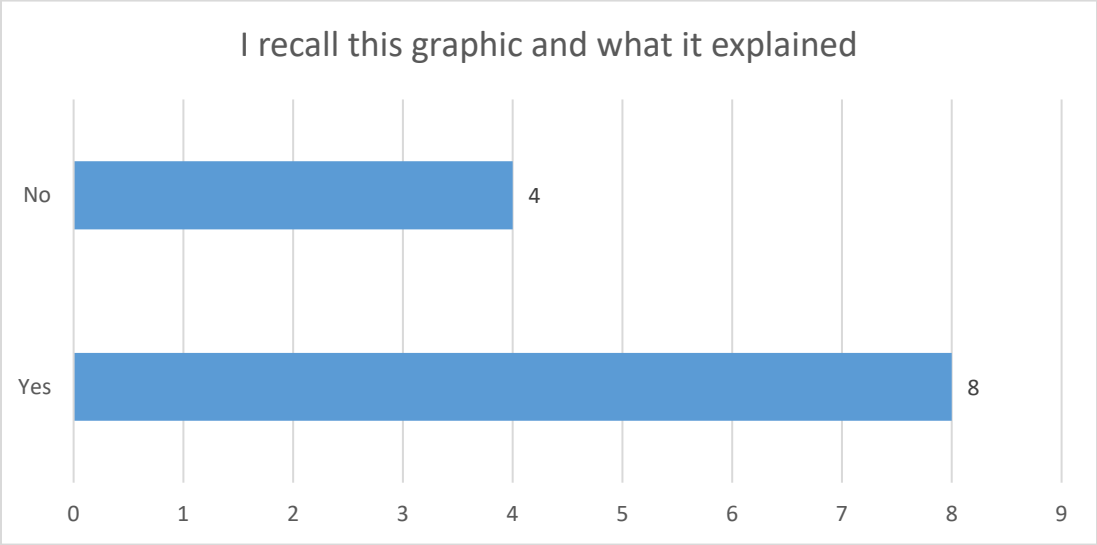
differentiation which makes the user experience less monotonous. Also, some aspect or scenes of the lesson utilized interpretative graphics to illustrate and make concepts clearer. Relevant graphics was presented alongside text for introducing the concepts of the lesson as well as during the practice and review activity sections of the lesson. Commenting on a chart used to explain people who are most likely to be bullied, participant 6 explained, “Yes I did notice this image within the lesson. It helped me perceive exactly what type of people get bullied.” Participant 7 stated, “Yes, I noticed the image. It provided a useful visual for understanding the content of the comprehension questions that followed.” Participant 12 commented, “it simplified the concept into a single image instead of a paragraph.” Most participants agreed that the graphics helped give a better understanding as well as visual representation of the information being presented in specific instances (Participants 3, 4, 8, 9, and 11), but not everyone was convinced the accompanying graphics did a great job of fostering their understanding of the text. Participant 2 noted, “Took me a second to understand the arrows being used as greater than and less than, but once I figured it out it was helpful.” Another participant noted, “It was kind of hard to follow at first glance, so I would use something that was easier to read.” (Participant 5). Few others appear to have glossed over the image as they went through the lesson, “I did not notice this in the lesson but looking at it now it helps break down the understand and factors of bullying…” (Participant 1).

When participants were showed some graphics used in sections of the lesson and asked if they noticed these relevant graphics and can recall what information they helped explain or how well it helped their comprehension of the presented material. Most

participants recalled the information presented together with those graphics, other simply could not recall or stated they may have skipped it during the lesson.

Figure 8

Survey Response of Participants for One of the Questions Related to Guideline 1



Guideline 2

Use animations to demonstrate procedures or to illustrate abstract ideas; Use a series of stills to illustrate processes.

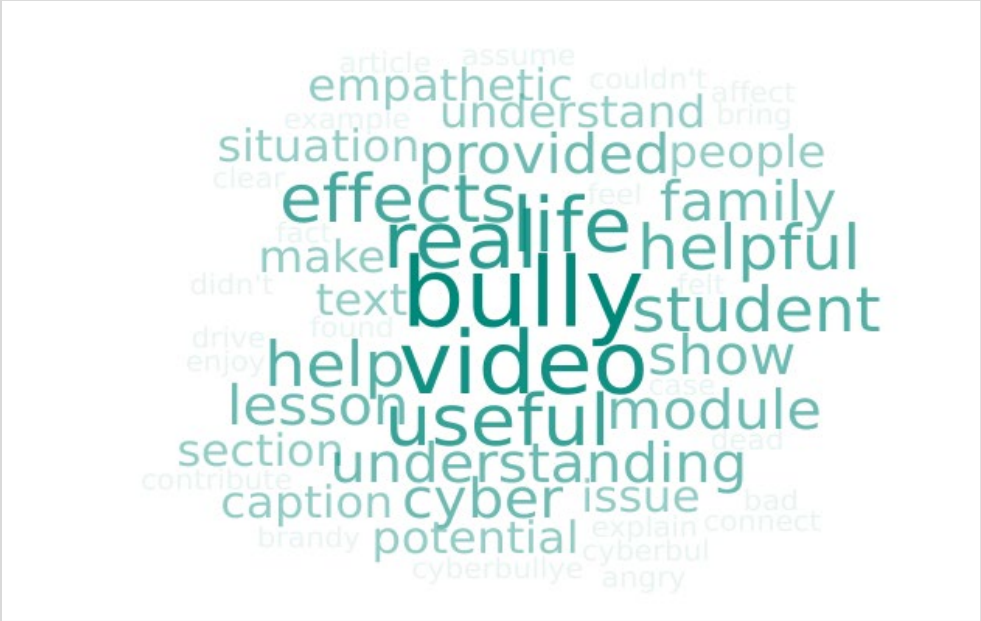
The designer (researcher) used a short video which was featured in a news broadcast illustrating an example of cyberbullying and the tactics people use. This was a good fit for this guideline as it illustrated the concept of cyberbullying, telling the story of an unfortunate real-life event. Also, several sections of the instance made use of a series of still graphics to illustrate some processes involved in bullying and steps to addressing bullying behavior.

What worked and did not work well? When learner feedback was sought regarding the use of the video to expound the concept of cyberbullying almost all the participant who went through the instance agreed that the use of animations was very helpful in their assimilation of the concept being presented. Here is what one student had to say, “Watching the video was useful in my understanding about the severity of bullying itself because it made it more relatable and made me feel empathetic.” (Participant 12). Others sharing similar sentiments, “The video was very impactful, bringing real life examples into the module really drives the point home.” (Participant 4). “This part of the lesson provided a time for me to really reflect on the impact of cyber bullying. I think it was a great tool to use for this part of the lesson.” (Participant 9). Participant 1 stated, “this helped my understanding because it was a real-life situation which helped me connect more with the facts that was in the module.”

Ignoring words such as bully and video which was reused from the question in most responses, The word cloud below was based on overall response to this item and shows descriptive words such as helpful, understand, impactful, empathetic as main or common words captured in the feedback from learners. The words bully and video appear because they were reused from the question in most of the responses.

Figure 9

Word Cloud Image of a Survey Response of Participants For One of the Questions on Guideline 2



One participant (participant 10) however did not comment at all on the impact of this video. Participant 5, commended the video as being a good preface to the issue of cyberbullying but still stated it did not help their understanding, “When a video is

presented within a slide, I usually ignore the text above it because of the size of the video. It didn't contribute to my understanding at all, but it was a good preface to the issues surrounding cyber-bullying."

Regarding use of series of still graphics, participants generally reported noticing the use of a series of still graphics to illustrate steps for addressing bullying behavior. When asked nine out of twelve indicated they clearly noticed the series of graphics and found them helpful.

Table 4

Participants Response to Question "I Recall This Series Of Graphics And It Helped My Comprehension".

#	Answer	%	Count
1	No	25.00%	3
2	Yes	75.00%	9
	Total	100%	12

Guideline 3

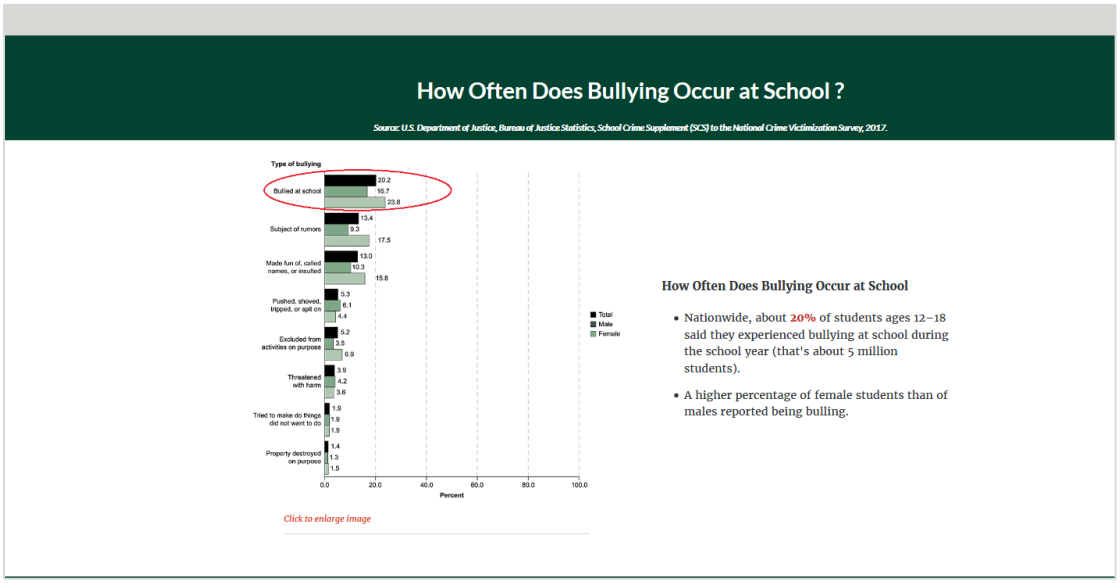
Use explanatory visuals that show relationships among content topics to build deeper understanding

The third guideline for implementation of the multimedia learning principles is to use explanatory visuals when presenting relationships among content topics to deepen understanding. One way the designer (researcher) demonstrated this within the instance

was by using relational charts or graphs, and a combination of signaling principle guidelines to help explain some relationships. By using cues that highlighted essential material, attention of learners was guided to some aspects of graphics that had relevant information.

Figure 10

Screenshot of Use of an Explanatory Image Within a Section of Instance



What worked and did not work well? Most participants expressed positive remarks about the use of charts and graphs to summarize quantitative relationships. Seven of the participants (1, 5, 6, 7, 8, 9, 12) agreed that the use of relational charts was beneficial to their comprehension and it helped them visually contextualize the information. Participant 1 shared that "the graphs are more compact than paragraphs, showed where bullying happens most." Participant 5 said, "The graph gave a clear indication of the seriousness of bullying within schools." Participant 12 stated, "This was helpful because I could visually see the impact in numbers instead of just reading and not seeing the impact visually." Participant 7 had similar comments, "It provided an effective visual for explaining where the most bullying occurs."

Upon a cursory look, the charts did not communicate effectively to some participants, the accompanying words helped clarify the context. As participant 11 stated:

> It made me feel like not many kids were being bullied due to the bars being on such a small scale. It was helpful to have the words next to this figure stating that 20% is 5,000,000 kids approximately.

Others expressed concern about the size and proportion of the graphs being misleading. Participant 10 commented, "It seems like bullying really is not that prevalent due to 14.9 just being so small and the bar so short." Similarly, Participant 4 noted, "…zoom in so the graph is closer because from just looking at it someone could think, oh that is a low number and the differences do not appear to be so much. In reality, they are shocking numbers." Few other participants did not like the use of charts finding them not as attractive or engaging enough. Participant 2 stated, "I think an info-graphic that was more

specific would be better." Participant 3 also pointed out, "I am very bad with bar graphs, but I think it did a fair job of representing bullying types. However, the picture and video examples were stronger and more memorable".

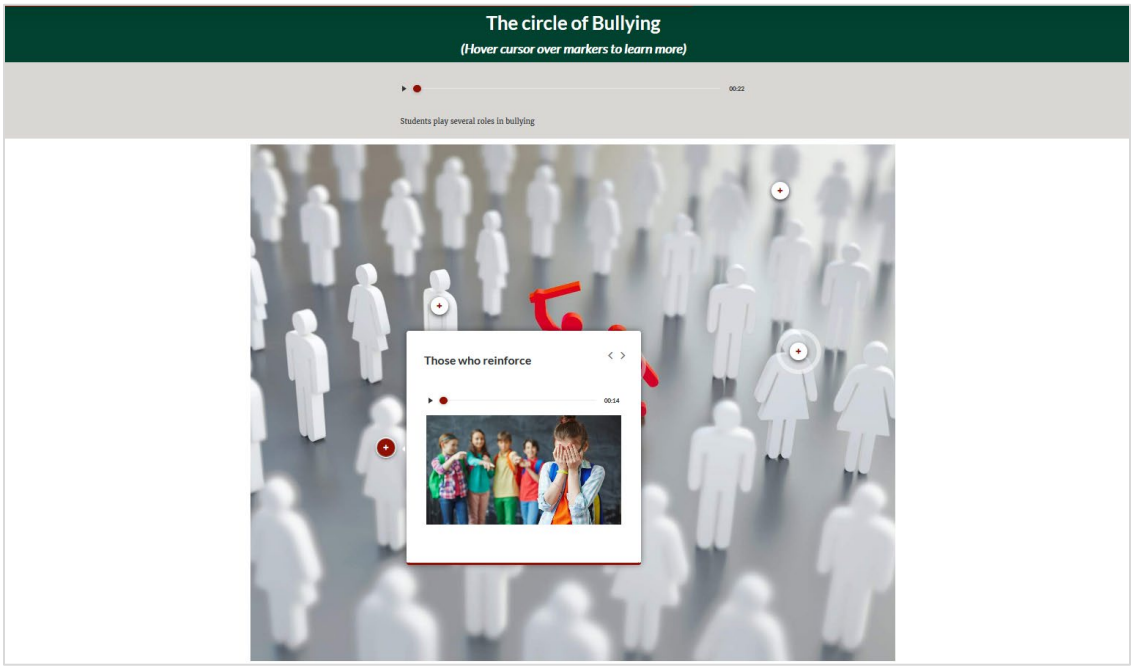
Guideline 4

Use interpretive graphics to explain how a system works or to illustrate abstract ideas.

