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Measuring the Additive Effects of Multimedia Social Cue Principles on Learners' Cognitive Load, Emotions, Attitude, and Learning Outcomes

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MEASURING THE ADDITIVE EFFECTS OF MULTIMEDIA SOCIAL CUE PRINCIPLES ON LEARNERS' COGNITIVE LOAD, EMOTIONS, ATTITUDE, AND LEARNING OUTCOMES

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ABSTRACT

MEASURING THE ADDITIVE EFFECTS OF MULTIMEDIA SOCIAL CUE PRINCIPLES ON LEARNERS' COGNITIVE LOAD, EMOTIONS, ATTITUDE, AND LEARNING OUTCOMES

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Multimedia principles are developed and employed to design effective multimedia instructions that foster learning. Specifically, multimedia principles such as personalization, voice, and embodiment principles are developed based on social cues to promote deep learning. Most researchers in the past have investigated the individual effects of these principles on learning. The goal of the present study was to investigate the additive effects of these abovementioned principles on learners' perceived cognitive load, emotions, attitude, and learning outcomes (i.e. retention and transfer of knowledge). Sixty college students participated in this study. Participants were asked to complete two short instructional modules and a short learning assessment after each module. Additionally, they were asked to complete a NASA Task Load Index (TLX) questionnaire, emotion assessment, and attitude questionnaire. The results suggested that non-personalized instructions lead to higher cognitive load than the personalized instructions. Participants in the personalized voice with embodiment condition had the least feelings of disgust when learning the information and had highest retention scores. Additionally, personalized voice narrations were found to be detrimental for learning. However, if personalized voice narrations are used for instructional purposes, then it must be accompanied with an embodiment to foster learning and improve performance on transfer of knowledge. The findings of this study could be used to improve the design of the multimedia instructions that are effective in fostering learning.

I dedicate this dissertation to my immensely supportive family. Thank you for always standing by me and supporting me through my PhD journey. Without your love and support this wouldn't have been possible.

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CHAPTER I

INTRODUCTION

Multimedia instructions involve the presentation of words and pictures to promote learning. In multimedia learning, the words may be presented in the form of spoken words or printed texts and the images may be presented in the form of photographs, animations, videos and illustrations (Mayer, 2002). Multimedia instructions lead to multimedia learning which suggests that learners engage in deeper learning when instructions are presented by combining word and images rather than when they are presented by using words alone (Mayer, 2003).

In order to design multimedia instructions, it is important to understand how humans perceive and process the information that is presented to them. Therefore, it is imperative to recognize learners' cognitive structure and processes to understand how instructions should be designed to promote learning. The cognitive theory of multimedia learning (CTML) framework serves as a foundation for the design of multimedia instructions. It provides a framework regarding how humans process verbal and visual information to foster deep meaningful learning (Mayer, 2002).

Being cognizant of the fact that learners have limited working memory capacity, it is important to develop multimedia instructions that manage the cognitive load to help learners process the information presented to them. Different types of multimedia principles have been developed to design effective multimedia instruction; of which, coherence principle, spatial and temporal contiguity principles, signaling principle, and redundancy principle were developed to reduce extraneous cognitive load; segmenting principle, pre-training principle, and modality principle were developed to manage intrinsic load; and personalization principle and voice principle were developed to increase generative load (Veronikas & Shaughnessy, 2005).

However, for the purpose of this study, only personalization, embodiment, and voice principles will be addressed.

Problem Statement

Personalization, embodiment, and voice principles are developed based on social cues to foster deep learning (Mayer, 2014). Researchers in the past have conducted several studies to investigate the individual effects of personalization principle (Ginns et al., 2013; Kartal, 2010; Mayer, Fennell, Farmer, & Campbell, 2004; Moreno & Mayer, 2004; Reichelt, Kämmerer, Niegemann, & Zander, 2014), voice principle (Atkinson, Mayer, & Merrill, 2005; Mayer & DaPra, 2012; Mayer, Sobko, & Mautone, 2003), and embodiment principle (Lusk & Atkinson, 2007; Mayer & DaPra, 2012; Wang, Li, Mayer, & Liu, 2018) on learning outcomes. The individual effects of these abovementioned principles on learning have been fairly established. However, less is known about the additive effects of these principles on learning. Therefore, it is important to understand whether simultaneously employing the abovementioned principles additively help foster learning. The information that is garnered by investigating the additive effects of these principles will provide insights regarding how multimedia instructions should be designed and developed to create optimal instructions to promote learning. This study will help fill the gap in literature regarding the additive effects of personalization, voice, and embodiment principles on learners' cognitive load, emotions, attitude towards the learning materials, and learning outcomes (i.e. retention and transfer of knowledge). The results of this study will contribute to the knowledge base of multimedia instructional design and will provide instructional designers and educators empirical guidelines regarding whether or not the social cuing multimedia principles should be simultaneously employed to create optimal instructions to foster meaningful learning.

Literature Review

The theoretical foundations for designing multimedia instruction and the different types of multimedia design principles (i.e. personalization, voice, and embodiment) that are developed based on social cues to promote deep learning are discussed in this section. The literature review provides information regarding the individual as well as combined effects of the personalization, voice, and embodiment principles on learners' cognitive load and learning outcomes (i.e. retention and transfer of knowledge). It also provides information regarding the role that emotions and attitude play in the learning process. Additionally, this section discusses the shortfalls in the literature and the purpose of the current study.

Human Cognitive Architecture

The human cognitive architecture is a natural information processing system. The characteristics of this system involve a large store of information, including procedures that help continue the store of information by transferring information from one entity to the other, procedures that change the stored information by creating new information, procedures that fortify the effectiveness of change of stored information, and procedures that help relate the information to the external environment (Sweller, 2008). These characteristics of human architecture involved in human cognition are described by the following five principles: (a) long-term memory and information store principle; (b) schema theory, and the borrowing and reorganizing principle; (c) problem solving and random generation principle; (d) working-memory and narrow limits of change principle; and (e) long-term memory and environmental organizing and linking principle (Wong, Leahy, Marcus, & Sweller, 2012).

The long-term memory and information store principle suggests that humans store the processed information in the structure called the long-term memory. The schema theory and the borrowing and reorganizing principle suggest that humans primarily learn from other's long-term memories by reading or hearing what others have written. Humans then reorganize the schema based on their own long-term memory (Wong et al., 2012). The problem solving and random generation principle suggests that humans do not create a new schema of information unless the borrowed information is inexact. During problem solving if information to solve the problem is unavailable either through their own or other's memories, then they involve in making random moves to solve the problem. This leads to formation of new knowledge. The working-memory and narrow limits of change principle suggests that the working-memory processes the new information (Wong et al., 2012). However, working memory capacity is limited when it engages in processing novel information for which there is little to no prior knowledge (Sweller, 2008). Lastly, the long-term memory and environmental organizing and linking principle assumes that working memory capacity is limited only when it engages in processing novel information. Working memory can easily process the information from the long-term memory and can thereby, help in reducing the cognitive load on the working memory (Wong et al., 2012).

Cognitive Load Theory

Cognitive load theory (CLT) focuses on the way in which the cognitive resources are allocated and employed during learning and problem solving (Chandler & Sweller, 1991). This theory serves as a framework for the instructional design principles based on the characteristics of the human cognitive architecture, mainly working memory and long-term memory (Wong et al., 2012). Working memory is responsible for cognitive processing of information. Because the working memory capacity is limited, it can only process two or three novel interacting elements at a given time (Paas, Renkl, & Sweller, 2004). Cognitive load theory research has mainly focused on developing effective and efficient instructional strategies to promote learning. That is, CLT is interested in the instructional strategies that could be employed to manage the working memory load to allow processing and changing of information in the long-term memory which is related to the schema construction and automation (Chandler & Sweller, 1991). It is concerned with the interaction between the human cognitive architecture and information structure (Paas et al., 2004).

Cognitive load occurs when the processing demands that evoke from the learning task surpasses the cognitive systems' processing capacity (Mayer & Moreno, 2003). There are three types of cognitive load (i.e. intrinsic, extraneous, and germane). Intrinsic load is the load that is inherent to the instructional information that is to be learned. Intrinsic load depends on the number of element interactivity that needs to be conducted to understand the information. This load is associated with the complexity of the instructional material and therefore, cannot be modified (Wong et al., 2012). Extraneous load evokes from the instructional design practices and therefore, can be managed or reduced by the instructional designers. This load arises when unnecessary elements are made to be processed in the working memory because of the way the instructions are designed. This load can be managed by altering the design of the instructional materials (Wong et al., 2012). Germane load is associated with the working memory required to manage the intrinsic load in order to promote learning (Wong et al., 2012). Research on human cognitive architecture and the cognitive load theory have led to the development of the cognitive theory of multimedia learning which ignited the development of several multimedia instructional design principles that help manage learners' cognitive load and foster meaningful learning.