The fourth guideline or strategy to implementing the multimedia design principle is to incorporate graphics that are interpretive, making use of a combination of static illustrations, charts, pictures, and/or dynamic graphics such as videos or animations to illustrate a phenomena or complex concept or system. The designer (researcher) created a section labelled the circle of bullying scene in which he used interactive graphics, still picture with accompanying narration (a blend of personalization principle with multimedia), short video clips alongside descriptive text placed next to each interpretive graphic in that scene. Other interpretive graphics were used sporadically in other sections of the instance.

Figure 11

Screenshot of Use of an Interpretive Graphic Used Within a Section of Instance



What worked and did not work well? The intent of using interpretive graphics is to encourage learners to engage actively by mentally making linkages between words and pictures to gain a better understanding of concepts which may be abstract or complex. After going through the module participant 5 noted, “I loved this interactive scene. I was very unfamiliar with bystander effects on bullying until I was able to picture visually a bullying scene like this one. I found this part of the module incredibly explanatory and helpful.”

Participant 3 stated, “I thought that the picture with the plus signs were very helpful, because it gave a specific visual of the situation.” In a similar vein participant 7 also

stated, “being able to click on each person to see the effect they had on the situation was helpful.” The ability to interact with the content by clicking on some icons, images and charts was a feature most participants enjoyed in this scene. Participant 10 also noted, “I liked scrolling over each person and seeing the roles of each, it was a good visual for what an actual bullying scene may look like.”

Participant 8 expressed similar thoughts, “The different icons that could be clicked on made this a visually stimulating image and made it easy to remember the key concepts that were being brought about.”

Although most of the participants agreed this interpretive graphics was helpful in contributing to their comprehension of the concept being presented in an engaging and stimulating manner, one participant indicated some frustration. Participant 2 noted, “This part bugged me because I had to keep clicking through it and playing the audio all the way through until it would let me go to the next page.”

Guideline 5

Use relevant graphics explained by brief audio narration to communicate content to novice learners (Multimedia & modality)

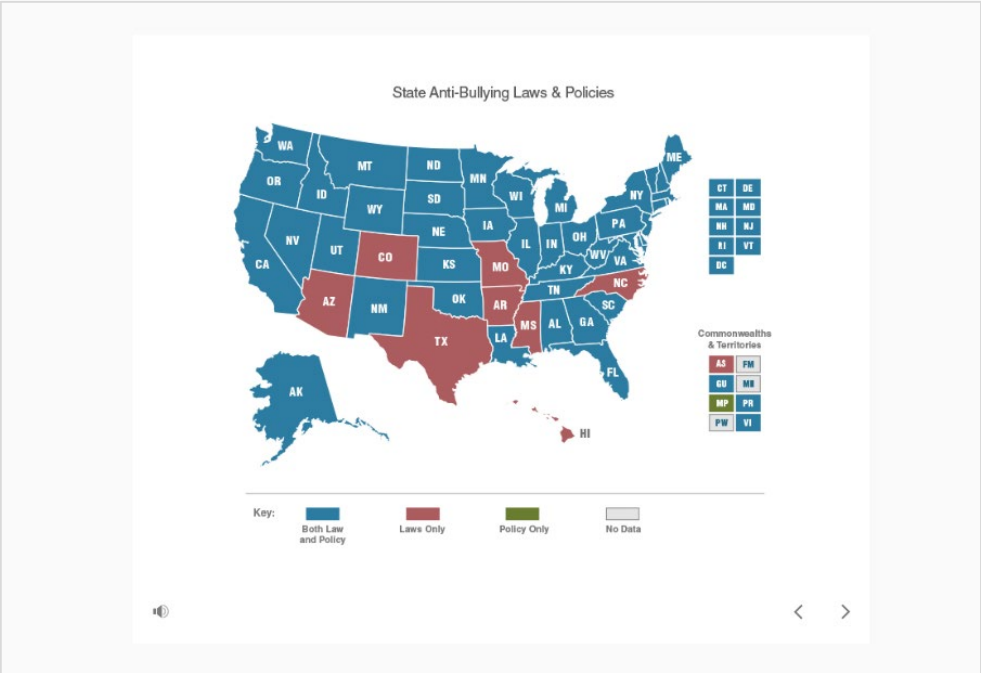
The fifth guideline or strategy combines the modality and multimedia principles and it is demonstrated by audio narrations and relevant graphics used to explain lesson content. The modality principle states that people learn better from graphics and narrations than from animation and on-screen text.

The researcher (designer) embedded a storyline block - a design functionality unique to the application used in the development of the instance (Articulate 360 design suite)

which allows the designer the option to create custom interactive learning elements. The researcher coded custom interactions to a relational graphic (map of US), adding overlays which allow learners to play narrations and read summarized text of specific anti-bullying laws for each state by hovering mouse and clicking on it.

Figure 12

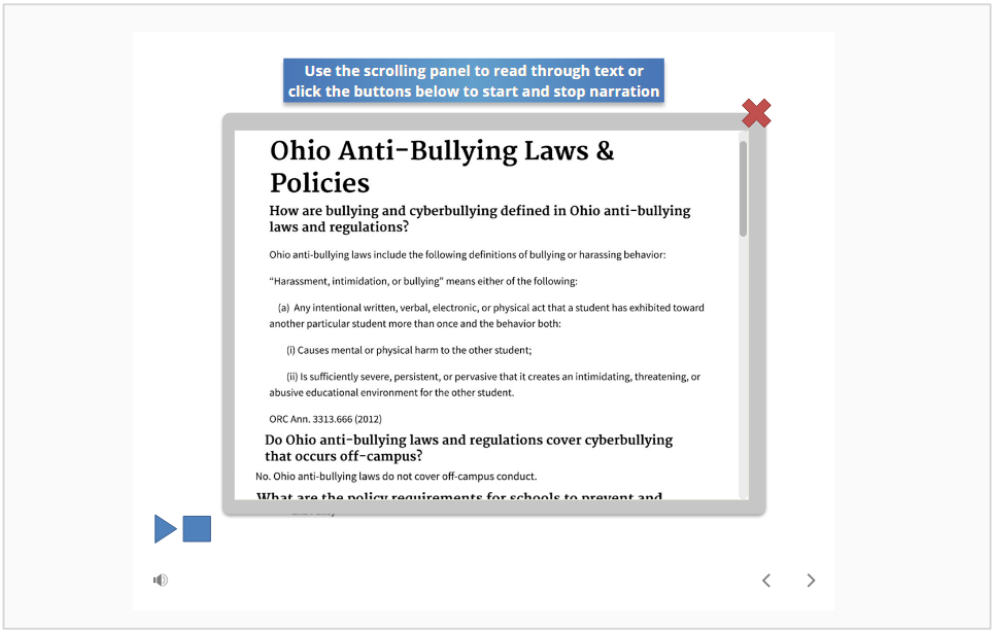
Screenshot of interactive map of US combining a relational graphic (multimedia) with narrations (modality)



The next figure shows the scene that displays when a user clicks on a section of the map, for example the State of Ohio.

Figure 13

Screenshot showing overlay of summary text with option to play narrations which are triggered by users clicking on sections of the map



The designer also added a process block - a design layout that features a carousel of images and utilized explanatory graphics and narration to explain the steps involved in addressing bullying behavior. By utilizing relevant graphics with narrations in a variety of designs and in different aspects of the instance, this guideline was applied.

What worked and what did not work well? When asked to comment on what elements were useful or not as learners went through sections of the lesson where this strategy was implemented, most of the participants acknowledged the graphics were relevant and helpful to their understanding of the information being presented. Participant

2 commented that the graphics made the text easily comprehensible particularly when reading about bystander and narrations were helpful. "It was cool to be able to look at the specific laws for Ohio, and the colored map really helped as well. I like the visual way of representing information better than just reading it." Participant 10 also felt the images provided a nice visual example which "painted a picture of what a 'typical' bullying scenario looks like", the participant also noted that the narrations was "useful, especially for people who may be vision-impaired or have a difficult time reading." Participant 5 also commented about legibility of text, "I liked this visual, but I struggled to read the font."

However, there was mixed reactions about the use of narrations accompanying the graphics. Participant 11 stated, "I think having narrations is a good idea. I personally did not use it, but I think it is still smart." Similarly, Participant 12 shared regarding usefulness of the narration. "I did not use it because I typically read faster and understand things better when I read them myself rather than listening to someone else read it." A few others skipped over the narration part as participant 7 noted, "To be honest, I overlooked the narration feature, so I cannot say whether or not it was effective or useful." Other learners noted, "I did not notice that there was a narration aspect for this part. If I would have noticed I probably would have used it instead of reading it" (Participant 9). Such as the case for participant 6, "I did not notice the narration of this until taking the survey."

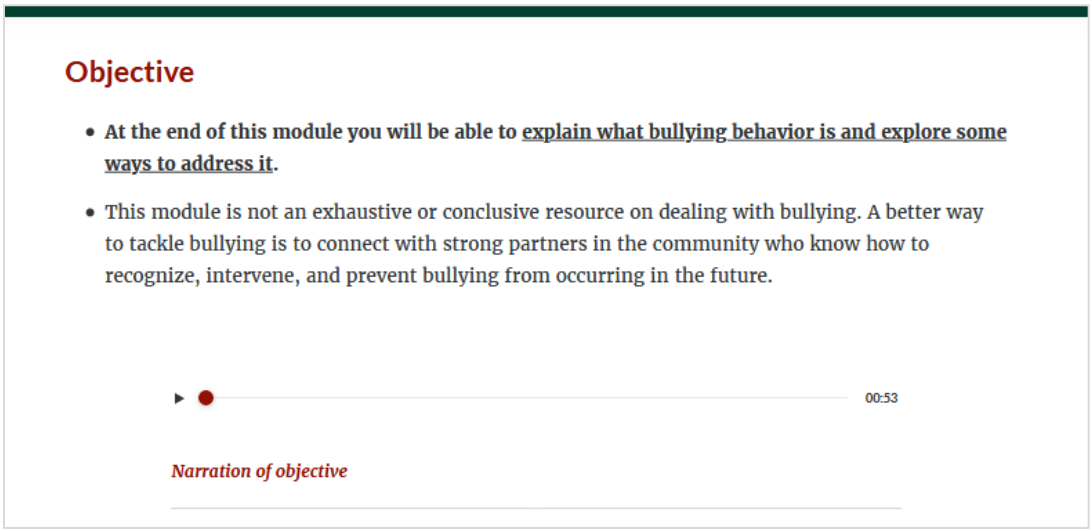
Guideline 6

Personalization: Voice and Text - Script audio or write text in a conversational style using first and second person

The lesson content was presented in simple and clear language with the text at an eighth grade reading level, avoiding use of technical terms or use of abbreviations without prior explanation in full terms. For example, instead of stating objectives in a format like this, "*at the end of the lesson, the student/participant will be able to explain what bullying behavior is…*" The designer captured or presented this within the instance in a conversational style (the use of you making it direct and personal) and included a narration of the text as well as shown in the figure 14 below.

Figure 14

Screenshot showing objectives written in a conversational style (with narration option)

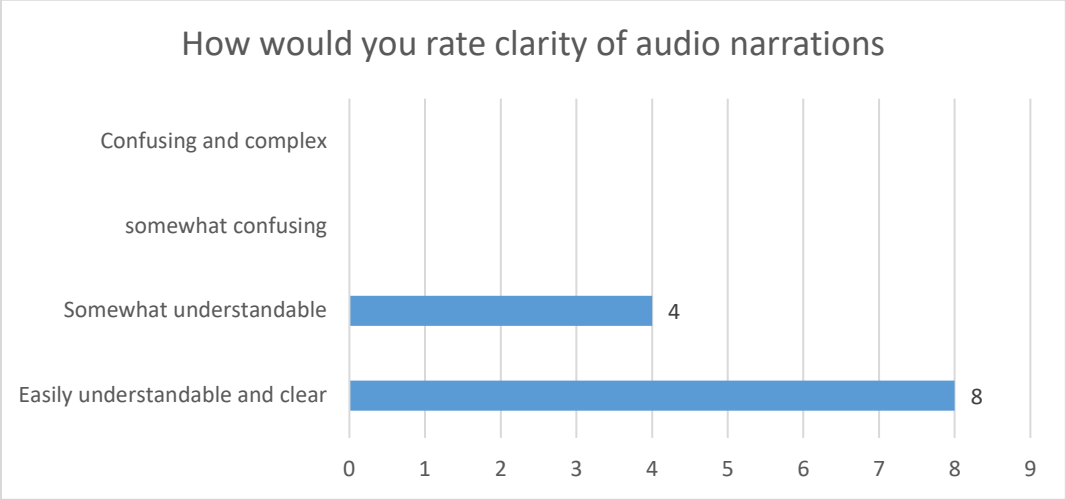


All voice scripts were read in human voice by the researcher and no computer-generated voice was used as the research in multimedia instruction claims it does not foster meaningful learning. Consideration was given to the diction, intonation and words were politely presented to learners in a conversational style.

What worked and what did not work well? Participants were asked to rate the clarity of text and audio narrations, choosing whether it was easily understandable and clear, somewhat understandable, somewhat confusing, or confusing and complex. There was a positive response by participants in agreement of how well they liked the narrations used throughout the instance. Most of the participants indicated how easily relatable and clear the audio narrations were. Of the twelve participants who went through the instance about 67% indicated the narrations were easily understandable and conversational in style with 33% stating the narrations where somewhat understandable (Figure 15) Some commented that a few of the narrations sounded as though they were whispered, as such was not easily heard. Others stated that the narrations were not easily seen or visible within the module, as such they initially missed it until they were prompted to return to play it before moving on to the next section. Their choice (somewhat understandable) was partly due to the frustration they faced locating the narrations within the lesson.