Cognitive Theory of Multimedia Learning (CTML)

When designing multimedia instructions, instructional designers must consider the human cognitive architecture and the processes involved in processing and storing the information to the long-term memory. Based on the cognitive theories, three assumptions namely dual channel, limited capacity, and active processing provide information on how people learn from words and pictures (Mayer, 2002). The dual channel assumption states that there are two different channels to process visual and verbal information. Pictures enter cognitive process through eyes whereas, spoken words enter the cognitive process through ears.Therefore, pictures and words are processed in two different channels (Mayer, 2002). The limited capacity assumption suggests that each channel in the human cognition system has limited capacity to hold and process information at a given time. Therefore, if too much information is presented simultaneously in each channel, then this could result in a cognitive overload that can impair the processing of the information (Mayer, 2002). The active processing assumption states that meaningful learning occurs when learners select relevant incoming information (i.e. words or pictures), organize them into the pictorial or verbal models, and integrate the information with each other and with the prior knowledge (Mayer, 2002).

The cognitive theory of multimedia learning (CTML) is based on the three abovementioned assumptions regarding how humans process information. According to this theory, the learners carefully select the sound and images from the sensory memory and then process this information in the working memory. Learners then organize the information to form pictorial and verbal models. Lastly, the learners integrate the new information from pictorial and verbal models with their prior knowledge and store the information in their long-term memory for future use (Mayer, 2003).

Managing Cognitive Load

One consistent problem that emerged in the literature on multimedia learning was the problem of cognitive load. Meaningful learning requires learners to engage in considerable cognitive processes during the learning process. Because learners' cognitive processing capacity is limited, they are unable to adequately engage in the cognitive processes that are required for meaningful learning. Instructional designers designing for meaningful learning often encounter challenges with cognitive overload that results when the intended cognitive processing that is required for learning exceeds learners' available cognitive capacity (Mayer & Moreno, 2003). Therefore, instructional designers have realized the need to design instructions that are sensitive to the cognitive load (Mayer & Moreno, 2003). To help instructional designers design effective instructions that take into account the learners' cognitive load, Mayer and Moreno (2003) developed methods to reduce cognitive overload. The researchers presented five types of cognitive overload scenarios. For each scenario, they provide one or two suggestions or methods based on the cognitive theory of multimedia learning to reduce cognitive load.

There are three main types of processing in multimedia learning namely essential processing, incidental processing, and representational holding. Essential processing involves making sense of the information or material presented that involves selecting, organizing, and integrating information. The incidental processing involves processing non-essential information that is being presented along with the other instructions. The representational holding involves "holding visual or verbal representations in the working memory" (Mayer & Moreno, 2003, p. 45).

According to Mayer and Moreno (2003), the cognitive load caused by essential processing of information in the visual channel could be reduced by off-loading some of the information presented in the visual channel to the auditory channel. In situations where both auditory and visual channels are overloaded, segmenting and pre-training methods could be employed to reduce the cognitive load. Segmenting information involves allowing time between two consecutive bit-size instructional segments. Pre-training involves providing information about the names and characteristics of the component to the learners prior to the instructional segment (Mayer & Moreno, 2003). When one or both channels are overloaded due to incidental and essential processing, weeding method could be employed to eliminate extraneous materials that may be interesting but do not add value to the instructions. This reduces the extraneous materials that the learners have to process during the learning process. Additionally, providing signaling to inform learners how to process the instructional materials could also help reduce processing of extraneous materials and thereby, reduce cognitive load (Mayer & Moreno, 2003).

In situations where both the channels are overloaded because of the essential and incidental processing of the information that is caused by the confusing presentation of the essential materials, the cognitive load could be reduced by aligning information such that text is closer to the relevant image. This will reduce the visual scanning that the learners have to perform and will thereby reduce the cognitive load. Additionally, eliminating redundant information would also reduce cognitive load (Mayer & Moreno, 2003). If one or both channels are overloaded due to essential processing and representational holding, then employing the synchronizing technique of presenting narrations with visual animations would reduce the need to hold information in the working memory and would reduce the cognitive load. Also, knowing whether the learners possess the abilities or skills to hold the mental representation would be beneficial (Mayer & Moreno, 2003).

Learners' cognitive load plays an important role during the learning process. It is in the best interest of the instructional designers to try and reduce learners' cognitive load to help facilitate learning. The suggestions that Mayer provided to manage learners' cognitive load are helpful. Instructional designers can reduce the extraneous cognitive load that results from processing the extraneous materials along with the actual instructional material by employing the coherence principle, signaling principle, redundancy principle, spatial contiguity principle, and temporal contiguity principle (Veronikas & Shaughnessy, 2005). They can use the segmenting principle, pre-training principle, and the modality principle to manage the intrinsic load that is associated with processing the actual instructional material that is related to the instructional goal. The personalization and the voice principles can be employed to foster generative learning to facilitate deeper and reflective processing of the information (Veronikas & Shaughnessy, 2005). The multimedia instructional design principles and suggestions to manage the learners' cognitive load guide instructional designers through the instructional design process.

Social Agency Theory

The social agency theory developed by Mayer, Sobko, and Mautone (2003) states that social cues prime learners' social conversation schemas. This allows learners to act as if they are conversing with another person. Once learners interpret the interaction with the computer as human-to-human communication, then the social rules of human-to-human communication also come into play (Mayer et al., 2003). In computer-based learning, learners interact with the computer and engage in some form of communication with it. If learners interpret the computer as social, then they are likely to interact with it as if it is a human (Mayer et al., 2003). This makes learners' feel like they are in a social relationship with the on-screen agent (Moreno & Mayer, 2004). This makes learners put more effort in making sense of the information presented to them by the computer and thereby, helps them engage in deep learning (Mayer, et al., 2003). Personalization, embodiment, and voice principles of multimedia instructions are developed based on social cues to foster deep learning (Park, 2015).

Multimedia Principles Based on Social Cues

Personalization principle. Personalization principle involves presenting multimedia instructions in a conversation style or polite style (Mayer, 2003). This is because, learners learn better when the multimedia instructions are presented in the conversation style rather than when they are presented in the formal style (Mayer, 2003). Personalized instructions are created using first and second person in the sentences and by using the word "your" instead of the word "the" to allow learners to view themselves as the reference point (Mayer, 2003; Mayer, Fennell, Farmer, & Campbell, 2004). This increases learners' interest in the instructions and encourages them to use the available cognitive resources to process the incoming information during the learning process. This also helps learners to engage in deeper learning (Mayer et al., 2004). The formal style instructions are created using third-person monologue style wordings (Mayer, 2003).

Researchers in the past have reported that learners perceive personalized communication style in instructions as friendlier than the non-personalized formal communication style (Ginns, Martin, & Marsh, 2013; Moreno & Mayer, 2004). Additionally, personalized instructions have positive effects on retention test (Ginns et al., 2013; Kartal, 2010; Reichelt, Kämmerer, Niegemann, & Zander, 2014) and transfer of knowledge test (Ginns et al., 2013; Mayer et al., 2004). However, some researchers have reported contradicting results asserting that there is no significant effect of personalization on retention scores (Mayer et al., 2004; Kühl & Zander, 2017) and transfer scores (Reichelt et al., 2014). Employing personalization principle in the design of the instructions is found to reduce learners' cognitive load and promote generative cognitive processing of the information (Park, 2015). However, Zander, Reichelt, and Wetzel (2015) reported contradicting results as they found no significant effect of personalization on learners' cognitive load.

Emotional averseness of the instructional content is identified as being a plausible boundary condition for the personalization principle (Kühl & Zander, 2017). In the past, most of the research studies conducted to assess the effects of personalization principle on learning have measured the effects of this principle when learning emotionally non-aversive or neutral contents (e.g. how a respiratory system works) (Mayer et al., 2004). Kühl and Zander (2017) assessed the effects of personalization principle when learning emotionally aversive health related information (i.e. cerebral hemorrhage). The authors reported that learners in the personalized instruction condition performed worst on the transfer test for emotionally aversive topic than those who received non-personalized instructions. Therefore, an inverse effect of personalization was observed when it was used to learn emotionally aversive content (Kühl & Zander, 2017). This shows that it is important to be cognizant about the averseness of instructional content before employing the personalization principle to design the multimedia instructions.

Voice principle. The voice principle states that learners learn better from the instructions when the words are presented in human-voice than in machine-voice (Mayer & DaPra, 2012). Previous studies have investigated the effects of human-voice and machine-voice instruction on transfer knowledge scores. It was found that learners who received human-voice instruction performed better on the transfer tests than those who received machine-voice (a.k.a. non-human voice) instruction (Atkinson, Mayer, & Merrill, 2005; Craig & Schroeder, 2017; Mayer, Sobko,

& Mautone, 2003). Therefore, voice principle is only effective when instructions are presented in human-voice. Using machine-voice to present instructions nullifies the positive effects of social cueing and does not promote learning (Mayer & DaPra, 2012).