Figure 15

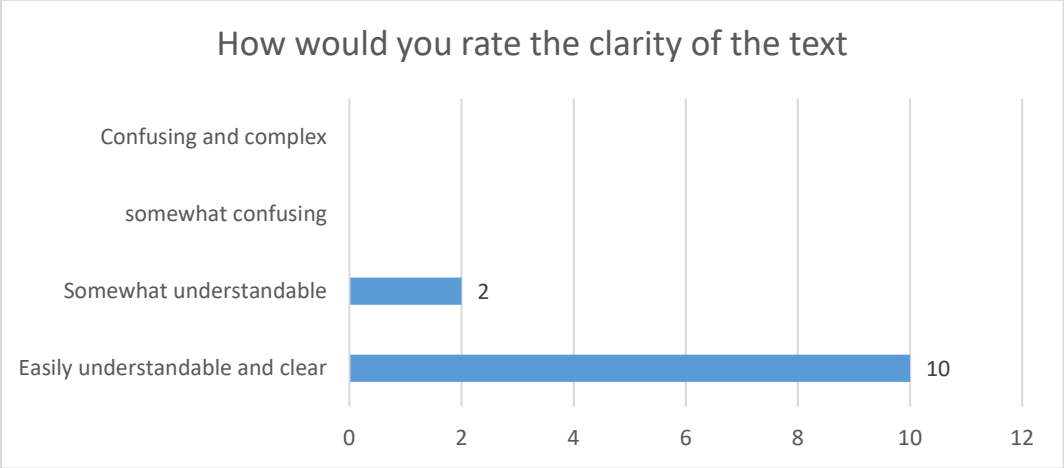
Chart of Learner Response to a Survey Question on Clarity of Narrations



Regarding text used in the lesson, almost all the participants commented on how easily understandable and relatable the text used throughout the lesson was. Only two participants stated the text was somewhat understandable citing instances where they felt some text was not very clear to them.

Figure 16

Chart of Learner Response to a Survey Question on Clarity of Textual Information



Focus Group Interview – Summary Findings

The focus group involved open-ended interviews with participants who were asked to share their overall learning experience, pointing out what was helpful or not.

> Researcher: First off, what were your general impressions about the module? I know you have put some information in the survey but if there is something you could not articulate well or additional details you want share, I would like to hear about that.

Participant 3 shared:

> I liked that there were the little knowledge quizzes after each section, because I feel like a lot of people would not read that and then not actually remember the information so like being forced to have to answer questions about what you just read helps you to retain the information that you just learnt.

Participant 4 also responded:

> I liked how interactive it was. You do not really see assessments like that throughout a module. They are so differentiated a lot, you are not doing the same thing over again, either you are matching things, clicking on different things, you are moving around, so it is never boring and keeps your attention.

The lesson presentation, organization and sequencing were one of the features about the instance which participants liked. The interactivity was also a feature that worked for most of them. Whenever a multimedia guideline was applied, they enjoyed it better if they were able to move things around, click through, type in text, or interact with the content in a way to reveal additional information.

Others had concerns about the format of the lessons, navigating some sections, volume or clarity of narrations, and nature of images used.

Participant 12 narrated that:

> When you used slides that you had to click through, there was often two or more ways of clicking through it and I felt that made it a little busy looking, so just having one way to do it, like one arrow that you just keep clicking that will make it easier to understand.

Participant 10 commented, “The press for audio, we often scrolled by the button that you were supposed to click for audio, it just blends in the background very easily.”

Body language and contribution of participants communicated keen interest although some appeared tired. No tensions were spotted, but there was crosstalk about some points of weakness being reported. In one instance, participant 1 commented:

> It would be nice to have closed captioning or transcripts of the video. I am not hard of hearing but for someone who is hard of hearing it would be nice to be able to read what is going on in the video.

To this participant 10 quickly pointed out that there was a transcription for the video. Participant 1 seemed to disagree, but this was possibly an omission on her part as there was a transcription. In such instances, the discourse served as a check and balance to enhance the quality of the data, a strength the literature points out for focus groups (Krueger & Casey, 2000, 2008).

The entire session lasted approximately 23 minutes. In terms of participation one participant did not have anything to say although the researcher strived to coordinate the conversations well. Two others did not talk extensively but simply concurred or disagreed with views that had been shared, and with one participant having to leave early that night, the discourse involved eight participants who were actively engaged. However, the focus group was helpful for the recognition of major themes (Krueger, 1994).

Participants Observation and Analysis

Prior to the date of the data collection, the researcher secured a computer lab to be used for the designed instance experimentation. The researcher ensured all the computers had headphones fitted on them and the required recording software.

About 30 minutes before the participants came in on the day, the researcher launched the recording software, which was used to capture learners screen activity, OBS Studio on all the computers and tested it. By 6:00 p.m. Eastern Standard Time (EST) all twelve participants had reported and, they exchanged pleasantries with each other. The instructor of this teacher education class welcomed them and introduced the researcher to the group. The researcher informed the group of the purpose of the research through their instructor earlier but still used the first few minutes briefing participants again of the purpose of the study and the different activities they would go through that night, which involved reading the participants consent form and indicating their willingness to participate or not. Then completing the online lesson on cyberbullying, as well as taking an end of lesson test, completing an end of lesson survey, and participating in a focused group interview session afterwards. The researcher took time to clarify that their role as participants or learners was to review the instance and critique it to help in improving the design guidelines that have been applied to the creation of the instance. Any weakness spotted or perceived by them was only a reflection of the application of the design principle and not their fault. They were thus encouraged to be thorough in reviewing the instance and critical to point out anything that did not help their learning experience.

Participants sat at the computers and launched the website having the online module. The researcher observed about four of them had their phones next to the monitor, and at one points participant 2 was spotted multitasking with the phone, either replying to a text message or typing something on their phone. During the instance, every participant appeared to be keenly focused on their computer screens and did not have conversations with each other. Participants 2 and 8 were the first to get through the actual lesson. They were seen to be scrolling and clicking through the lesson fast. This observation was corroborated with a review of screen video recordings (document analysis) which confirmed the same navigation pace. However, this did not necessarily translate to poor retention or transfer of information presented in the lesson. Participant 2 score on end of lesson review test was 78.95%, which was above the mean score of 75.26%. Participant 8 on the other hand had 64.74%, which was slightly higher than the score of the participant who completed the lessons last (Participant 11), so it cannot be simply assumed that time on task translates to higher learning outcomes as evidenced by test scores.

The researcher observed the narrations sections within the instance was skipped by a few other participants, as the researcher noticed them coming back to click through it after they encountered a practice questions within the lesson or were restricted from proceeding in lesson (Participants 5, 6, 9). Besides these, the group seems well coordinated and cooperative. There was about 15 – 20 minutes wait time to enable all complete the lessons before the focused group session started. The researcher observed participants were engaged and shared their experiences during the focused group session well (See Appendix B).

The last part of the chapter presents results of test which assessed learner's retention and recall of the lesson content (cyberbullying) as a demonstration of learner's comprehension of the informational content presented in the instance.

Participants Test Score Results

Participants completed practice test during various sections of the lesson and a review test at the end of lesson. The practice tests allowed multiple attempts and offered explanatory feedback after each attempt, the review test allowed only one attempt and learners did not receive any feedback on those attempts. There were twenty practice questions within the lesson and nineteen review questions at the end of the lesson. Question in both practice and review tests covered areas in the instance where the guidelines for multimedia learning principles had been applied to the content. Different question formats were used for both tests such as multiple-choice questions, short answers, drag and drop, matching and sorting activities, true or false questions, etc. As noted earlier, this variety of activities was a design decision the researcher made to create some degree of differentiation, reduce monotony of the browsing experience, but keeping the overall lesson sequence standardized. Multimedia was incorporated in a few of the questions. The test scores were numerically coded into a file system and analyzed using a Microsoft Excel spreadsheet. The quantitative data is presented in the table below.

Table 5

Participants Test Scores and Completion Time.

Participant	Practice test score (out of 20)	Review test score (out of 19)	% score for review test	Time spent on instance
Participant 1	17.66	12.50	65.79%	29 mins
Participant 2	13.46	15.00	78.95%	20 mins
Participant 3	14.86	10.50	55.26%	31 mins
Participant 4	14.57	18.00	94.74%	43 mins
Participant 5	8.91	14.25	75.00%	24 mins
Participant 6	15.36	13.95	73.42%	22 mins
Participant 7	12.46	16.70	87.89%	25 mins
Participant 8	12.91	12.30	64.74%	21 mins
Participant 9	15.60	16.00	84.21%	24 mins
Participant 10	12.67	16.87	88.77%	27 mins
Participant 11	16.41	12.12	63.77%	56 mins
Participant 12	12.88	13.40	70.53%	35 mins

Time on Task

The efficiency of the design knowledge being evaluated is a function of different measures of cost and time in development or instructional time. The time on task learners spent completing the instance a measure of the efficiency of the module which is focused on here. The designer estimated a completion time of 40 minutes for the instance and about 12 minutes for the end of lesson survey. The participant with the highest score did spend 43 minutes on the instance, however it appears most learners completed the instance faster than estimated. Mean completion time was about 30 minutes.

Table 6

Time Spent in Minutes by Learners in Completing the Lesson as Well as the End of Lesson Survey

Participants	Completion of instance (Lesson + review test) (mins)	Completion of end of lesson Survey (mins)	Total Time spent (minutes)
Participant 1	29.44	10	39.44
Participant 2	20	11	31
Participant 3	31	10	41
Participant 4	43	16	59
Participant 5	24	11	35
Participant 6	22	12	34
Participant 7	25	15	40
Participant 8	21	11	32
Participant 9	24	10	34
Participant 10	27	13	40
Participant 11	56	18	74
Participant 12	35	11	46
Mean	29.79	12.33	42.12

Categorizing the Findings

This section presented a summary of the findings based on learner feedback of what worked and what did not work. Due to the nature of the study, the analytic approach that led to establishing themes was based on what worked well and what did not work well. The guiding questions which served as a categorizing technique for the chain of evidence gained through learner feedback. In determining the overall impression of learners' reaction towards the instance, the researcher asked participants after completing the module, about what aspects of the module they liked the most (what worked) and what can be improved (what did not work well). Some key data excerpts that were later linked to specific codes have been extracted from the findings and presented here as a conclusion of this chapter.

Participant 4 indicated, "I like how engaging the lesson was. Although I was eager to get done with and head home for spring break, it wasn't boring so I could stay focused through out, I feel the interactive nature helped." Similarly, participant 7 shared, "I like the different interactive ways to learn about the topic." Many others pointed out the interactivity used throughout different scenes of the lesson was a feature they liked about the lesson and their learning experience (Participants 2, 5, 12). Some participants also enjoyed having graphics in the form of still pictures and videos or short animations used throughout the lesson (Participants 1, 5).

Others stated after completing the module that the lesson was informative, and they had a good comprehension of what was presented which is what they liked about the lesson. The fact that they grasped the information it contained (Participants 8, 9, 10)

Another characteristic most participants liked was the concise nature of particularly text-based information. The lesson sequencing where information was presented using both graphics and text, with examples given, followed by brief knowledge checks in the form of practice questions, and some additional information or examples presented as a summary of each segment of the lesson was an enjoyable, very manageable presentation format as many participants reported (Participants 3, 6, 11). As participant 11 sums it up, "I liked the range of information provided in the lesson. I like the use of charts and the knowledge checks because they hammered in the information that was previously provided.

Regarding what did not work, participants were asked to comment on aspects of the instance that can be improved based on what they did not like or would have wanted to see. The feedback broadly touched on nature or presentation of text-based content, use of graphics (still pictures and videos), clarity of instruction, and narrations. One had no comments at all. Some participants commented on the parts of the module which had large paragraphs of text only information, stating it should be condensed if possible, and key words highlighted for easy and fast reading (Participants 5, 6, 9). Participant 5 suggested, "More bolding on specific texts that are important so that it could be easily spotted and comprehended". Commenting on the use of graphics (still pictures and videos), some participants (Participants 1, 3, 10) noted they will prefer having more pictures and video and one did not particularly like the use of emojis. Participant 1 commented, "Use a lot of the images and graphs. Some of the images even made me chuckle like the cop emoji and downplayed the seriousness of lesson". Citing a similar

concern, participant 3 describe some graphic illustrations as “Poor visuals that distract as much as they can aid.” Another called for more examples of knowledge areas presented in the lesson, stating “the use of more examples could make some examples easier to understand” (Participant 10).

Some others commented on clarity of instruction which bothered on unclear guidelines, or typographical errors in some text. As participant 2 noted, “Some of the directions were a tad unclear at times, I had to go back to re-read a few times and there were just a few typos and other than that I thought it was very nicely set up”. Participant 11 commented:

> I think that some of the questions were confusing, because I did not know if I should choose one answer or multiple. I think if the question said, "choose one" or "choose all that apply", that would clear things up.

Three others had comments about the narrations, citing difficulty in clearly noticing the audio player or control buttons as well as difficulty hearing some narrations. Participant 7 noted, “…in my opinion, I feel like the audio during the narration was rather quiet.” Another stated a preference for more narrations even for the areas with review questions, “I am more of an auto learner. Also, I am not the best reader so maybe just an option when it comes to test questions someone could read them aloud.” (Participant 4). Learner control and autonomy regarding the use of narrations was another concern. The lesson instance required learners to go through all sections and click through each media before a learner was permitted to move further. Participant 8 felt the audio feature should be made optional and lesson progression unrestricted.

Chapter 5: Discussion and Conclusion

The purpose of this study was to examine how the multimedia learning principles, specifically the principles for optimizing generative processing hold up based on learners feedback, when applied to the Instructional design of online courses as an attempt to improve the application of the theory or by extension the theory.

This chapter first presents a discussion of data analysis results associated with the research questions for the study to identify the strengths and challenges of implementing multimedia learning principles in an online course, implementations of the design theory that worked or did not work, and possible improvements that can be made to its application. In addition, this chapter addresses the implications of the findings, limitations of the study and finally offers suggestions for future research.

The study used a qualitative research methodology - formative research, to investigate and answer the following research questions:

1. What are the strengths and challenges of implementing multimedia learning principles in online courses from the perspective of the instructional designer?
2. What implementations of the multimedia learning principles in the design instance worked well and did not work well based on learner feedback?
3. How can the application of multimedia learning principles be improved based on learner feedback to support online learning?

The researcher designed an instance of an online informational lesson (on the topic Cyberbullying) for teaching pre-service teachers as a specific instantiation of the multimedia learning principles. The development lifecycle of the instance spanned about

seven months from August 2019 to February 2020. Twelve (12) preservice teachers were recruited as participants to critique the instance to evaluate the multimedia learning principles.

The results of research question three are presented as plausible recommendations following each guideline that is discussed under research question two. The data analysis results presented earlier and discussed in this chapter is based on participants' one-time use of the design instance on cyberbullying with an average usage time of thirty minutes. The researcher as a designer also reported on the challenges and strengths related to the implementing of the multimedia learning principles. This served as another data source. The discussions are done within the context of existing research literature and recommendations offered at the end.

Research Question 1

What are the strengths and challenges of implementing multimedia learning principles in online courses from the perspective of the instructional designer?

The researchers' notes during the development lifecycle of the instance, as well as information based on his experience as an instructional designer which was presented in the previous chapter is summarized and discussed in this section. The following strengths were noted:

- A rubric that maps design principles to instruction
- Access to advance design and development technology
- Access to a Community of practice
- Clearly identifying the instructional goal

- Performing evaluation and revision

The points noted as strengths offer some guidance and support to the instructional designer when applying design principles such as the multimedia learning principles. Although these are not exhaustive, they are measures that proved helpful to the researcher in this study.

The following challenges were noted:

- Demonstrating competence of the knowledge areas (Multimedia Learning principles) and making sound design decisions.
- Cost of resources
- Staying current with research and skills
- Intent versus implementation
- Short of tight deadlines
- Loosing focus of the learner in a bid to apply principles

The researcher found that a designers competence in the design principles being applied was critical for success, considering the multifaceted nature of design decisions to be considered during a designers workflow, this finding concurs with Khalil and Elkhider (2016) view that a lack of the knowledge base can affect the quality of instructional materials that are produced. The cost of resources; design applications or software, cost of hiring professional media specialist or creating high quality instructional materials can become a challenge that affects design choices when implementing design principles.

The pace of technological advancements and research in learning design has created a tough situation for designers to be on the cutting edge. The challenge

instructional designers face lies in their ability to remain current, balancing the tensions, and seizing opportunities for growth and professional development through formal and informal training (Yanchar & Hawkley, 2015). Another challenge the researcher cautions against is the possibility of a designer getting indulged in the quest to apply all relevant design principles in their work that they lose focus of the learner (Reigeluth, 1999). These factors tend to also contribute to intent versus actual implementation dilemma which is another challenge the researcher noted.

Research Questions 2 and 3

The discussion for research question two is presented according to the guidelines for the multimedia learning principles that were implemented in the design instance. The results of research question three (***How can the application of multimedia learning principles be improved based on learner feedback to support online learning?***) are presented as tentative recommendations following the discussion of what worked and did not work for each implementation of the multimedia learning principles.

Research Question 2: What implementations of the multimedia learning principles in the design instance worked well and did not work well based on learner feedback?

The set of guidelines focused on for this study fall under the principles that foster generative processing in multimedia learning. According the Mayer (2009), multimedia principle, personalization (voice and image) are the main techniques which help guide learners cognitive processing, so they are able to make meaning of material presented in lessons by organizing the content presented into coherent structures and integrating with prior knowledge.

Discussion and recommendations of the multimedia learning principles that worked well and did not work well as used in the design instance for this study are organized by the guidelines/strategies.

Guideline 1

Use relevant graphics to accompany text for novices.

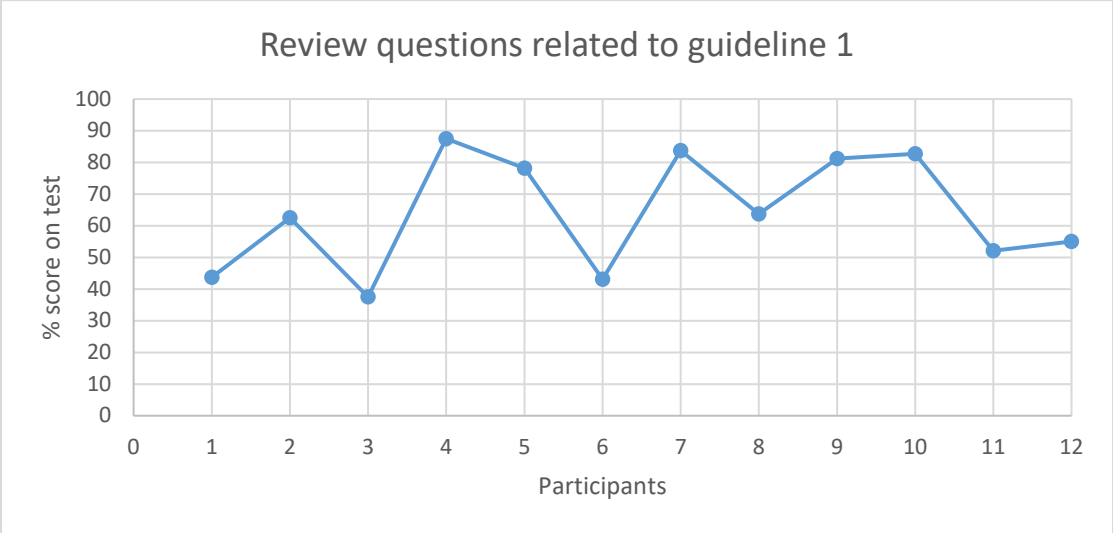
The first guideline to use relevant graphics to accompany text for novices was mainly applied in three sections of the design instance. A graphic depicting a boy crying and several hands pointing at him was used in the introductory section that explained bullying behavior, a series of still images used to explain cyberbullying prevention tips in a form of slide show, and an infographic showing people who are mostly at risk of being bullied. All the participants indicated noticing these applications except for three who confirmed not to have noticed one of the applications as they went through the instance. Generally, most of the participants seemed to like the use of relevant graphics to accompany text in the design instance. Nine out of the twelve shared this opinion, stressing on how well the graphics reinforced the concept being presented in text to the extent of evoking empathy in some. When graphics which serve instructional purposes are used in multimedia instruction, exposure to such relevant graphics (multimedia) can subtly guide the learners, trigger an emotional commitment which sustains interest and reduce monotony (McGreal & Elliott, 2008). This can help learners construct mental models that make sense of the material presented as measured by subsequent test scores.

The results of review test associated with this guideline shows meaningful learning occurred to an extent. Test scores related to this specific guideline had a

minimum score of 37.5% and a maximum of 87.5%, with a mean score of 64%. This was comparatively low but not insignificant or dismissive of the effectiveness of this guideline. The line chart below shows the range of scores for the twelve participants.

Figure 17

Plot of Participants Test Scores on Sections Related to Guideline 1



Some researchers have criticized the role of graphics in creating emotional attachment for learner. The effect has been termed emotional-grabbing adjunct. This preposition stems from the arousal theory (Garner, Gillingham, & White, 1989; Renninger, Hidi, & Krapp, 1992). They argue that it may not necessarily translate to meaningful learning or cognitive interest, especially when such graphics are merely decorative. However, analyzing this specific guideline within the design instance the results of review test of the application of the guideline shows learners may have processed essential material well, an indication which is consistent with evidence that some meaningful learning

occurred (Clark & Mayer, 2016). It must also be noted that this guideline is particularly helpful for novice learners who may require more guidance than high-knowledge learners. From this perspective the first guideline seemed to be effective however, care must be taken as Mayer, Heiser, and Lonn (2001) assert, when interesting but unrelated graphics are used excessively it may only lead to less understanding.

Relevant graphics were also used during practice and review test sections of the instance. As Clark and Mayer (2016) noted, "relevant visuals are one powerful method to support psychological engagement in the absence of behavioral activity" (p.73). Accompanying these questions with relevant graphics is a proven way promoting deeper cognitive processing and this was another way the guideline was applied throughout the instance to ascertain its impact on learners.

Recommendations for Guideline 1

In terms of improving the first guideline - use relevant graphics to accompany text for novices, in one instance the graphic used was representational, it also attempted to serve an interpretive purpose to illustrate the concept of bullying. For such an informational based lesson, this single graphic did not necessarily help their understanding of the material as some learners reported (participants 1, 10, 12). Learners reported it conveyed a stereotypical idea of bullying and does not fully capture the evolving nature of bullying and could be done better.

For the design instance, the application of this guideline could be improved by using a video or multiple graphics showing contextually different examples preferably involving human subjects and not clip art, sketches, or comic designed characters.

Learners quickly spotted images that appear doctored. The use of varied examples will extend the understanding of the concept being presented in a broader sense instead of a single relevant graphic in the introductory scene. A preference for realistic graphics or videos was stressed by the participants in the focus group session as well. Although some literature suggest schematic animations or graphics are more effective (Scheiter et al., 2009).

Guideline 2

Use animations to demonstrate procedures or to illustrate abstract ideas; Use a series of stills to illustrate processes.

An animation was used to illustrate the idea or concept of cyberbullying and its related effects. In one area of the instance this was done with a short video clip featuring a news broadcast of a teenager who committed suicide because she was cyberbullied. This real-life example was sequenced in the lesson within the cyberbullying section of the instance. Almost all participants reported enjoying the video and felt driven to find out more or challenged to stand up against bullying. As participant 8 noted “It made me intrigued to learn more about the issue to prevent it.” In terms of increasing motivation and potentially meaningful learning, this finding supports Mayer’s and Chandler’s (2001) claim of the benefits of animated multimedia and learner control. The video had controls which afforded learners to chance to pause, stop or playback. The additional learner control over the animated multimedia has been noted to alleviate cognitive load, boost motivation, and improve learning.

Learners test score for practice and review questions that tested knowledge areas covered in sections this principle was applied showed a maximum score of 100% (participant 4), a minimum percentage score of 30% (participant 8) and a mean score of 68% based on the twelve participants. Although most literature report animations to be more effective when the content is procedural (Hoffler & Leutner, 2007; Lowe & Schnotz, 2015), the animation used in this study's instance, which was based largely on informational content proved effective and helped illustrate the concept of bullying to almost all the learners based on review test scores.

Table 7

Participant Test Score for Review Questions Related to Guideline 2

Participant	Percentage score (%)
Participant 1	63
Participant 2	90
Participant 3	50
Participant 4	100
Participant 5	73
Participant 6	67
Participant 7	90
Participant 8	30
Participant 9	87
Participant 10	77
Participant 11	33
Participant 12	60

This study used both animations and series of static graphics, it did not compare the use of one versus the other since there is no evidence to suggest animations are more effective than static diagrams in multimedia lesson (Mayer, Hegarty, et al., 2005). The interactivity principle was combined with animation in this guideline (Betrancourt, 2005). A series of still graphics were also used in the instance to explain the circle of bullying and roles played by bystanders, and in another section to explains the steps

involved in addressing bullying behavior. The combination of interactivity and animation allowed the learners some degree of control to manipulate the animation which helped them discover and visualize phenomena presented. Test and survey responses indicated this was helpful to most learners for the retention of information where the series of graphics or animation were applied.

Recommendation for Guideline 2

When asked to comment on ways to improve the application of this guideline, two participants stated during the focus group discussion that video/animations should not replace text as some learners would still prefer to read. The other commented on ensuring that the right disclaimers are given within lesson instance always for learners who may have motion sensitivity. Both comments relate to accessibility and user experience (UX) and this is a real concern (Head, 2015).

Designers must be purposeful to design with accessibility always in mind. Offering transcripts for videos, closed captioning, giving learners (users) the option to control the video or animation, using simple and consistent layouts, simple sentences presented as bullets as opposed to a block of text, using simple colors instead of bright contrasting colors are simple but useful ways to address some of these concerns. Designers must be aware there may be learners with anxiety, low vision, hard of hearing, dyslexia, among other disabilities, as such must strive to design for accessibility.

Guideline 3

Use explanatory visuals that show relationships among content topics to build deeper understanding.

According to the research evidence on multimedia learning and cognitive theory, online courses that combine words and graphics instead of words alone allow learners construct verbal and visual mental model and build connections between them (Mayer, 2001, 2009). Seven participants indicated the use of explanatory visuals in the form of graphs, interactive maps and charts helped their comprehension of the topic. They seemed to have a better visualization of the relationships being explained just be engaging with the graphics. This finding agrees with the perspective of some researchers on how interactive explanatory multimedia in learning environments can improve meaningful learning (Puntambekar et al., 2003; Rouet, 2006; Rouet & Potelle, 2005). The explanatory graphics used in the instance were presented in both a pre-determined format as well as an interactive multimodal format. In two sections of the instance the explanatory graphics presented slight interactivity in the form of controlling, navigating, and manipulating (Moreno & Mayer, 2007).

In one graphic, learners could click on sections of a pie chart, causing changes in the graphic that highlighted specific sections, showing quantitative and descriptive information related to it. In another multimodal interactive graphic, learners were able to click on parts of a map to trigger specific content in the form of narrations and accompanying text related to the part of the map clicked. These interactive explanatory visuals did not only show relationships among content but allowed minimal interactivity,

which was a very likeable feature as reported by most learners. Data from test result support their qualitative responses with a mean percentage score of 89% on the review test of knowledge areas covered in sections this principle was applied. This reflects positively on the effectiveness of the application of this guideline.

Recommendation for Guideline 3

Three participants did not find the visuals on their own too helpful, stating concerns about the size of the graphs being small, although all the graphics could be enlarged by clicking on them. It is likely those participants missed that. However, they mentioned the text next to those graphics was what helped their understanding and recommended such design practice of always including explanatory text next to graphics be encouraged. This finding supports Moreno's and Mayer's (2000) contiguity principles and learner-centered approach to multimedia instructions which proposes presenting pictures and corresponding relevant text near each other. By consistently integrating explanatory text close to relevant explanatory visuals, learners who did not find explanatory visuals very helpful were still guided to build deeper understanding using the text.

The other learner recommendation for improvement focused on making important guidelines clearer to avoid learners missing elements of the instruction or feeling confused. For example, where explanatory visuals have additional features to allow learners to interact with the visuals, prompts to inform learners of these features must be presented in a clear and consistent style. One learner also stated a preference for motion

graphics (video or animation) over static graphics for explanatory visuals used to show relationship among content topics.

Guideline 4

Use interpretive graphics to explain how a system works or to illustrate abstract ideas.

Participants stated the interpretive graphics used in the instance was helpful. They felt concepts such as bystander effects on bullying was clearly explained and enjoyable going through those sections. One interpretive graphic section in the instance featured graphics, narrations, text and combined multimedia and personalization principles to explain some concepts of bullying. Some participants shared how the interpretive graphics made the concept of bystanders realistic and concrete. The goal as Clark and Mayer (2016) put it, "is to incorporate graphics that help the learners understand the material (called transformational and interpretive graphics)" (p. 72). This was the designer's intent in creating the circle of bullying as an interpretive graphic scene to unpack relationships or abstract ideas presented.