Researchers in the past have also assessed whether using standard accent voice for narrations is better than using foreign accented voice for fostering retention and transfer of knowledge. Mayer et al. (2003) conducted two experimental studies to investigate the effects of voice principle on learning. In one experiment, the researchers assessed whether the narration presented in Native-English speaker's voice (i.e. standard accent voice) is more effective in promoting learning than the narration presented using the foreign accent voice (i.e. Russian accent). The authors reported that learners who learned using the standard accent outperformed those who learned using the accented voice on the transfer test. However, they found no significant difference between the retention scores of the students who learned the material with standard accent narration and those who learned using the accented voice narrations (Mayer et al., 2003). In the second experiment, the researchers assessed whether the narration presented in Native-English speaker's voice (i.e. human-voice) is more effective in promoting learning than the narration presented using machine-synthesized voice. The authors reported that learners who received instructions in human-voice outperformed the learners who received instructions in machine-voice on the retention test and transfer test (Mayer et al., 2003).

In the past, researchers have also investigated the effects of voice principle on learners' cognitive load. Park (2015) found that learners' perceived cognitive load was lower and attention was higher when the pedagogical agents provided narrations in human voice than when no narration were presented to the learners. Craig and Schroeder (2017) tested three types of voice in their study: classic synthesized voice (i.e. Microsoft speech engine), modern voice (i.e.

Neospeech voice engine), and human-voice (i.e. female native English speaker). The authors reported that there was no significant difference in cognitive load between the voice groups.

Embodiment principle. The embodiment principle states that learners learn better when the multimedia instructions include on-screen agents that display human-like gestures, eye gaze, facial expressions, and movement than when the instructions involve low embodiment (i.e. static image of the on-screen agent) (Mayer & DaPra, 2012). It was found that learners performed better on the transfer knowledge test when they learned the information using multimedia instructions that contain embodiment than when they learned the information using multimedia instructions that had no embodiment (Mayer & DaPra, 2012). Lusk and Atkinson (2007) investigated whether the level of embodiment (i.e. high, low, or absent embodiment) has an effect on learning. They found that learners in the low embodiment condition had higher learning outcomes than those who were in the absent embodiment condition. There was no difference between the learning outcomes of the high embodiment and the minimal embodiment group (Lusk & Atkinson, 2007).

Wang, Li, Mayer, and Liu (2018) evaluated whether the pedagogical agents that point to relevant information of an illustration increase learning outcomes. The authors reported that learners learned and performed better when the pedagogical agent was present in the online instructions than when it was absent. Additionally, learners' learning improved when the pedagogical agents were making human-like gestures than when they were merely standing idle (i.e. motionless). Therefore, the authors supported the embodiment principle that learners learn better with high embodiment pedagogical agents than with low embodiment pedagogical agents.

Some researchers have reported boundary conditions for embodiment principle. It is suggested that employing high embodiment on-screen agents helps generate deeper learning but only when the on-screen agents spoke in the human-voice and not when the agents spoke in machine-voice (Mayer & DaPra, 2012). The possible explanation for this boundary condition is that when agents speak in machine-voice the learners do not perceive the agents as social partners. This negative social cue (i.e. machine-voice) creates an environment that nullifies the positive effects of high embodiment (Mayer & DaPra, 2012). Therefore, it is important to recognize these boundary conditions before employing the embodiment principle to promote learning.

Combined Effects of Multimedia Principles

Recently, some researchers have begun to study the combined effects of these different multimedia design principles on learning outcomes. Wang and Crooks (2015) studied the individual effect of personalization and the combined effect of personalization and embodiment on learning the culture of the foreign language. They found that students in the personalization and embodiment instruction condition performed better on the retention test than those who received instructions with personalization alone. Lusk and Atkinson (2007) investigated the combined effects of embodiment and voice principles on learning outcomes. In this study, the high embodiment condition consisted of an animated agent (i.e. parrot) that provided gaze and gesture to guide learners' attention. The minimal embodiment condition consisted of the same animated agent but in this condition the parrot only provided verbal communication. The voice only condition presented only the narrative instruction in the absence of the on-screen agent. The authors found that participants in the minimal embodiment condition had higher learning outcomes than those in the voice only condition (Lusk & Atkinson, 2007). Park (2015) investigated the combined effects of personalization, voice, and embodiment on cognitive load and learning outcomes. It was found that learners had lower cognitive load and higher attention when pedagogical agents provided instructions in human-voice than when no narrations were presented to the learners. There was no significant effect of social cues on the recall and comprehension scores.

Emotions and Attitude

Along with cognition, emotions too play an important role in learning. Learners' affective state has a significant effect on their motivation to learn the material (Heidig, Müller, & Reichelt, 2015). Therefore, it is reasonable to believe that negative emotional states like anxiety, disgust, and depress among others may in fact impede the learning process. Anxiety reduces learner's attention control and thus, hinders the cognitive processing efficiency (Eysenck, Derakshan, Santos, & Calvo, 2007). When designing multimedia instructions, specifically for aversive content, it is important to be cognizant of how the content information and the instruction presentation style could affect the learners' emotions and the learning process. For instance, if personalized instructions are employed to present aversive information, then it is plausible to believe that learners would probably refrain from engaging deeply with the content information as it could arouse the feeling of disgust (Kühl & Zander, 2017). Therefore, it is important to design instructions in a way that would induce less negative emotional states and promote learning.

Researchers in the past have identified six different types of affective states namely frustration, boredom, flow/interest, confusion, eureka (i.e. Ah huh!), and neutral and have measured their relationship with learning. It was found that increased interest and confusion leads to increased learning. Increased boredom and frustration leads to decreased learning. Eureka is found to have no significant effect on learning. This shows that there is an interplay between emotions and learning (Craig, Graesser, Sullins, & Gholson, 2004). Therefore, it is important to design instruction in a way that induces learners' interest in learning the material and reduces their boredom during the learning process. This is because, if learners have high interest and motivation to learn the material, then they are more likely to put effort in learning the material and thereby, engage in making sense of the information presented to them. This increases the generative processing of the information and fosters deep meaningful learning (Mayer & Estrella, 2014).

Purpose of the Study

Literature review indicates that most of the research studies in the past have assessed the individual effects of these multimedia design principles on learning. However, there is a paucity of research conducted to assess the additive effects of personalization, voice, and embodiment principles on learning outcomes (i.e. retention & transfer of knowledge) specifically, when learning emotionally aversive content. Additionally, there is not much known about the effects of these principles on learners' emotions, perceived cognitive load, and attitude towards learning. Therefore, the purpose of this study is to assess the additive effects of the abovementioned principles on learners' perceived cognitive load, emotions, attitude towards learning, and learning outcomes (i.e. retention and transfer knowledge) when learning emotionally aversive and emotionally neutral content.

Research Questions and Hypotheses

The following are the research questions that were addressed in this study:

1) To what extent do instructions containing personalization, voice, and embodiment principles (i.e. social cues) collectively have an additive effect on the time that participants spend on the instructional modules to learn the information?

2) To what extent do instructions containing personalization, voice, and embodiment principles (i.e. social cues) collectively have an additive effect on participants' perceived cognitive load?
3) To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on participants' emotional state?
4) To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on participants' attitude towards learning the material?
5) To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on participants' learning outcomes (i.e. retention and transfer test scores)?

The following are the specific hypotheses that were tested in this study:

a) Participants in the personalized voice with embodiment condition will have lower perceived cognitive load than the students in the other treatment groups across instructional content conditions. This hypothesis was elaborated from Park (2015).
b) Participants in the personalized voice with embodiment condition will have a more positive emotional state than the students in the other treatment groups across instructional content conditions. This hypothesis was elaborated from Kühl and Zander (2017).
c) Participants in the personalized voice with embodiment condition will have a more positive attitude towards learning than the students in the other treatment groups across instructional content conditions. This hypothesis was elaborated from Wang and Crooks (2015).

d) Participants in the personalized voice with embodiment condition will have higher learning outcomes than the students in the other treatment groups across instructional content conditions. This hypothesis was elaborated from Lusk and Atkinson (2007) and Wang and Crooks (2015).

CHAPTER II

METHOD

Experimental Design

Multimedia instructional styles and averseness of information were the independent variables in this study. A 4 (multimedia instruction styles) X 2 (averseness of information) split-plot design was employed for this study. Multimedia instructional design styles based on the social cue principles served as the between groups variable. There were four levels of multimedia instruction style: (a) non-personalized text instruction, (b) personalized text instruction, (c) personalized voice instruction, and (d) personalized voice with embodiment instruction. Averseness of information served as the within-subjects variable consisting of two levels: (a) emotionally non-aversive/neutral (i.e. how the human respiratory system operates) and (b) emotionally aversive (i.e. cerebral hemorrhage) (see Figure 1). Participants were randomly assigned to one of the four instructional treatment groups. Students' perceived cognitive load, emotions, attitude towards the learning materials, learning outcomes (i.e. retention and transfer of knowledge), and time spent on instructional units served as the dependent variables.