Learners reported that the graphic was visually stimulating and made the concept easy to understand. There was significant positive feedback from almost all the learners (participants 1, 3, 4, 5 ,6 ,7, 8, 9, 10, 11, 12) regarding the usefulness of this principle's application and an investigation of test results regarding areas of the instance that applied this principle showed eleven out of the twelve scored 100% and one learner scoring 50%, giving a mean score of 96%. The application of this guideline was thus effectiveness and had features which appealed to learners. The interactivity of the interpretive graphic seemed to be the most liked characteristic for this graphic per learners' feedback. This

feature deals with visual appeal and engagement which aligns with the cognitive engagement constructs, a critical factor for success as identified within Webster's and Hackley's (1997) framework for effectiveness in online learning.

Recommendation for Guideline 4

The research often discusses interactivity along a continuum with varying functions of learner control and multidirectional communication in bimodal environments (Anderson, 2008; McMillan, 2002). One participant pointed out a feature used with the interpretive graphics that to them was a weakness. Learner navigation of the various elements in that section and most of the instance was restricted or locked, to the extent that a learner could not skip through scenes but had to at least click through every page, listen to or at least play every audio or video before being allowed to move to the next page, to participant 2, that was frustrating and did not aid their learning.

Such learner feedback suggests the need for more probing. Are there negative effects to the application of this guideline or multimedia principles in general when learner autonomy is restricted to an extent? Questions such as this may be suitable for further research.

For this instance's application of guideline 4, a recommendation of allowing learners autonomy, even at a minimal level of unrestricted lesson navigation and controls may foster meaningful learning for some learners. Within the constructivist and connectivism learning domains such affordances for learners gained through interaction establishes contact with the instructor or learning media within online learning environments (Anderson, 2008; Reinders & Hubbard, 2013; Shank, 1993).

Guideline 5

Use relevant graphics explained by brief audio narration to communicate content to novice learners (Multimedia & modality).

This guideline combines the multimedia principle with the modality principle and was applied in several places within the design instance. A map of the US used as a relevant organizational visual with interactive overlay effect which triggers a narration and transcript of antibullying laws specific to Ohio, the narration effect is user controlled. This graphic thus allowed learner the option engaging the content as graphics together with narrations (modality principle) and also was an application of the multimedia principle since text and images were combined consistent with the literature (Mayer & Moreno, 2003).

There are some overlaps regarding the application of these principles where one relevant graphic, series of graphics or animation may be applicable to more than one guideline, in such cases tentative improvement prescriptions may also overlap. At least two other sections of the instance incorporated a blend of the modality and multimedia principle such as the section on circle of bullying (which also applied to guideline 4) and short animation on real life example of bullying (which also applied to guideline 2). There was a section with a graphic used metaphorically to convey the notion and importance of perspective in addressing bullying situations which also applied this guideline. The score of review test usually measures an aspect of effectiveness of the application of the guideline (Reigeluth & Frick, 1999). This guideline was effective in

this regard based on participants performance on test items that focused on areas where the guideline was implemented. Learners on average scored 83%.

Recommendation for Guideline 5

Participants seemed to like the use of relevant graphics with text to explain key information as well combining the use of narrations and graphics, however five of them did not use this feature at all, citing reasons such as personal preference for reading text to themselves rather than listening to it being read, others completely overlooked or missed the narrations.

Prescriptions for improvement of the guidelines for the multimedia and modality principles based on learner feedback includes ensuring the font size of text or transcripts are bold and legible. If it is possible to allow the font size to be adjusted as part of the functionality of the module, that would be a great accessibility feature addition and will enhance the experience when this guideline also. Drawing some linkages to the interconnection of success factors in figure 1, this recommendation can fit under the course design factors, such as interface design which fall under the social constructivism in the figure.

Guideline 6

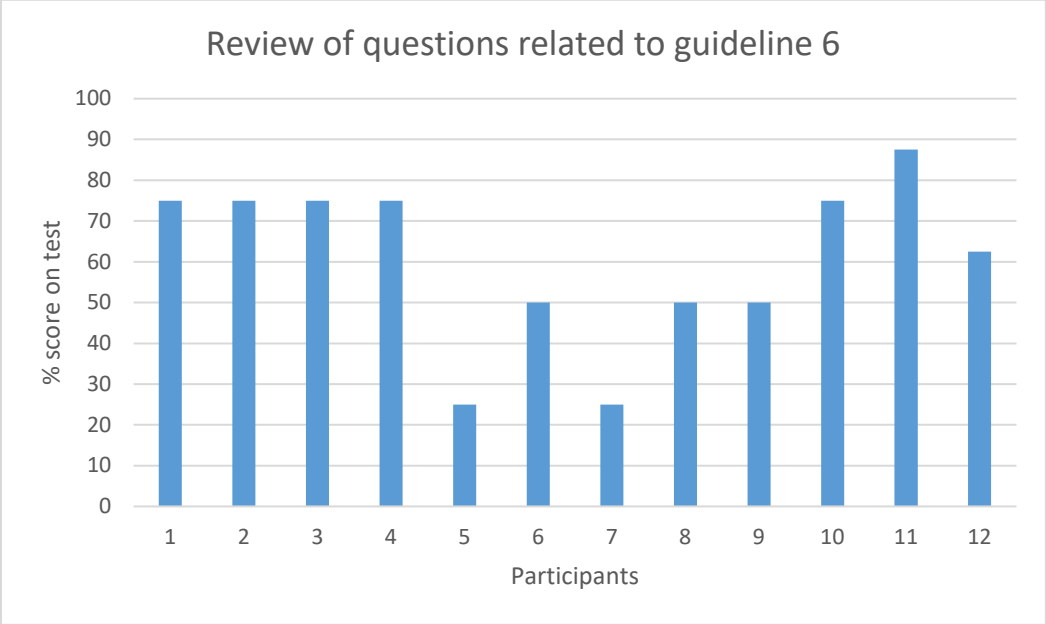
Personalization: Voice and Text - Script audio or write text in a conversational style using first and second person.

The personalization principles help draw learner's attention and engage them through social and emotional cues. To the extent possible, the designer avoided formal language use in some aspects of the lesson text, presenting information in a conversational manner. Narrations were done by the researcher and not with computer / machine generated voice. The evidence suggest learning is promoted when narrations are by a human speaker rather than machine generated voice. Computerized voice and use of virtual coaches can be counter effective in ensuring meaningful learning (Mayer, 2009; Mayer & DaPra, 2012; Mayer, Sobko & Mautone, 2003).

The language and narration were intended to sound polite and conversational to appeal to learners and bridge any social gap between the learner and instructor within such an online learning space which in turn fosters meaningful learning. This is consistent with research which suggest that such personalization cues in multimedia instruction promote generative processing as the learners make an effort to understand what the speaker is saying and this leads to improved test performance (Mayer, Fennell, et al., 2004*;* Nass & Brave, 2005). Participants had an average score of 60.4% on test items that focused on areas where the personalization guidelines were applied (figure 15) This relatively low score compared to the other guidelines and may reflect a weakness in the implementation of this guidelines.

Figure 18

Participants Score on Review Test Related to Guideline 6



Eight out of twelve participants indicated narrations were clear and easily understandable, and ten out of twelve stated text was clear and easily understandable as well.

Recommendation for Guideline 6

Learners feedback on aspects of this guideline which was not liked centered on visibility of the audio controls within the lesson. Although this concern was cited by few learners (participants 5, 6, 9), it will be helpful to ensure audio controls are visible and not easily missed to reduce learner's frustration and enhance generative processing.

A brief onboarding activity designed to mimic the modules in terms of aesthetics design, navigation flow and user control features can be presented to learners first, as a form of pretraining. This may improve the efficiency (time on task) as well as the effectiveness of

the instance. This would resemble applying Clark's and Mayer's (2016) concept of pretraining and segmenting principles but in addition to presenting key concepts which may be complex or new to learners ahead of the actual lesson, the goal would be to help learners familiarize with the instance design layout, controls and key features so that cognitive processing can be focused on essential material. Also drawing connection to figure 1 that showed the interconnection of success factors and a mapping to multimedia learning principles, attitude to technology, prior experience and comfort of use were identified as some factors that contribute to students and instructors having a successful online learning experience. Referencing figure 1 again, one of the factors that influence course design in online learning is learning theories. Under the connectivism learning theory, learner preparation activities were identified as necessary factors and this onboarding activity can consistently align with such factors identified in figure 1. As such an onboarding activity will be a great way to increase the key factors that cause both students and instructors to be well positioned for successful online learning.

Evaluating Participants Test Score Results Based on Guidelines

When evaluating a guideline or method for a design theory, the main interest is preferability. As Reigeluth and Frick (1999a) point out and further explain, “different methods are often preferable for different situations, and, indeed, it is the provision of different methods for different situations that raises the design knowledge above the level of a method" (p.3).

Based on the designed instance used in this study, a review of average test scores - one measure of learners’ understanding of content presented with the aid of the multimedia learning principles, as well as learners feedback of their learning experience offer support that the implementations of the multimedia learning principles were generally effective. A rundown of review test on areas that covered each guideline is seen in table 8 below.

Table 8

Summary of Mean Scores Related to Review of Each Guideline and the Number of Questions Involved in Each Test.

Guideline	Review test scores in percentage (%)	Number of test items/questions
1. Use relevant graphics to accompany text for novices (Multimedia)	64	8
2. Use animations to demonstrate procedures or to illustrate abstract ideas; Use a series of stills to illustrate processes	68.3	3
3. Use explanatory visuals that show relationships among content topics to build deeper understanding	89	4
4. Use interpretive graphics to explain how a system works or to illustrate abstract ideas	96	2
5. Use relevant graphics explained by brief audio narration to communicate content to novice learners (Multimedia & modality)	83	2
6. Personalization: Voice and Text - Script audio or write text in a conversational style using first and second person	60.4	4

Summary

Human learning can be complex being influenced by several changing elements such as prior knowledge, emotions, beliefs, moods, experience, and situational changes, among others (Ausubel, 2012; Mayer, 1999). It can be time consuming to create quality multimedia instruction, designing realistic graphics, creating animations, recording, and editing videos, recording, and editing narration to promote learning.

This chapter discussed the evaluation results from implementing the multimedia learning principles that focus on optimizing generative processing in a designed instance of an online course on cyberbullying.

The following themes capture the points participants identified as aspects of the application of the multimedia learning principles that worked and did not work based on their learning experience going through the designed instance:

What Worked:

- Interactivity

  One of the key finding was that the lesson's interactivity was an enjoyable feature for most learners irrespective of the type of media being used (graphic or video) or the guideline being applied. Whether explanatory visual were used to show relationships among content topics, animations or series of still were used to illustrate a process, or relevant graphics were simply used to help convey information to novice learners, if there was some degree of interactivity between learners and the multimedia that was an engaging feature. With formative research a major concern is preferability, arrayed along the dimensions of

effectiveness, efficiency, and appeal (Reigeluth & Frick, 1992). For these learners, it appears the appeal of the module was a priority (Participants 2, 4, 5, 7, 12). If they liked the design interface and user experience, they were more likely to focus and go through the module. This finding supports how the literature links interactivity as a key function in online learning (Wenger, 2002).

- Content accuracy and relevance

  The accuracy, relevance and scope of information presented in the designed instance was the focus for other learners (participant 8, 9, 10). The presentation of this content using graphics or videos was to an extent a medium of conveying this information to them, what they liked was how accurate, valid, or relevant the information being presented was.

- Lesson sequence, presentation flow

  The presentation flow of the instance was seen by some learners (participants 3, 6, 11) as useful and a feature that worked well for them. The manner in which the instance was sequenced, presenting information, following it up with varied in-lesson practice activities, showing examples or non-examples of information presented, and conducting a final review activity helped learners to navigate smoothly and allowed the presentation of information to be assimilated better due to the multiple avenues to recall and transfer through the lesson sequence.

- Presence of realistic pictures and animations

  The final item that worked for learners was the presence of multimedia throughout the instance. Learners particularly liked the use of graphics and videos

that appeared realistic and reported their use in different guidelines to improve their recall and comprehension of the information that was presented (Participant 1 & 5).

What Did Not Work

- Presentation of text-based content

  Learners pointed out that aspects of the lesson that had text only content could have been formatted to improve its presentation in terms of fonts, style, spacing and arrangement. Large blocks of paragraphs of text was not easy to quickly read through and digest for some learners (Participant 5, 6, 9)

- Use of graphics & examples

  Some participants simply did not like static graphics, specifically emojis, clip arts or schematic drawings (Participant 3, 10, 1). They indicated a preference for videos to replace images used to illustrate concepts or give examples to help explain abstract concepts such as in guideline 4.

- Clarity of instruction (typo, question instruction in one/two cases choose all or one)

  Unclear guidelines in the question text used in some of the review questions made it confusing for two learners. This may have affected their response to those questions and was pointed out as a weakness or an aspect of the instance that did not work for them (Participant 2 &11).

- Narrations

  Some participants appear to miss the narration block in some parts of the lesson, the pointed out that these audio players appear to blend in the background in some parts and the audio volume too was low. (Participant 4, 7)

- Learner autonomy and control

  The final concern raised by learners bothered on the way the lesson was set up. Participants were required to review all sections of the lesson, play through audio, videos and click through scenes and pages. This restriction created frustration and burdened some learners who were either fast readers and did not want to play through a narration or simply wanted to navigate the entire lesson freely.

Plausible Recommendations

For an informational based content lesson such as the designed instance used in this study, the following recommendations were offered as areas of guidance when applying the multimedia learning principles to optimize generative processing. The researcher considers the two revisions that led to the final version of the design instance discussed in this study were sufficient to merit the following recommendations to the guidelines for applying the design theory under review (multimedia learning principles). These recommendations were based on learners' feedback of what implementations of the design principles worked and did not work in the design instance, as well as the researcher's notes based on an analysis of the study. These are summarized below:

- Where possible consider making image minimally interactive, such as a change of state in an explanatory graphic such as charts or maps, upon mouse over, to high

level of interactivity that requires learner to click, enter input to get a response that unlocks new information.