		Between-Subjects			
Within-Subjects		Non-Personalized Text	Personalized Text	Personalized Voice	Personalized Voice with Embodiment
	Emotionally Neutral (How the Human Respiratory System Operates)				
	Emotionally Aversive (Cerebral Hemorrhage)				

Figure 1. Illustration of the experimental design.

Participants

The recruitment process involved contacting professors who were teaching courses during the fall 2019 and spring 2020 semesters at the participating university and requesting them to share the recruitment letter/email with their students. The recruitment email informed students about the research study, the time it will take to complete the study, the tasks that they will be asked to complete during the study, and included information about the incentive that they will receive for participating the study. Additionally, students were informed that participation in this study was voluntary and that they could quit the study at any time.

G*Power software version 3.1.9.2 (Faul, Erdfelder Lang, & Buchner, 2007) was used to conduct an a priori power analysis for this study. Effect size of $f = .25$ was used to conduct the power analysis. The power level (1- ß) was set to be .80 and α to be .05. According to the power analysis, approximately 48 participants would be required for this study. However, given that this was a unique study with different variables taken into account, it is reasonable to believe that data from a few more participants was required to avoid Type I and Type II errors. Therefore, 62 college students from a mid-sized urban university located on the east coast of the United States were recruited for this study. However, five participants reported not having normal-to-corrected to normal hearing. Of which, two participants received instructions in a voice format as they were randomly placed in the personalized voice and personalized voice with embodiment conditions respectively. Therefore, they were excluded from the study. The remaining three participants received instructions in a text format.Two of those participants were in the personalized text condition and the other participant was in the non-personalized text condition. Hence, those three participants were included in this study because impaired hearing would not interfere with their learning of information from text-based instructions.

The analyzed sample consisted of 60 college students (24 males, 36 females). There were equal number of participants in each instructional group (*n* = 15). The sample population comprised 40 undergraduate (2 freshmen, 9 sophomores, 18 juniors, & 11 seniors) and 20 graduate students (10 masters, 10 doctoral). All participants were at least 18 years old. The mean age of participants was 28.83 years (*Min* = 18 years, *Max* = 63 years, *SD* = 11.30). Upon completion of the study, all participating students were entered into a random drawing for a chance to win one of four $10 gift cards to a local retailer.

Materials

Technological materials. Articulate Storyline 360 software was employed to develop the self-paced e-learning instructional modules for this study. This software was selected because it provides the flexibility to select and embed human-like talking avatars (i.e. virtual agent) from its wide range of character database. Additionally, it also enables insertion of voice narrations, text, and images to design instructions as per needs. Based on the requirements of the instructional module, human-like avatar, text, images, and voice narrations were added to the e-learning modules by using this software. . The virtual agent that was used in the personalized voice with embodiment instructional module was selected from the character database of the software. Participants used their personal computers or mobile devices to participate in this study. A teleconferencing application was used to communicate with the participants and to conduct the study in a virtual setting. Blackboard CourseSite, a free learning management system (LMS), was used to host the e-learning modules. This is because the identified university uses the Blackboard LMS for most courses that are offered at the university. Therefore, it is the expectation that the students participating in this study would be familiar with this LMS.

Instructional materials. Most of the courses taught in the higher education setting fall under the emotionally neutral content areas (e.g. education leadership, business administration, instructional design and technology, and engineering among others) or emotionally aversive content areas (e.g. medical laboratory science, nursing, and dental hygiene among others). Therefore, it is important to assess the effects of social cue principles such as personalization, embodiment, and voice principles on learning across different content areas (i.e. emotionally neutral and emotionally aversive) as this will help make informed decisions about what works to promote learning of emotionally aversive and emotionally neutral information. The instructional modules that were used in this study were from health-related content area. One instructional module included information regarding cerebral hemorrhage and the other module included information about the how the human respiratory system operates. The instructional module on cerebral hemorrhage was considered to be emotionally aversive and the module on how the human respiratory system operates was considered to be emotionally neutral.

These two abovementioned instructional topics were selected because the topic of cerebral hemorrhage was empirically tested to be more emotionally aversive than the topic of the respiratory system (Kühl & Zander, 2017). Hence, it is certain that these two instructional contents are significantly different from each other in regard to the averseness of information. The module on cerebral hemorrhage included information about the definition of the respected disease/ illness, symptoms, causes (Kühl & Zander, 2017), diagnosis, treatment, and ways to prevent the respected illness. The module on respiratory system included information about the organs of the respiratory system, functions of organs in the upper and lower respiratory system, the three stages of respiration (i.e. inhaling, exchanging, and exhaling), and the process of respiration that takes place in each stage (Mayer et al., 2004).

In this study, the instructional modules were self-paced. That is, participants could take their time to proceed through the instructional slides to learn the material. They could use the back arrow and front arrow keys to go back and forth across the instructional slides to learn the material. In the personalized voice and personalized voice with embodiment conditions when speech narrations were employed to present the instructions, the participants could pause, rewind, or skip forward the voice instructions when they were interacting with the instructional modules. The instructional module on cerebral hemorrhage consisted of eight slides that included approximately 417 words and two images. The instructional module on how the human respiratory system operates consisted of seven slides that included approximately 370 words and two images. The number of words and images for the cerebral hemorrhage and how the human respiratory system operates remained consistent across the four multimedia instructional conditions.

Design of the multimedia instructions. There were four types of multimedia instructional styles: (a) non-personalized text instruction, (b) personalized text instruction, (c) personalized voice instruction, and (d) personalized voice with embodiment instruction that were employed to present the instructions on cerebral hemorrhage and how the human respiratory system operates to the participants. The following paragraphs describe the design of each of the abovementioned multimedia instructional style condition.

Non-personalized text condition. In this instructional style condition, instructions were presented in the non-personalized conversation style. The non-personalized conversation style (i.e. with no social cues) served as the control group for this study. The non-personalized multimedia instruction style presented instruction in a formal style by using the word “the” instead of the word “your” (Mayer, Fennell, Farmer, & Campbell, 2004). The instructions for both cerebral hemorrhage and how the human respiratory system operates were presented using the text format. No narrations were included in this instructional style condition. Wireframe of this instructional style is illustrated in Figure 2.

Personalized text condition. In this instructional condition, personalization principle (i.e. one social cue) was employed to design the multimedia instructions to present information on cerebral hemorrhage and how the human respiratory system operates. Based on the personalization principle, instructions were presented in the personalized conversation style that involved using first- and second-person point of view. That is, the word "your" was used instead of the word "the" when presenting the instructions (Mayer, Fennell, Farmer, & Campbell, 2004). This multimedia instructional style condition presented personalized instructions in a text-based format. No narrations were included in this instructional style condition. Wireframe of this instructional style is illustrated in Figure 2.

Personalized voice condition. In this condition, both personalization principle and voice principle (i.e. two social cues) were employed to design the multimedia instructions to present information on cerebral hemorrhage and how the human respiratory system operates. The instructions were presented in the personalized conversation style. Additionally, the instructions were presented via speech narrations instead of text-based instructions as voice principle was also employed in this condition. Human-voice was used to present the personalized instructions to the participants. The instructional narrations were presented in English by a female native English speaker. The instructional narrations were exactly the same as those that were presented in the personalized text instructional condition in a text-based format. No text-based instructions were added in this multimedia instructional condition. This is because including text instruction along with narrations would add redundancy to the instruction. This would cause split attention that would be detrimental for learning (Mayer & Moreno, 2003). Wireframe of this instructional style is illustrated in Figure 2.

Personalized voice with embodiment condition. In this condition, personalization, voice, and embodiment principles (i.e. three social cues) were employed to design the multimedia instructions to present information on cerebral hemorrhage and how the human respiratory system operates. That is, the additive effects of all three social cue principles on learning was assessed in this instructional condition. Just like the personalized voice condition, instructions in this condition were also presented via speech narrations in personalized conversation style. Additionally, no text-based instructions were added in this multimedia instructional condition to avoid redundancy. Along with this, embodiment (i.e. virtual agent) were included on each slide of the instructional modules however, the position of the virtual agent on the screen varied. The virtual agent displayed human-like facial expressions and gestures when instructional speech narrations were being presented to the participants. Wireframe of this instructional style is illustrated in Figure 2.