- Pay attention to sound systematic instructional design, working with subject matter experts to verify content accuracy and relevance. Frame the lesson sequence appropriately, segmenting the entire content into manageable chunks, interspersing content presentation with practice assessments of different formats, and provided multiple examples or non-examples to support information presented. The multimedia presentation can be great, but a poorly sequenced lesson instance may hamper meaningful learning.
- Pay attention to text content as well in multimedia instruction. Properly format text, summarize key points, make use of bullets or tables, ensure readability by choosing appropriate fonts following standard accessibility guidelines. Keep design standardized as much as possible in terms of navigation and themes.
- As much as possible, minimize the use of emojis, clips arts and cartoon sketches (unless the focus and context of the instruction is on these types of graphics) and use human-like and realistic graphics or animation. Learners report having more attachment and higher recall when realistic images were used, while use of emojis or clip arts gave some learners an idea of a comical presentation.
- Animations proved helpful for explaining informational content. Add proper disclaimers or notifications for learners who may have motion sensitivity. Apply accessibility requirements.

- Allow the option to increase the size of images and add clear instructions to guide learners of the option to enlarge images. Include explanatory text that explain visuals. Always consider combining the use of contiguity principles with the guideline to use explanatory visuals that show relationships among informational content topics to build deeper understanding.
- Consider allowing learner control of interactive multimedia is used as interpretive graphics to explain how a system works or to illustrate abstract ideas. Explain ahead to learners if some features have been restricted or cannot be skipped (are required) as a form of advance organizer.
- Present a brief onboarding activity to prepare learners. The onboarding activity must resemble the actual implementation in terms of aesthetics design, navigation flow and user control features and must be simple to follow through.

Recommendation for Practitioners

The study presents the implementation of the multimedia learning principles, specifically the principles for optimizing generative processing to teach an online course on cyberbullying. The researcher emphasizes the need for designers to remain current in their knowledge of design principles and continue polishing the skills when it comes to use of design software and applications.

Some key recommendations emerging from this study is for instructional designers to consider avenues to incorporate elements of interactivity when designing multimedia instructions. This study showed that learners enjoyed such multimedia lessons and it helped their comprehension of the lesson. Also, the use of human-like or

realistic graphics was perceived as helpful to learners engagement with content and recall of information, but where the creation of these media assets have to be outsourced or contracted to a professional media specialist, the instructional designers must weigh several factors such as cost, time and its impact on attaining the intended learning goals. Instructional designers must work with Subject Matter Experts (SMEs) validate content and establish learning objectives clearly and sequence lesson content in sizeable units to ensure an easy flow. While some of these recommendations may be foundational, it is important for designers when working with SMEs, to remain open and come to the drawing board with an open mind knowing that the contribution of SMEs and other stakeholders in the planning process is critical for delivering instruction successfully. Instructors who are not instructional design experts may also find some of the recommendations as helpful additions to consider as a checklist which they can circle back to while attempting to implement any of the guidelines for Mayer's multimedia learning principles focused in this study.

Sound instructional design practices must not be neglected at the expense of solely designing and incorporating good looking multimedia elements or solely focusing on the multimedia learning principles. Finally, offer learners an opportunity to interact with a version of the instance prior to taking the actual lesson, especially when special features are involved. This is a way of familiarizing with the lesson design and structure. This activity will serve as an onboarding activity and help reduce the cognitive load learners may incur trying to figure out how some aspects of the lesson work. Onboarding activities could be simulated as a user guided walk-through practice lesson or tutorial

videos, but these must be shorter than 6 minutes to keep it engaging (Guo, Kim & Rubin, 2014).

Recommendation for Future Research

The multimedia learning principles were applied to an informational based content and learners feedback sought on how well the applications worked or not. Their feedback comments, and tests were done right after taking the lesson. It will be interesting to know the effectiveness of the application of multimedia principles through a delayed retention test for example, to measure long term learning.

The use of simple schematic animations or graphic have been found to be more effective, however most of these studies were based on procedural content (Scheiter et al., 2009; Mayer, Hegarty, et al., 2005) clipart style graphics. In the research cited, the lessons were based on explaining complex procedures or a process, whereas the content of this study was generally informational and not procedural. Future studies should compare the use of realistic graphics and animation versus simple schematic graphics (clipart style) in lessons with both procedural and informational content.

Participants of this study went through the design instance near the end of their day, and while getting ready to leave for spring break. This may have influenced their receptiveness. Future studies should have participants experiment with the instance at different times of the day and / or time of academic calendar year and compare outcomes.

The multimedia learning principles work better for novice learners according to Mayer (2002). Future studies could examine any differences between learners who are required to take the lesson (novice) and learners who are experts?

Further studies could also investigate, under what circumstances might the benefits of applying multimedia learning principles outweigh the cost in terms of development time and expense? Other areas worth considering for further research fall within the context of emotional design. At what point or to what extent does a relevant graphic which is engaging become distracting and hamper learning?

Limitations of the Study

First, this study was based on a specific instantiation of the multimedia learning principles focused on optimizing generative processing. This was a single case bounded by a specific context. The content of the designed case was based on cyberbullying. Findings are prescriptive and may not be generalized to other instances beyond the boundaries of this study. Participants in this study were undergraduate is the Teacher Education program. Their prior knowledge was not assessed, but all self-reported to have some knowledge of the subject of cyberbullying and bullying in general. Their demographic, unique training, experience, and prior knowledge could impact the nature of their feedback.

The researcher's ability to balance note taking, audio recording, and facilitating the focus group discussion required mastering the skill. Although audio was being recorded having a research assistant could prove valuable. While participants' shared background is helpful in focus group discussions, familiarity may have its demerits. Besides the observed fatigue of a few, which may have affected full participation, the focus group session may have suffered from this limitation Patton (2014) points out on how focus groups work. 'The dynamics are quite different and more complex when

participants have prior established relationships' (p. 478). Feedback on what worked or did not work was documented and discussed. The instance evaluated in this study represents the third iteration and was not modified within the lifecycle of the project. Multiple iterations or cases of formative research on the instance based on themes that emerged may improve the dependability of the guidelines for applying the multimedia principle and by extension the design theory itself.

Conclusion

The goal of the study was to utilize formative research methodology to explore how the guidelines for the implementation of the multimedia learning principle for fostering generative processing hold up in an informational online lesson, and based on formative feedback from participants (learners) offer tentative recommendations to the guidelines. In conclusion, in terms of what worked well and did not work well with the implementation of the multimedia learning principles, the major findings revealed that when relevant graphics accompanied text (Guideline 1), making multimedia assets minimally interactive improved meaningful learning. Presenting more than one graphic to accompany informational text when the graphic (image) helps clarify a concept or idea. For example, for the design instance the use of a single image of bullying in the introductory section conveyed a one-sided idea of the concept which was not comprehensive enough for novice learners. Regarding use of schematic animations or graphics some literature have suggested it as effective to promote learning (Scheiter et al., 2009; Mayer, Hegarty, et al., 2005), the findings of this study on the contrary revealed the use of schematic, emoji-like, clip art sketches was disliked by learners and did not

promote meaningful learning in terms of retention or recall of information presented with such graphics (Guideline 4). It is worth noting that most of the studies that support schematic graphics were based on procedural content whiles this instance was based on an informational content. For guideline 2, animations / videos proved helpful for explaining informational content, concepts, or ideas although most literature report its effectiveness with procedural content (Hoffler & Leutner, 2007; Lowe & Schnotz, 2015). Video was preferred to use of graphics or combination of still graphics (guideline 3). Combination of interactivity and animation helped learning (Betrancourt, 2005), and the motivational benefits of animation and learner control was emphasized by learner feedback.

The feedback did not reveal whether the personalization cues (guideline 6) were able to both inspire the activation of social responses from learners and emotionally engage them. Such impact can be related to the characteristics of the speaker's voice. Nass and Brave (2005) found that for a subject area such as mathematics, which is seen as a male-dominated domain, a female narrator was more effective than a male. In the case of this study, the narrations were done by the researcher who is a male international student and with the demographic of the learners being American. The researcher recommends further examination on personalization and embodiment principles. How narrations from a male of African descent sounds to an American learner and to what extent it impacted their comprehension and enjoyment of the instructional material. Could there be possible sexism in voice of narrator's gender? What are the possible effects of the gender of the narrator in an instance based on an informational or

procedural content? Connections were made with the key recommendations under each guideline with some of the critical success factors for online learning and its linkages to multimedia learning principles as shown in figure 1. Although the figure 1 presented a general view of the constructs that impact successful online learning, and this study focused on a specific design instance, this instance afforded a context within which knowledge is constructive giving it authenticity and is key to the creation of understanding and meaning. This also reflects social constructionism since learning is mediated through the media instance, the media itself makes it social. As Ertmer and Newby (2013) suggested new knowledge keeps evolving and does so through social construction, employing strategies and teaching methods such as authentic case-based learning, reflective practice, among others. It is the researcher's belief and hope that the plausible recommendations of this study offer scholars and practitioners some additional and helpful variables to consider when evaluating e-learning alternatives for multimedia learning. The recommendations serve varying instructional situations and improves the guidelines for applying the multimedia learning principles in the creation of instructional materials for online lessons in a manner that will have an impact on the cognitive engagement of learners interacting with such multimedia in ways that optimize generative processing.

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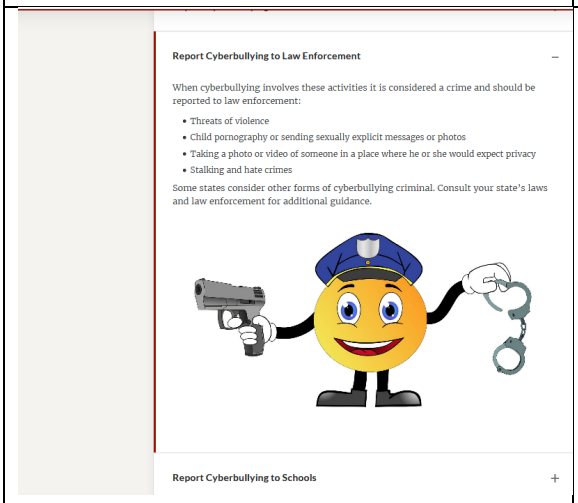
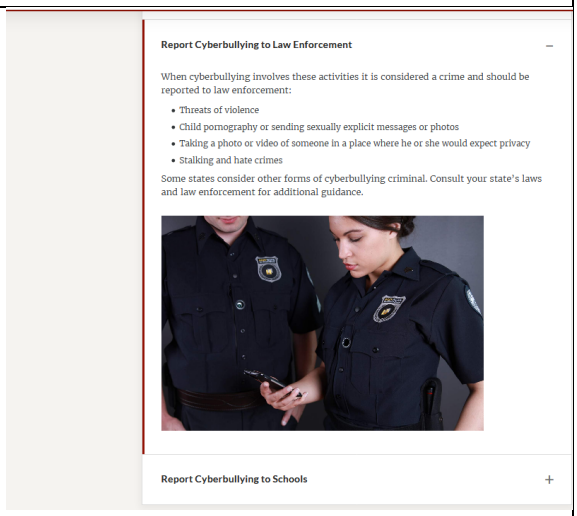
Appendix A: Screenshots of the Design Instance

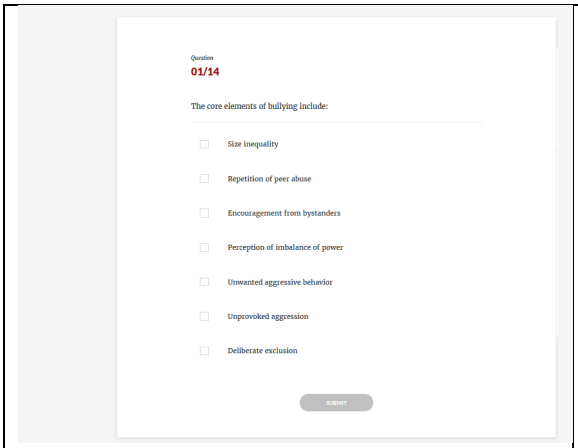
Some of the notable changes that were revised in subsequent iterations of the design instance.

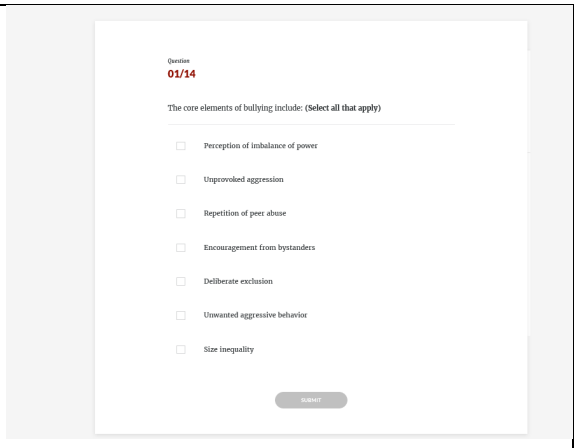




Clip arts were replaced in some sections of second iteration of the instance.

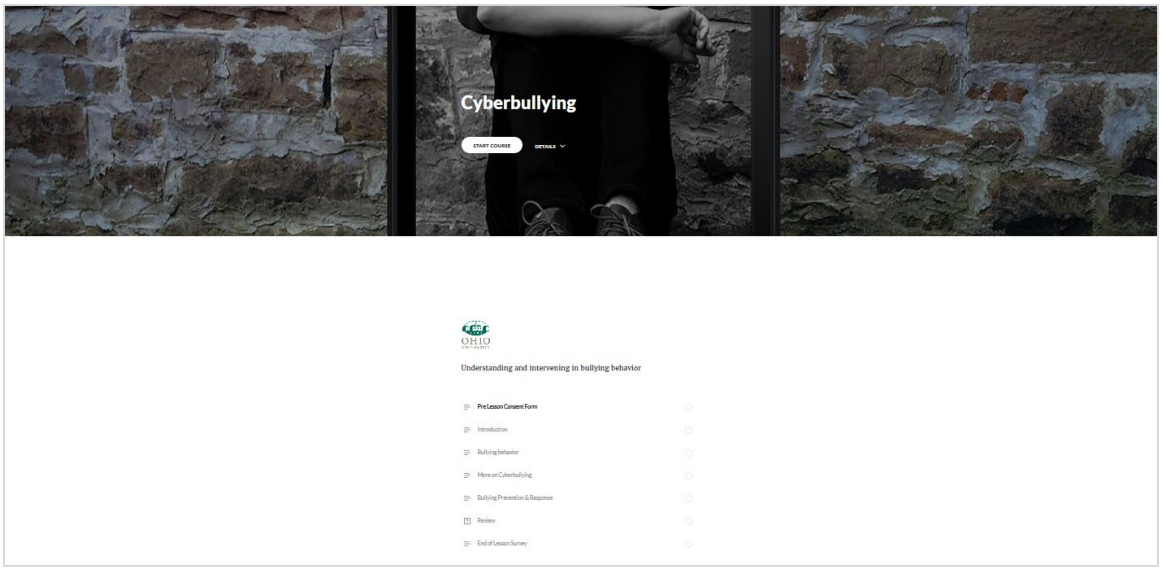
Option to enlarge images added (with direction in red text under image on right) to this graphic in the introduction section of the second iteration. Similar changes made in few other places.

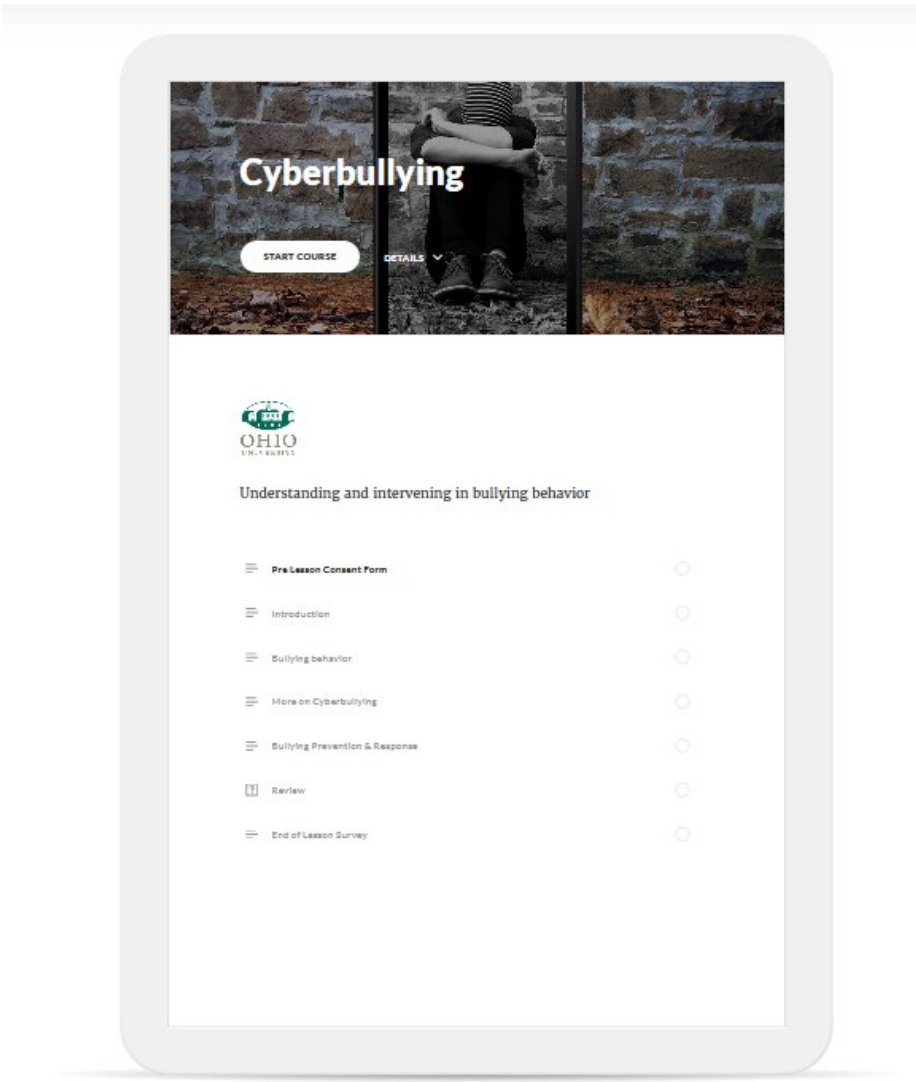




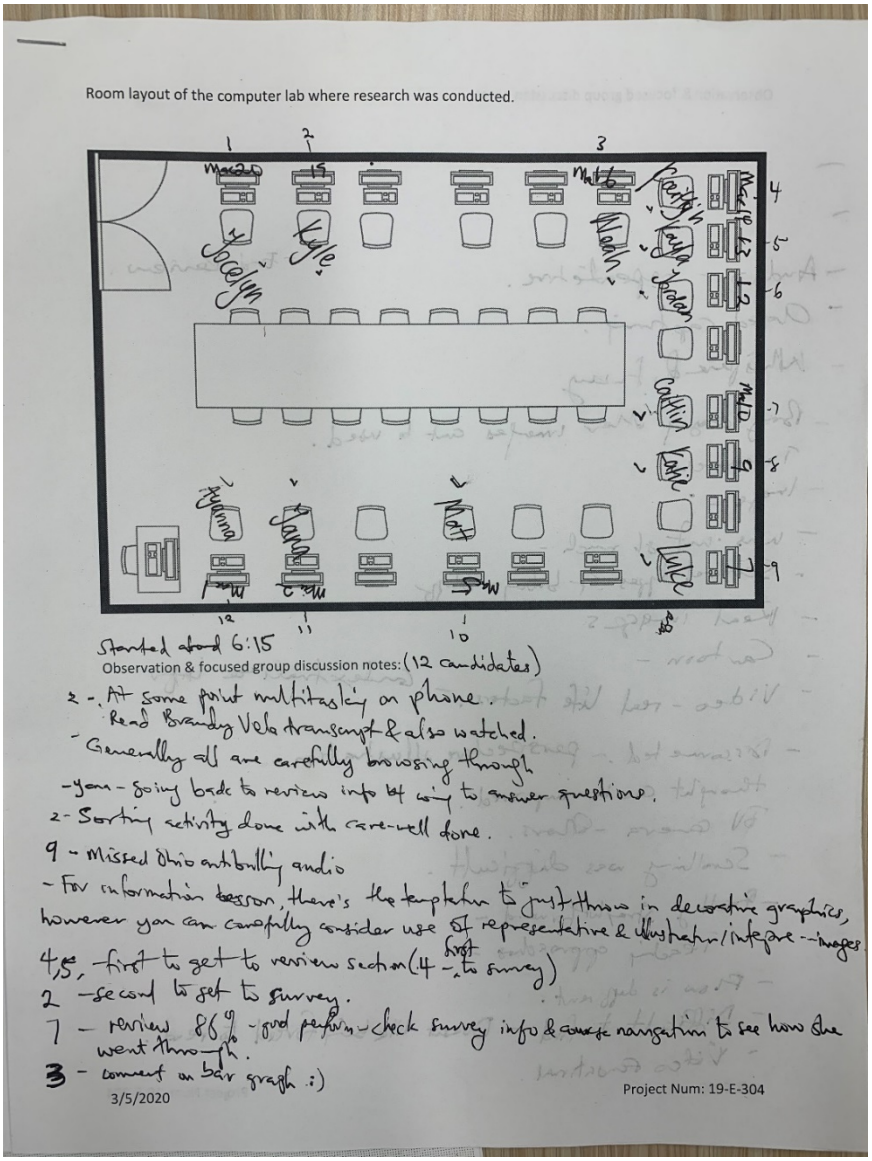
"Select all that apply". The omission of such a phrase in aspects of the second iterations made some question items unclear to few learners. Added for clarity in third iteration of the instance.

Main menu and general layout of the design instance interface captured in a desktop and mobile tablet portrait style.




Cyberbullying
START COURSE
DETAILS
OHIO
Understanding and intervening in bullying behavior
Pre Lesson Consent Form
Introduction
Bullying behavior
More on Cyberbullying
Bullying Prevention & Response
Review
End of Lesson Survey

Appendix B: Researcher Observation Notes Artifact During Data Collection



Room layout of the computer lab where research was conducted.

Started about 6:15

Observation & focused group discussion notes: (12 candidates)

2 - At some point multitasking on phone.
Read Brandy Vela transcript & also watched.
- Generally all are carefully browsing through
-yes - going back to review info bf going to answer questions.
2 - Sorting activity done with care - well done.
9 - Missed Ohio anti-bullying audio
- For information lesson, there's the temptation to just throw in decorative graphics, however you can carefully consider use of representative & illustration/informative images
4,5, - first to get to review section (4 - first to survey)
2 - second to get to survey.
7 - review 8 & 9 - good performance - check survey info & course navigation to see how she went through.
3 - comment on bar graph :)

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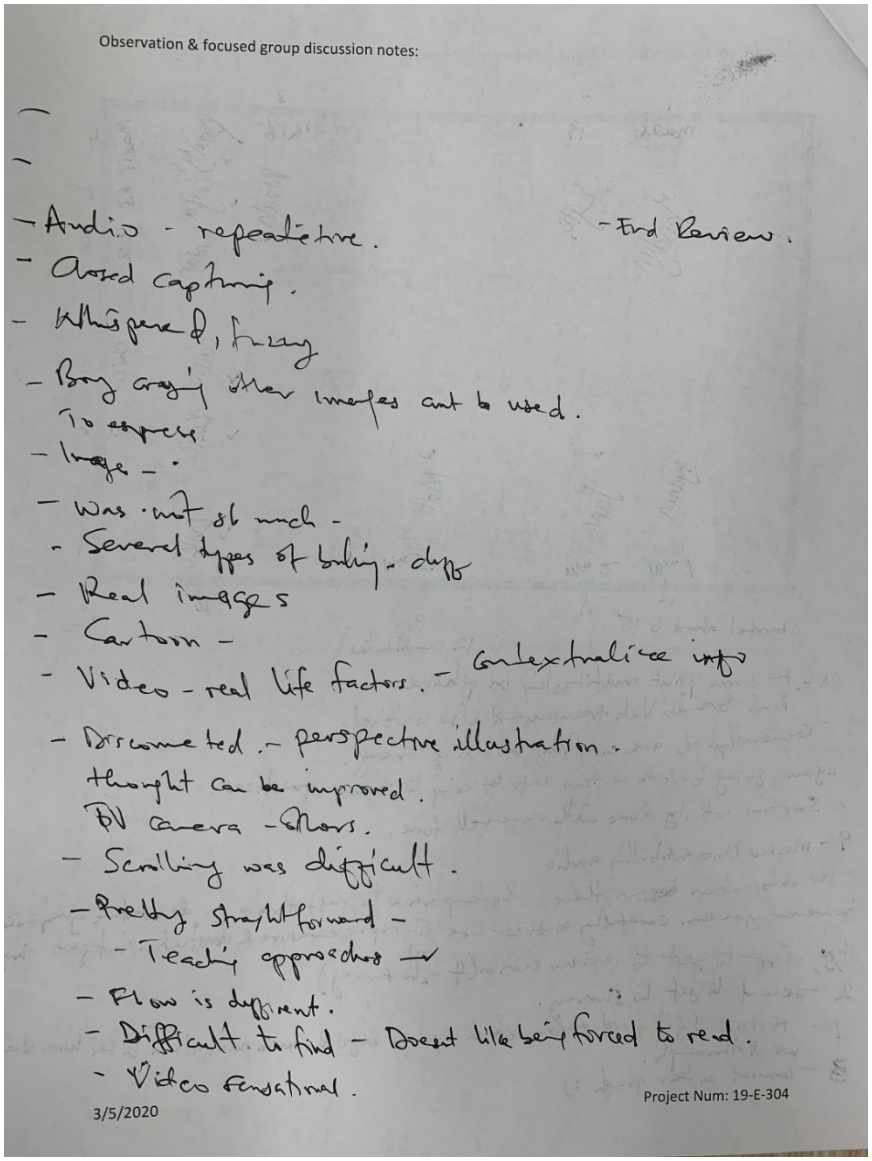

Observation & focused group discussion notes:

- Audio - repeatative.
- Closed captioning.
- Whispered, fuzzy
- Busy crazy other images cant be used.
  To express
- Image -
- Was not so much -
- Several types of baking - diffs
- Real images
- Cartoon -
- Video - real life factors. - Contextualize info
- Disconnected - perspective illustration.
  thought can be improved.
  BV camera - Colors.
- Scrolling was difficult.
- Pretty straightforward -
  - Teachy approaches →
- Flow is different.
- Difficult to find - Doesnt like being forced to read.
- Video sensational.

End Review.

3/5/2020

Project Num: 19-E-304

Appendix C: Practice and Review Test Questions

Practice and review test questions included a combination of retention(R) and transfer (T) type questions. These have been grouped according to the scene or section of the module there were presented to illicit feedback from learners and reinforce concepts of knowledge areas introduced.

LESSON/PRACTICE (WITH FEEDBACK)

BULLYING BEHAVIOR SCENE

Knowledge Check (KC):

1. When a student punches a student who doesn't hit back, the one throwing the punch is a student who bullies (T)

- True or <u>false</u>

Feedback: There is actually not enough information to tell if the incident constitutes a bullying episode, and bullying does not necessarily entail hitting.

2. The core elements of bullying include which of the following? (Check all that apply)

- Size inequality
- <u>Repetition of peer abuse</u>
- <u>Perception of imbalance of power</u>
- Unprovoked aggression
- Encouragement from bystanders
- <u>Unwanted aggressive behavior</u>
- Deliberate exclusion

Feedback: The core elements in bullying include Unwanted, aggressive behavior, an observed or perceived imbalance of power between the student(s) doing the bullying and the student(s) being bullied and the behavior that is repeated multiple times or is highly likely to be repeated. A bullying episode must include these. Other descriptors may not be present in a bullying episode

AFTER CIRCLE OF BULLYING SCENE

KC

3. How do passive bystanders make a bullying episode worse? (T)

- <u>Silence implies approval</u>

- They provide comfort to the person being bullied
- Obtaining help makes it end
- 85% of the time, they are present

Feedback: silence implies approval of the bullying behavior. Only by actively stepping up or getting help can a bystander help end a bullying episode

4. A change in perspective and terminology is encouraged when discussing bullying behavior among students. We would like to address the "victim" of a bullying episode as _____(R)

Feedback: Student who is bullied, Student who was bullied, Student who gets bullied, A person who is bullied, a person who gets bullied, someone who is bullied, someone who was bullied, someone who gets bullied, one who is bullied, one who was bullied

5. Why might a change in terminology be important when we talk about a bullying episode? (Check all that apply) (R)

- Calling it an “incident” sounds too scary
- It shifts the perspective to one of concern
- There is a need to label participants
- Bullying audiences must be held accountable, too
- It keeps the focus on behavior

Feedback: Having a shift in perspective is important to help keep our focus on behavior and show concern for the students involved.