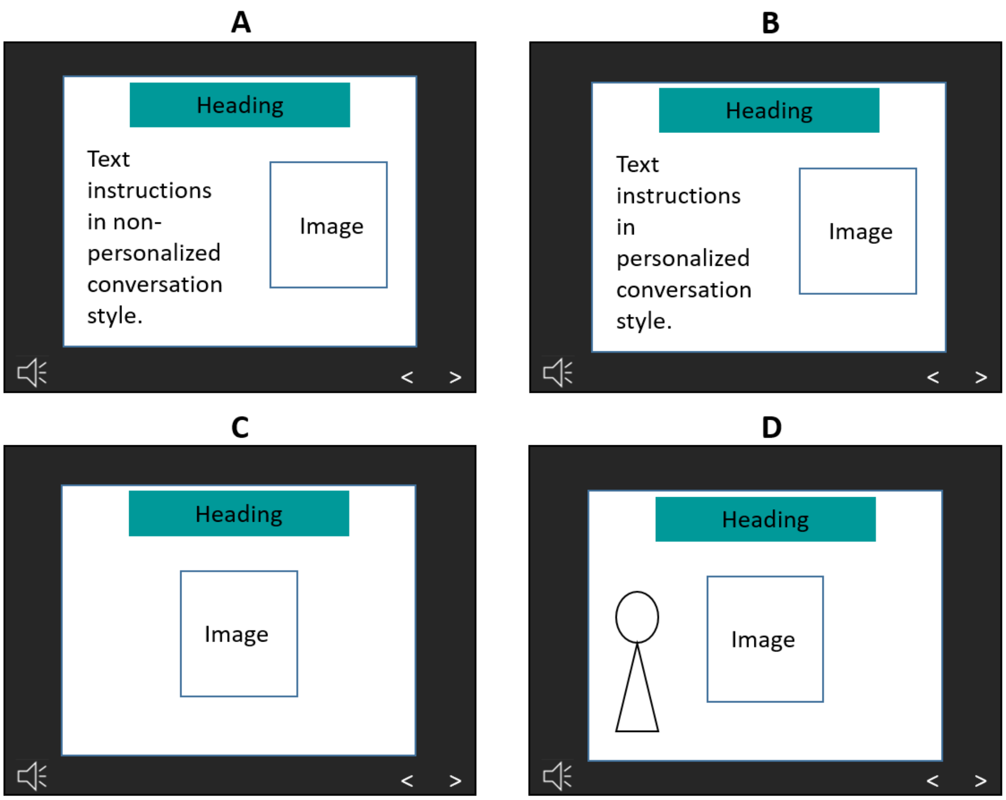

Figure 2. Example of wireframes illustrating the different multimedia instructional style conditions. A = Non-personalized text; B = Personalized text; C = Personalized voice; D = Personalized voice with embodiment. Text-based instructions were presented in the non-personalized text and personalized text instructional conditions. Speech narrations were employed to present instructions in the personalized voice and personalized voice with embodiment instructional conditions.

Instruments

Background information questionnaire. Background information questionnaire (Appendix A) was used to collect participants' demographic information such as age, sex, ethnicity, year in school, prior knowledge regarding how the respiratory system works and regarding cerebral hemorrhage, and experience with computer-based and web-based courses.

NASA task load index (TLX). The NASA TLX questionnaire (Appendix B) was used to measure participants' perceived cognitive load after they have completed each e-learning module. This questionnaire was developed by Hart and Staveland (1988). This questionnaire measures six factors (i.e. mental demand, temporal demand, physical demand, frustration, effort, and performance) that contribute to the overall cognitive load. This questionnaire has a test-retest reliability of $r = .769$ (Battiste & Bortolussi, 1988). Wiebe, Roberts, and Behrend (2010) evaluated the appropriateness of employing the NASA-TLX questionnaire and subjective cognitive load (SCL) questionnaire to measure cognitive load in a multimedia learning environment. The authors reported that both NASA-TLX and SCL were effective in detecting differences between the instructional modules and thereby, were effective in measuring changes in the intrinsic load. Additionally, the NASA-TLX questionnaire was found to be more sensitive to measure cognitive load than the SCL scale when self-paced materials were used in a non-laboratory (i.e. classroom) setting and when extraneous load was manipulated using cueing, and split-attention or modality effects; however, only when the intrinsic load level was not low (Wiebe, Roberts, & Behrend, 2010). The present study found a Cronbach α of .634 and .570 for the NASA-TLX scale for emotionally neutral and emotionally aversive instructional units respectively.

Emotion assessment scale. An emotion assessment scale (Appendix C) was used to assess participants' emotions and feelings after they interact with the instructional materials. This questionnaire consisted of the following statements that were rated on a 7-point Likert scale: I am feeling disgusted, I am feeling anxious, I am trying to avoid thinking about some aspects of the material, and I am feeling depressed. This questionnaire was adapted from Kühl and Zander (2017). The present study found a Cronbach α of .766 and .843 for emotionally neutral and emotionally aversive instructional units respectively.

Attitude questionnaire. The attitude questionnaire (Appendix D) was adapted and elaborated from Moreno and Mayer (2004). The questionnaire consists of eight statements on level of friendliness, helpfulness, difficulty, motivation, and interest of the instructional material that are rated using a 10-point Likert scale. The following statement was used to measure friendliness: How friendly was the computer that you interacted with? (1 =not very friendly, 10= very friendly). Helpfulness was measured using the following statement: how helpful is this material for learning about human respiratory/ system/ cerebral hemorrhage) (1= unhelpful, 10= helpful). Moreno and Mayer (2004) also used another statement to measure helpfulness of the program to learn the relationship between the related things (i.e. plant design & environment). However, this type of statement was not applicable to the contents used in this study. Therefore, no such statement was included in this questionnaire. The following two statements were used to measure participants' perceived difficulty with learning the materials: How difficult was the material? (1= easy, 10= difficult), and how much effort is required to learn the material? (1= little, 10= much). Participants' motivation was assessed using the following statement: if you had a chance to use this instructional style with new instructional content, how eager would you be to do so? (1= not eager, 10= very eager). Participants' level of interest in the instructional material was measured using the following statements: How interesting is this material? (1= boring, 10= interesting), and how entertaining is this material? (1= tiresome, 10= entertaining) (Moreno & Mayer, 2004). Participants' responses to the difficulty scale indicated the cognitive capacity available for the deep processing of information. This method of measuring attitude and cognitive capacity is similar to the one used by Moreno and Mayer (2004). Moreno and Mayer (2004) did not provided information about reliability or validity of this scale. However, the present study reported a Cronbach α of .768 for this attitude questionnaire for both emotionally neutral and emotionally aversive instructional units.

Learning achievement tests. Learning achievement test measured participants' knowledge on cerebral hemorrhage (Appendix E) and how the human respiratory system operates (Appendix F) after they completed the respected instructional modules. Each assessment consisted of three multiple-choice items that measured participants' retention of knowledge and two essay questions that measured their transfer of knowledge. Participants received one point for each correct response to multiple-choice questions and the essay questions. The essay questions were scored based on the accuracy of the response.

The following are the questions that were used to assess participants' retention of knowledge on cerebral hemorrhage: What are the causes of cerebral hemorrhage?, which of the following statements is true about cerebral hemorrhage?, and which of these is a symptom associated with cerebral hemorrhage?. The following are the questions that were used to assess participants' transfer of knowledge on cerebral hemorrhage: How can maintaining normal blood pressure affect the probability of suffering from cerebral hemorrhage?, what type of medical innovations could help prevent severe cerebral hemorrhage? (Please elaborate) (Kühl & Zander, 2017) (see Appendix E).

The following are the multiple-choice questions that were used to assess participants' retention of knowledge on how the respiratory system works: Which of these are organs of the lower respiratory system?, which of the following statements is true about the process of respiration that takes place during the exchange stage?, and which of the following statements is true about trachea?. The following are the essay questions that were used to assess participants' transfer of knowledge on how the respiratory system works: "Suppose you are a scientist trying to improve the human respiratory system. How could you get more oxygen into the bloodstream faster?", and "A researcher makes the claim that pollution causes heart disease. Explain why this would be true" (Mayer et al., 2004, p. 391) (see Appendix F). There is no information available about the reliability and validity of the learning assessments.

Procedure

Sixty college students from a mid-sized university located on the east coast of the United States participated in this study virtually using a teleconferencing application. Participants were asked to read and sign the informed consent form (Appendix G) if they wished to participate in the study. This form was used to inform the participants about the experiment, the tasks that they would perform during the experiment, and the potential risks and benefits of participating in the study. This form also stated information about participants' right to quit the study at any time without being penalized.

The researcher randomly assigned each participant to one of the four instructional design style conditions. Participants were asked to complete a background information questionnaire. Participants in each condition were then asked to complete a short self-paced e-learning instructional module on how the respiratory system works (i.e. emotionally neutral content) and the causes and treatments of cerebral hemorrhage (i.e. emotionally aversive content). The order of the instructional content was randomized to eliminate any order effects. Time spent by participants on each instructional module was measured using a stopwatch. After completing each e-learning instructional module, participants were asked to complete a short emotion assessment, NASA TLX cognitive load questionnaire, and attitude questionnaire. The emotion assessment was used to measure participants' emotions after they interacted with the instructional content. The NASA TLX questionnaire was administered to assess participants' perceived cognitive load by measuring different factors of cognitive load (i.e. mental demand, temporal demand, physical demand, performance, effort, and frustration). The attitude questionnaire was administered to assess participants' attitudes toward the learning material.