AFTER COMMON FORMS OF BULLYING SCENE (R)

6. For each example, match the type of bullying to the episode described, if you determine the episode constitutes bullying

- Shoving in line - Physical bullying
- Threatening notes - Verbal bullying
- Stealing an inhaler - Damage to property bullying
- Excluding from a game - Social bullying

7. According to the National Crime victimization survey 2017, what percentage of students between the ages of 12-18 reported being bullied during the school year? *(enter digit without % sign)*

- *20*

*Feedback: N*ationwide, about **20%** of students ages 12–18 said they experienced bullying at school during the school year (that's about 5 million students).

8. According to the National Crime victimization survey 2017, what estimated percentage reported experiencing electronic or cyberbullying? (R)
(enter digit without % sign)

- *15%, 14.99%, 14.9%*

Feedback: Among high school students, an estimated **15%** said they were bullied electronically during the school year.

AFTER IMPACT OF BULLYING SCENE

9. Sort the items in the top card by dragging into the correct category box below (T)

Likely to be an effect of bullying	Not likely to be an effect of bullying
Poor school performance Hurt from minor bruises Anxiety / depression Poor social functioning Withdrawal from classroom activities Negative physical or mental health outcomes	Energetic Excellent academic performance Athletic achievement Healthy friendships

10. Which of the following are differences for which a student might be bullied? (Check all that apply) (R)

- Religion
- Size

- Race
- Gender identity
- Athleticism
- Family income
- 'Preceived' sexual orientation

11. Who is more likely to be bullied (R)

- Female
- Male

12. Who is more likely to be bullied (select all that apply)

- heterosexual students
- Gay and bisexual males
- Lesbian and bisexual females

Feedback: Gay, lesbian, bisexual, and questioning students are bullied more than heterosexual students.

13. Electronic bullying is LOWER between students who have had sex with each other whether they are the same sex or the opposite sex.

- True / False

Electronic bullying is HIGHER between students who have had sex with each other irrespective of sexual identity or gender. The main factor is sexual contact of any kind between students and access to electronic media

END OF BULLYING BEHAVIOR SCENE

MORE ON CYBERBULLYING SCENE

KC

14. Sort the items in the top card by dragging into the correct category box below (T)

Typical of Bullying	Unique to Cyberbullying
Usually the student bullying can be identified	The student bullying can remain anonymous
One may find a safe space of escape in some cases	Hard to escape since harmful info persist online
Harmful information limited to onlookers	No geographic limitations
Student doing the bullying may have to physically meet "victim"	Difficult to empathize with the target
	Harmful information can go viral within seconds and remain permanent
	Unlimited access to tools allows bullying to occur without physical contact

15. Do Ohio anti-bullying laws and regulations cover cyberbullying that occurs off-campus?'

- Yes
- **No**
- It is not explicitly stated in the anti-bullying laws

Feedback: Ohio anti-bullying laws do not cover off-campus conduct. Each U.S. state addresses bullying differently.

16. Which of the following included in the bullying and cyberbullying definition in Ohio anti-bullying laws and regulations? (choose all that apply).

- **Any intentional written, verbal, electronic, or physical act that a student has exhibited toward another student more than once and the behavior causes mental or physical harm to the other student.**
- **Any intentional written, verbal, electronic, or physical act that a student has exhibited toward another student more than once and the behavior is sufficiently**

severe, persistent, or pervasive that it creates an intimidating, threatening, or abusive educational environment for the other student.

- Any written, verbal, electronic, or physical act that a student has exhibited whether accidentally or intentionally toward another student at least once whether the behavior occurs on or off-campus

17. Do Ohio anti-bullying laws and regulations include protections for specific groups?

- Yes
- **No**

BULLYING PREVENTION & RESPONSE SCENE

18. All the following are strategies that do not work (misdirections) in bullying prevention and response except? (R) largely text*

- Group therapeutic treatment for children who bully
- Using peer mediation to address bullying problems
- Simplifying the relationship between bullying and suicide
- The use of developmentally appropriate and proportional consequences for bullying others

19. Identify a task or step one can take to respond to a potential bullying episode (R) *largely text

- Encourage students involved to stop
- Exempt students involved from group activities
- Stop it on the spot

20. Sort the items in the top card by dragging into the correct category box below

Might help to address or prevent cyberbullying	Might not help address bullying
Speak with student directly	Peer mediation
Speak to a parent about it	Implementing zero tolerance policies
Reinforce and reward positive behavior	Group treatment for students who bully
Develop activities that encourage self-reflection and empathy for others	

END OF LESSON/POSTTEST (REVIEW WITHOUT FEEDBACK)

21. The core elements of bullying include: (R)

- Size inequality
- Repetition of peer abuse
- Perception of imbalance of power
- Unprovoked aggression
- Encouragement from bystanders
- Unwanted aggressive behavior
- Deliberate exclusion

22. Identify the main types of bullying (R)

- Intimidation
- Verbal
- Social
- Insults
- Physical
- Damage

23. Apart from the student who bullies and the student who is bullied, what term is given to the other roles played by students witnessing a bullying episode? (R)

- Bystander(s) [not case sensitive and may include '-' as in by-stander(s)

24. How do passive bystanders make a bullying episode worse? (Choose one) (R)

- Silence implies approval
- They provide comfort to the person being bullied.
- Obtaining help makes it end
- 85% of the time, they are present

25. What percentage of students **reported having experience bullying at school** according to the U.S. Department of Justice, Bureau of Justice Statistics, School Crime Supplement (SCS) to the National Crime Victimization Survey, 2017. (R)

- 15%
- 24%
- 20%
- 14.49%

26. Angie—usually a friendly, engaged student in your classroom—has started sitting in the back of the room and no longer gets involved much in class discussions. One day you observe that, as she's leaving class, two other students walking out of class right behind Angie are whispering to each other and giggling. Which of the following is likely true? (T)

- This is a clear example of bullying behavior; it contains all three core elements.
- The behavior would concern me, but it doesn't rise to the level of bullying.
- There is no clear indication based on the scenario, and I would need more information.
- This is not bullying.

27. Today is the day your students are presenting posters at the conclusion of their genealogy projects. All students are supposed to stand up and talk about their families and what they put on their posters. When Rita talks about her two dads, someone in the back of the room yells, "That's weird!" Which of the following is likely true? (T)

- This is a clear example of bullying behavior; it contains all three core elements.
- The behavior would concern me, but it doesn't rise to the level of bullying.
- There is no clear indication based on the scenario, and I would need more information.
- This is not bullying.

28. For each example, match the description to the type of bullying it represents, if you determine the episode constitutes bullying.

Pushing in a line	Physical bullying
Threatening notes	Verbal bullying
Stealing an inhaler	Damage to property bullying
Excluding from a game	Social bullying

29. Which of the following is a context where bullying can take place? (R)

- School and school events
- On the Internet
- A student's neighborhood
- Traveling to and from school

30. Among high school students, an estimated ____% said they were bullied electronically during the school year according to the U.S. Department of Justice, Bureau of Justice Statistics, School Crime Supplement (SCS) to the National Crime Victimization Survey, 2017.(R)

- 15

31. Students who are bullied are unlikely to report because of a number of reasons such as (choose all that apply)

- Feeling helpless and wanting to handle it on their own to feel in control again
- Perceived difference in sexuality
- Fearing backlash from the student or students who bullied them
- Wanting to avoid being seen as weak or a tattletale

32. Support for a student who is being bullied includes assuring the student that the abusive behavior is not his or her fault and working with him or her to understand how unimportant differences inspired the bullying (R) *

- **True** / False

33. Do Ohio anti-bullying laws and regulations cover cyberbullying that occurs off-campus?

- Yes
- **No**
- It does not state

34. Which of the following actions is NOT recommended when one experiences cyberbullying

- **Forwarding messages**
- Keeping evidence of messages, screenshots, description of instances
- Blocking the person
- Reporting to the online content or service provider

Additional end of lesson questions in end of lesson survey:

35. In your own words explain what bullying is?
36. In your own words can you explain what cyberbullying is?
37. Could you please share the first 3 task a teacher or an adult can take to address potential bullying behavior?
38. Could you please share the steps a teacher or an adult can take to address cyberbullying? (covers preventing and addressing cyberbullying scene)
39. Could you please share the steps any individual can take immediately they notice cyberbullying? (covers reporting scene)

Appendix D: End of Lesson Survey

END OF LESSON SURVEY QUESITONS

1. First Name
2. Last Name
3. Email
4. Before this lesson, how knowledgeable were you about what constitutes bullying behavior?
   Would you say you were: Very knowledgeable, knowledgeable, somewhat knowledgeable, not at all knowledgeable.
5. Before this lesson, how knowledgeable were you about the issue of cyberbullying?
   Would you say you were: Very knowledgeable, knowledgeable, somewhat knowledgeable, not at all knowledgeable.
6. Before this lesson, how knowledgeable were you about the best practices in addressing bullying behavior?
   Would you say you were: Very knowledgeable, knowledgeable, somewhat knowledgeable, not at all knowledgeable.
7. Before this lesson, how knowledgeable were you about the best practices in cyberbullying prevention?
   Would you say you were: Very knowledgeable, knowledgeable, somewhat knowledgeable, not at all knowledgeable.
8. Carefully look at a screenshot below from a section of the lesson and tell me what elements were useful when you got to this section of the lesson and why? *(Brandy Vela video – a2)*
9. Did you notice the image in a section of the lesson? What were your thoughts about it? *(first image in course child crying, fingers pointing)*
10. Did you notice the image in a section of the lesson? How did it help or hamper your understanding of the material? *(most likely to be bullied sex orientation icons graphic)*

11. Carefully look at this scene from a section of the lesson. Do you recall which aspect of the lesson these images helped to explain? If yes, elaborate.? *(short video clip- cyberbullying prevention tips slide show)*

12. How was this image helpful in your comprehension of cyberbullying prevalence? *(chart showing occurrence of bullying and cyberbullying in 2017)*

13. How was this image helpful in your comprehension of bullying prevalence?*(signaling use in occurrence of cyberbullying)*
14. Carefully look at scene below and tell me what elements were useful when you got to this section of the lesson and why? *(circle of bullying scene)*
15. What do you think of the narration feature on scene X? *(Ohio antibullying laws)*
    a. Did you find it specifically useful or not?
    b. Elaborate:
16. How would you rate the clarity of the text used throughout the lesson?
    Easily understandable and clear, Somewhat understandable, somewhat confusing, confusing and complex
17. How would you rate the clarity of the audio narrations used throughout the lesson?
    Easily understandable and clear, Somewhat understandable, somewhat confusing, confusing and complex
18. Please tell me how satisfied you are overall with the cyberbullying online lesson. Would you say you were: Satisfied, Somewhat satisfied, Somewhat dissatisfied, Dissatisfied
    a. Can you kindly comment further / elaborate:
19. What did you like the most about the lesson? Elaborate:
20. What aspects of the lesson presentation could be improved? Elaborate:
21. After this lesson, how knowledgeable are you about what constitutes bullying behavior?
    Would you say you were: Very knowledgeable, knowledgeable, somewhat knowledgeable, not at all knowledgeable.
    a. Any further comments/elaboration
22. After this lesson, how knowledgeable are you about the issue of cyberbullying? Would you say you are: Very knowledgeable, Knowledgeable, Somewhat knowledgeable, Not at all knowledgeable
    a. Any further comments/elaboration:
23. After this lesson, how knowledgeable are you about the best practices in addressing bullying behavior?
    Would you say you were: Very knowledgeable, knowledgeable, somewhat knowledgeable, not at all knowledgeable.
    a. Any further comments/elaboration:

24. After this lesson, how knowledgeable are you about the best practices in addressing cyberbullying prevention?
    Would you say you are: Very knowledgeable, Knowledgeable, Somewhat knowledgeable, Not at all knowledgeable
    a. Any further comments/elaboration:
25. In your own words explain what bullying is?
26. In your own words can you explain what cyberbullying is?
27. Could you please share the first 3 task a teacher or an adult can take to address potential bullying behavior?
28. Could you please share the steps a teacher or an adult can take to address cyberbullying?
29. Could you please share the steps any individual can take immediately they notice cyberbullying?
30. Would you recommend this lesson to your other teacher education majors who want to know more about this topic?

Appendix E: Interview Guide

GUIDING QUESTIONS

- What did you like the most about the lesson? Elaborate:
- What aspects of the lesson presentation could be improved? Elaborate:
- (Note to self) Circle back to survey questions for elaborations if needed.

Appendix F: IRB Approval

From: compliance@ohio.edu <compliance@ohio.edu>
Sent: Monday, September 30, 2019 2:04 PM
To: Boadum, Nana Kwabena Anyani <nb013915@ohio.edu>
Subject: LEO: IRB PROTOCOL 19-E-304 APPROVED

Project Number	19-E-304
Project Status	APPROVED
Committee:	Office of Research Compliance
Compliance Contact:	Rebecca Cale (cale@ohio.edu)
Primary Investigator:	Nana Kwabena Anyani Boadum
Project Title:	Formative Research on Multimedia Learning Principles in the Instructional Design of Online Courses
Level of Review:	EXEMPT

The Ohio University Office of Research Compliance reviewed and approved by exempt review the above referenced research. The Office of Research Compliance was able to provide exempt approval under 45 CFR 46.104(d) because the research meets the applicability criteria and one or more categories of research eligible for exempt review, as indicated below.

IRB Approval:	09/30/2019 2:04:18 PM
Review Category:	3

Waivers: No waivers are granted with this approval.

If applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. In addition, FERPA, PPRA, and other authorizations / agreements must be obtained, if needed. The IRB-approved consent form and process must be used. Any changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

It is the responsibility of all investigators and research staff to promptly report to the Office of Research Compliance / IRB any serious, unexpected and related adverse and potential unanticipated problems involving risks to subjects or others.

This approval is issued under the Ohio University OHRP Federalwide Assurance #00000095. Please feel free to contact the Office of Research Compliance staff contact listed above with any questions or concerns.

The approval will no longer be in effect when the Primary Investigator is no longer under the auspices of Ohio University, e.g., graduation or departure from Ohio University.

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