After participants complete the questionnaires, they were asked to complete a short retention test and a transfer test. Participants had no time-limit to complete the assessments. They were given a three-minute break between the first and the second e-learning session to help avoid fatigue effects. Figure 3 provides visualization of the procedure used in this study. After completing both the e-learning sessions and assessments, participants were debriefed and thanked for their participation. All participants were entered into a random drawing for a chance to win one of four $10 gift cards to the local retailer.

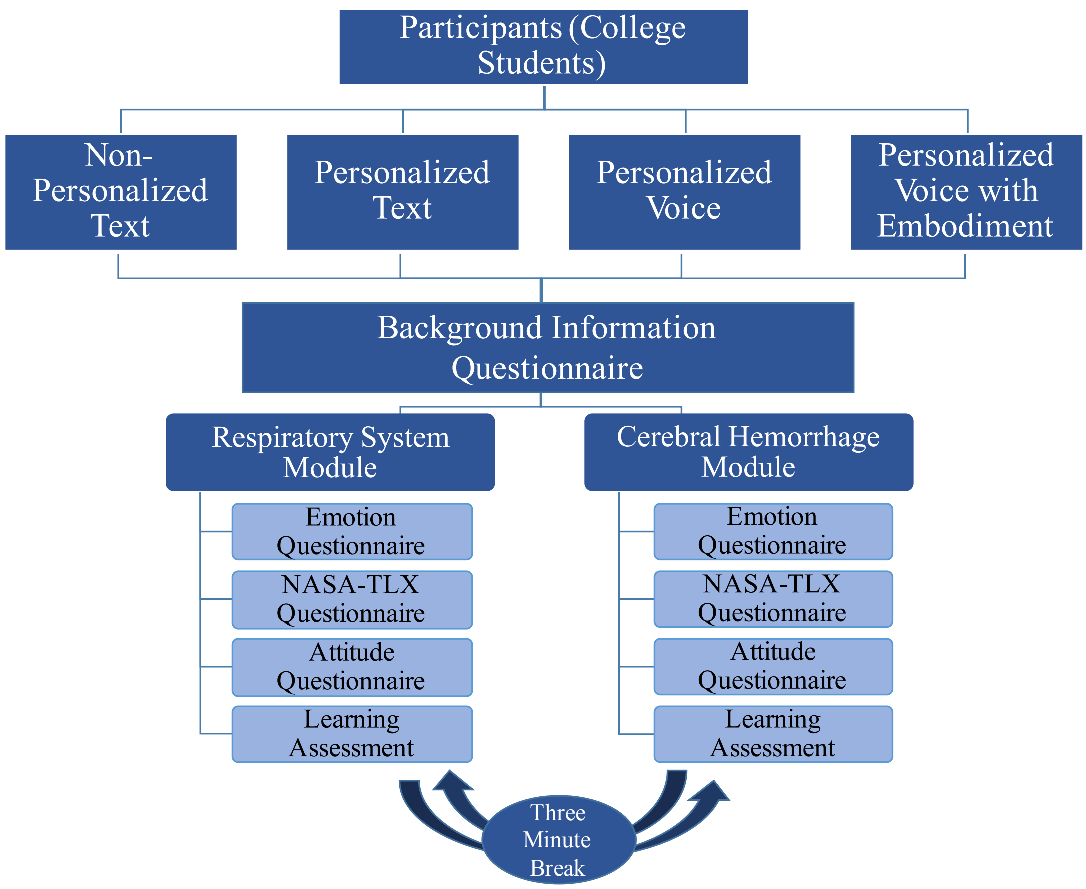

Figure 3. Flow-chart visualizing the procedure used in this study.

Data Analysis

The following paragraphs provide information about the data that was used to address each research question (RQ) identified in this study.

RQ 1. Time that participants spent on each instructional module was measured using a stopwatch. Time spent on instructional modules was measured in seconds. The time scores were used to address the first research question: To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on time spent on instructional modules?

RQ 2. Participants' scores on NASA TLX questionnaire were used to address the second research question: To what extent do instructions containing personalization, voice, and embodiment principles (i.e. social cues) collectively have an additive effect on learners' perceived cognitive load?

RQ 3. Participants' ratings on the emotion assessment scale were used to address the third research question: To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' emotional state?

RQ 4. Participants' ratings on the attitude questionnaire were used to address the fourth research question: To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' attitude towards learning the material?

RQ 5. Participants' correct response scores on the retention test and the transfer test were collected to assess the fifth research question: To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' learning outcomes (i.e. retention and transfer test scores)?

This was a quantitative research study. All the data were entered into the Statistical Program for the Social Sciences (SPSS) software. The data were screened for normality, outliers, and missing scores. Additionally, the data were examined to ensure that there were equal number of participants in each condition. There were no missing scores in the data. There were no outliers in the time spent on module, retention of knowledge, and transfer of knowledge data. However, there were some outliers in the emotions, workload, and attitude towards the learning materials data. The outliers were counted as extreme scores and were therefore, not excluded from the data.

The normality test suggested that only the data on time spent on module and cognitive load in the cerebral hemorrhage (i.e. emotionally aversive) condition were normally distributed. Hence, the normality assumption was violated for the other dependent variables. However, Analysis of Variance (ANOVA) is robust to the violation of the normality assumption (Maxwell & Delaney, 2004, p. 112). In this study, the alpha level for statistical significance was determined as $p < .05$. Levene's tests indicated that the assumption of homogeneity of variance was met for most of the ANOVAs. The homogeneity of variance assumption was violated for transfer scores in the cerebral hemorrhage condition, friendliness scores for both aversive and neutral emotional conditions, and scores for feelings of disgust in both aversive and neutral emotional conditions and for feelings of depress scores in emotionally neutral condition. However, ANOVA is robust to the violation of the homogeneity of variance assumption as there are equal number of participants in each group (Maxwell & Delaney, 2004, p. 112).

In this study, scores from self-rated subjective questionnaires and assessments were used to answer the research questions. Participants' information collected using the background information questionnaire was used to learn about the characteristics of the sample. Participants' self-rating scores on prior knowledge scale for each instructional content was used to measure their perceived prior knowledge. These scores were used to identify if there was a pre-existing difference in learners' knowledge. Analysis of Variance (ANOVA) was conducted to see if there is a significant difference in the participants' prior knowledge of cerebral hemorrhage and respiratory system across instructional style conditions. Repeated measures split-plot ANOVA was conducted to assess the main effects and interaction effects of independent variables on the dependent variables (i.e. time on module, perceived cognitive load, emotions, attitude, and learning outcomes). Additionally, paired-samples t-test was conducted to compare the levels of workload between the emotionally neutral and emotionally aversive conditions. Table 1 provides specifications regarding the alignment between the research questions, the variables assessed for each research question, and the analysis method conducted to examine the data.

Table 1.

Specifications for Research Questions, Variables, and Data Analysis Method.

Research Questions	Variables	Analysis
1) To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on time spent on instructional modules?	IV_1: Multimedia instructional style IV_2: Averseness of information. DV: Time spent on instructional modules	Repeated Measures Split-plot ANOVA
2) To what extent do instructions containing personalization, voice, and embodiment principles (i.e. social cues) collectively have an additive effect on learners' perceived cognitive load?	IV_1: Multimedia instructional style IV_2: Averseness of information DV: Perceived cognitive load	Repeated Measures Split-plot ANOVA Paired Sample t-test.
3) To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' emotional state?	IV_1: Multimedia instructional style IV_2: Averseness of information DV: Emotional state	Repeated Measures Split-plot ANOVA
4) To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' attitude towards learning material?	IV_1: Multimedia instructional style IV_2: Averseness of information. DV: Attitude towards learning material	Repeated Measures Split-plot ANOVA
5) To what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' learning outcomes (i.e. retention and transfer test scores)?	IV_1: Multimedia instructional style IV_2: Averseness of information DV: Learning outcomes	Repeated Measures Split-plot ANOVA

CHAPTER III

RESULTS

Prior Knowledge

The analysis of variance (ANOVA) suggested that there was no significant difference between multimedia instructional style groups for prior knowledge scores on cerebral hemorrhage $F(3, 56) = .938$, $p = .428$, *partial* $\eta^2 = .048$, observed power = .244 and how the human respiratory systems operates $F(3, 56) = .089$, $p = .966$, *partial* $\eta^2 = .005$, observed power = .065. Participants reported having higher perceived prior knowledge for how the human respiratory system operates ($M = 4.80$, $SD = 2.07$) compared to cerebral hemorrhage ($M = 2.82$, $SD = 2.05$) content area. However, perceived prior knowledge score had no significant effect on participants' retention of knowledge scores for how the human respiratory system operates, $F(9, 50) = 1.079$, $p = .394$, *partial* $\eta^2 = .163$, observed power = .470 and for cerebral hemorrhage, $F(8, 51) = 1.635$, $p = .138$, *partial* $\eta^2 = .204$, observed power = .653 content areas, and on participants' transfer of knowledge scores for how the human respiratory system operates, $F(9, 50) = .311$, $p = .968$, *partial* $\eta^2 = .053$, observed power = .143 and for cerebral hemorrhage, $F(8, 51) = .646$, $p = .736$, *partial* $\eta^2 = .092$, observed power = .265 content areas.

Time Spent on Instructional Modules

The analysis of the repeated measures split-plot Analysis of variance (ANOVA) indicated that there was a significant interaction effect of averseness of information and multimedia instructional style on time spent on module $F(3, 56) = 2.812$, $p = .048$, *partial* $\eta^2 = .131$, observed power = .646. Follow-up simple effects analysis revealed that there was a significant effect of multimedia instructional style on time spent on modules for both aversive (i.e. cerebral hemorrhage) $F(3, 56) = 8.559$, $p < .001$, *partial* $\eta^2 = .314$ and non-aversive (i.e. respiratory systems) $F(3, 56) = 12.370$, $p < .001$, *partial* $\eta^2 = .399$ conditions. The simple effects analysis also revealed that there was a significant effect of averseness of information on time spent on modules, but only in the personalized voice embodiment condition $F(1, 56) = 11.434$, $p = .001$, *partial* $\eta^2 = .170$. Such that, participants in the personalized voice embodiment condition spent more time on the non-aversive module (*M* = 322.12, *SD* = 106.60) than the aversive module (*M* = 260.78, *SD* = 84.82) (see Figure 4).

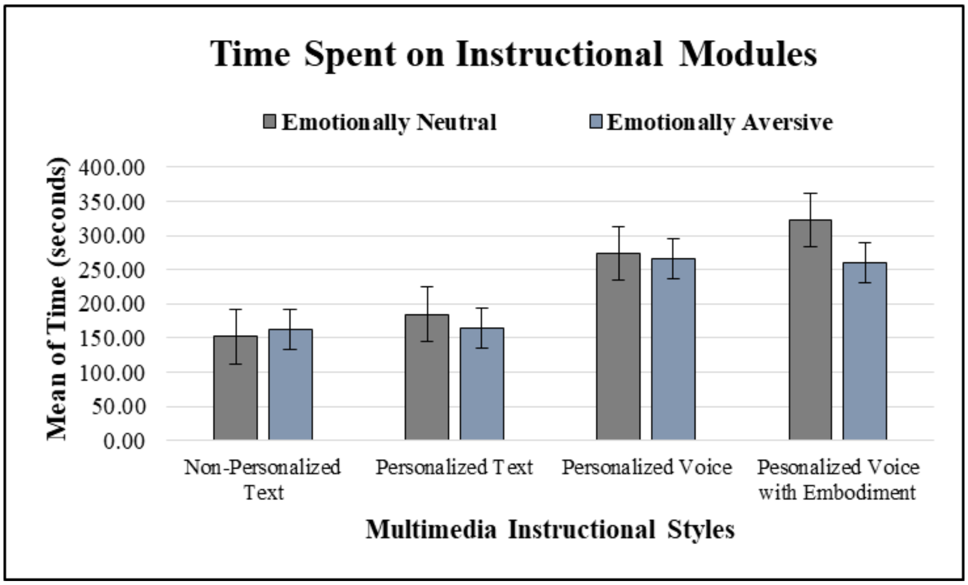

Figure 4. Mean of time spent on instructional modules across multimedia instructional style conditions.

There was a main effect of averseness of information on time spent on modules, $F(1, 56) = 4.802$, $p = .033$, *partial* $\eta^2 = .079$, observed power = .577. Participants spent more time on the emotionally neutral (i.e. respiratory systems) module (*M* = 233.24, *SD*= 108.53) than the emotionally aversive (i.e. cerebral hemorrhage) module (*M* = 213.36, *SD* = 90.63). There was also a main effect of multimedia instructional style on time spent on modules, $F(3, 56) = 12.460$, $p < .001$, *partial* $\eta^2 = .400$, observed power = 1.000. Participants spent highest amount of time on modules in the personalized voice embodiment condition (*M* = 291.448, *SE* = 19.45) and the least amount of time in the non-personalized text condition (*M* = 157.14, *SE* = 19.19).

Follow-up Bonferroni comparison revealed that the amount of time spent on modules was significantly less in the non-personalized text condition (*M* = 157.14, *SE* = 19.09) than in the personalized voice condition (*M* = 270.24, *SE* = 19.09) ($p = .001$) and personalized voice with embodiment condition (*M* = 291.45, *SE* = 19.09) ($p < .001$). Time spent on modules in the personalized voice with embodiment condition (*M* = 291.45, *SE* = 19.09) was significantly higher than that in the personalized voice condition (*M* = 270.24, *SE* = 19.09) and personalized text condition (*M* = 174.38, *SE* = 19.09) ($p < .001$). The time spent on modules in the personalized voice condition (*M* = 270.24, *SE* = 19.09) was significantly higher than that in the personalized text condition (*M* = 174.38, *SE* = 19.09) ($p = .005$).

Cognitive Load

The results indicate that there was no significant main effect of averseness of information on participants' cognitive load, $F(1, 56) = 1.333$, $p = .253$, *partial* $\eta^2 = .023$, observed power = .206. Participants' cognitive load in the emotionally aversive condition (*M* = 31.41, *SE* = 1.60) was not significantly different from the emotionally neutral condition (*M* = 29.82, *SE* = 1.52). There was no main effect of multimedia instructional style on participants' cognitive load, $F(3, 56) = 1.391$, $p = .255$, *partial* $\eta^2 = .069$, observed power = .350. However, participants in the non-personalized text condition reported having higher cognitive load (*M* = 33.87, *SE* = 2.80) than participants in the personalized text (*M* = 26.01, *SE* = 2.80), personalized voice (*M* = 31.01, *SE* = 2.80), and personalized voice with embodiment (*M* = 31.56, *SE* = 2.80) conditions. Additionally, there was no significant interaction effect of averseness of information and multimedia instructional style on participants' cognitive load, $F(3, 56) = .079$, $p = .971$, *partial* $\eta^2 = .004$, observed power = .063 (see Figure 5).

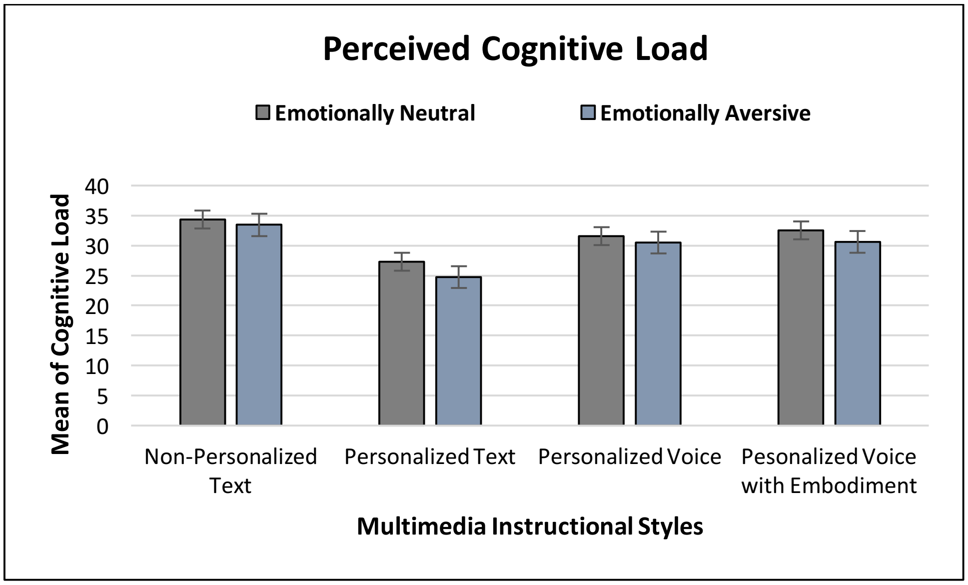

Figure 5. Mean scores of perceived cognitive load across multimedia instructional conditions.

A paired-samples t-test was employed to compare the levels of workload (i.e. mental demand, physical demand, temporal demand, frustration, effort, and performance) between emotionally aversive and emotionally neutral condition. The results indicated that there was no significant difference in the means of mental demand $t(59) = -1.917$, $p = .060$, $d = -.25$, physical demand $t(59) = -.469$, $p = .641$, $d = -.06$, temporal demand $t(59) = .499$, $p = .620$, $d = .06$, effort $t(59) = -1.568$, $p = .122$, $d = -.20$, performance $t(59) = 1.174$, $p = .245$, $d = .15$, and frustration $t(59) = -1.542$, $p = .129$, $d = -.20$. Means and standard deviations for each level of workload across averseness of information condition are listed in Table 2.

Table 2.

Means and standard deviations for each level of workload across averseness of information conditions.

Levels of Workload	*Averseness of Information*	*M*	*SD*
Mental Demand	1	43.50	25.14
	2	38.13	26.01
Temporal Demand	1	16.93	17.67
	2	18.07	20.26
Physical Demand	1	5.27	7.91
	2	4.83	9.54
Effort	1	32.40	26.20
	2	28.22	27.32
Performance	1	75.22	23.34
	2	78.25	20.50
Frustration	1	15.13	19.02
	2	11.40	18.38

Note. Averseness of Information. Level 1 = emotionally neutral condition; Level 2 = emotionally aversive condition.

Emotions

Disgust. The repeated measures ANOVA analysis suggested that there was a significant main effect of averseness of information on participants' feeling of disgust, $F(1, 56) = 6.502$, $p = .014$, *partial* $\eta^2 = .104$, observed power = .707. Such that, participants reported having high feelings of disgust in the emotionally aversive condition ($M = 1.35$, $SD = .82$) than in the emotionally neutral condition ($M = 1.12$, $SD = .32$). There was no significant main effect of multimedia instructional style on participants' feeling of disgust, $F(3, 56) = 1.681$, $p = .181$, *partial* $\eta^2 = .083$, observed power = .417. However, the means indicated that participants' feeling of disgust was highest in the personalized voice condition ($M = 1.47$, $SE = .131$) and lowest in the personalized voice with embodiment condition ($M = 1.07$, $SE = .131$). Additionally, there was no significant interaction effect of averseness of information and multimedia instructional style on participants' feeling of disgust, $F(3, 56) = .389$, $p = .755$, *partial* $\eta^2 = .021$, observed power = .124. Means and standard errors for participants' feeling of disgust for emotionally neutral and emotionally aversive conditions across multimedia instructional styles are reported in Table 3.

Avoidance. The results indicated that there was a significant main effect of averseness of information on participants' feeling of avoiding to think about certain aspects of the topic, $F(1, 56) = 8.255$, $p = .006$, *partial* $\eta^2 = .128$, observed power = .806. That is, participants reported avoiding thinking about certain aspects of the topic in the emotionally aversive condition ($M = 1.62$, $SD = 1.21$) than in the emotionally neutral condition ($M = 1.20$, $SD = .44$). There was no significant main effect of multimedia instructional style on participants' feeling of avoiding to think about certain aspects of the topic, $F(3, 56) = .254$, $p = .858$, *partial* $\eta^2 = .013$, observed power = .095. Additionally, there was no significant interaction effect of averseness of information and multimedia instructional style on participants' feeling of avoiding to think about certain aspects of the topic, $F(3, 56) = .506$ $p = .680$, *partial* $\eta^2 = .026$, observed power = .147. Means and standard errors for participants' feeling of avoiding to think about certain aspects of the topic for emotionally neutral and emotionally aversive conditions across multimedia instructional styles are listed in Table 3.

Anxiousness. The results indicated that there was no significant main effect of averseness of information on participants' feeling of anxiousness, $F(1, 56) = 2.555$, $p = .116$, *partial* $\eta^2 = .044$, observed power = .349. There was no significant main effect of multimedia instructional style on participants' feeling of anxiousness, $F(3, 56) = .153$, $p = .928$, *partial* $\eta^2 = .008$, observed power = .076. Additionally, there was no significant interaction effect of averseness of information and multimedia instructional style on participants' feeling of anxiousness, $F(3, 56) = .295$ $p = .829$, *partial* $\eta^2 = .016$, observed power = .103. Means and standard errors for participants' feeling of anxiousness for emotionally neutral and emotionally aversive conditions across multimedia instructional styles are listed in Table 3.

Depress. The results suggest that there was a significant main effect of averseness of information on participants' feelings of depress, $F(1, 56) = 4.187$, $p = .045$, *partial* $\eta^2 = .070$, observed power = .520. That is, participants reported feeling more depressed in the emotionally aversive condition ($M = 1.23$, $SD = .65$) than in the emotionally neutral condition ($M = 1.10$, $SD = .44$). There was no significant main effect of multimedia instructional style on participants' feeling of depress, $F(3, 56) = .582$, $p = .629$, *partial* $\eta^2 = .030$, observed power = .163. Additionally, there was no significant interaction effect of averseness of information and multimedia instructional style on participants' feeling of depress, $F(3, 56) = .872$ $p = .461$, *partial* $\eta^2 = .045$, observed power = .228. Means and standard errors for participants' feeling of depress for emotionally neutral and emotionally aversive conditions across multimedia instructional styles are included in Table 3.

Table 3.

Means and standard errors for participants' emotions in emotionally neutral and emotionally aversive conditions across multimedia instructional styles.

Emotions	Averseness of Information	Non-Personalized Text		Personalized Text		Personalized Voice		Personalized Voice with Embodiment	
		M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Disgust	1	1.13	.08	1.07	.08	1.27	.08	1.00	.08
	2	1.33	.21	1.27	.21	1.67	.21	1.13	.21
Avoidance	1	1.27	.12	1.13	.12	1.27	.12	1.13	.12
	2	1.40	.32	1.73	.32	1.80	.32	1.53	.32
Anxiousness	1	1.53	.22	1.33	.22	1.20	.22	1.47	.22
	2	1.67	.28	1.53	.28	1.67	.28	1.60	.28
Depress	1	1.27	.11	1.07	.11	1.07	.11	1.00	.11
	2	1.33	.17	1.27	.17	1.07	.17	1.27	.17

Note. Averseness of Information. Level 1 = emotionally neutral condition; Level 2 = emotionally aversive condition.

Attitude towards the Learning Materials

Friendliness. The repeated measures split-plot ANOVA revealed that there was no significant main effect of averseness of information on participants' rating of the friendliness of the instructional module, $F(1, 56) = .109$, $p = .742$, *partial* $\eta^2 = .002$, observed power = .062. There was no difference between the participants' rating of the friendliness of the instructional module for the emotionally neutral ($M = 7.90$, $SD = 1.93$) and emotionally aversive ($M = 7.97$, $SD = 2.31$) content areas. There was no significant main effect of multimedia instructional style on participants' rating of the friendliness of the instructional module, $F(3, 56) = 2.227$, $p = .095$, *partial* $\eta^2 = .107$, observed power = .535. However, the trends suggested that participants in the non-personalized text condition rated the instructional modules to be friendlier ($M = 8.80$, $SE = .496$) than participants in the personalized text condition ($M = 8.23$, $SE = .496$), personalized voice condition ($M = 7.10$, $SE = .496$), and personalized voice with embodiment condition ($M = 7.60$, $SE = .496$). There was no significant interaction effect of averseness of information and multimedia instructional style on participants' rating of the friendliness of the instructional module, $F(3, 56) = .927$, $p = .434$, *partial* $\eta^2 = .047$, observed power = .241.

Helpfulness. The results indicated that there was no significant main effect of averseness of information on participants' rating of the helpfulness of the instructional module, $F(1, 56) = 1.751$, $p = .191$, *partial* $\eta^2 = .030$, observed power = .255. That is, there was no difference between the participants' rating of the helpfulness of the instructional module for the emotionally neutral ($M = 7.77$, $SD = 2.06$) and emotionally aversive ($M = 8.08$, $SD = 1.85$) content areas. However, there was a significant main effect of multimedia instructional style on participants' rating of the helpfulness of the instructional module, $F(3, 56) = 3.483$, $p = .022$, *partial* $\eta^2 = .157$, observed power = .749. Such that, participants' rating of the helpfulness of the instructional module in the non-personalized text condition (*M* = 8.80, *SE* = .42) was higher than those reported for personalized text condition (*M* = 8.17, *SE* = .42), personalized voice condition (*M* = 6.93, *SE* = .42), and personalized voice with embodiment condition (*M* = 7.80, *SE* = .42). The follow-up Bonferroni post-hoc analysis suggested that the means of participants' perceived helpfulness of the instructional module in the non-personalized text (*M* = 8.80, *SE* = .42) was significantly higher than that in the personalized voice condition (*M* = 6.93, *SE* = .42) ($p = .003$). There was no significant interaction effect of averseness of information and multimedia instructional style on participants' rating of the helpfulness of the instructional module, $F(3, 56) = 1.803$, $p = .157$, *partial* $\eta^2 = .088$, observed power = .444.

Difficulty. The results indicated that there was no significant main effect of averseness of information on participants' rating of the difficulty of the instructional module, $F(1, 56) = .145$, $p = .705$, *partial* $\eta^2 = .003$, observed power = .066. That is, there was no difference between the participants' rating of the difficulty of the instructional module for the emotionally neutral (*M* = 4.97, *SD* = 2.12) and emotionally aversive (*M* = 4.85, *SD* = 2.18) content areas. There was no significant main effect of multimedia instructional style on participants' rating of the difficulty of the instructional module, $F(3, 56) = .403$, $p = .751$, *partial* $\eta^2 = .021$, observed power = .125. However, the trends indicate that participants in the personalized voice with embodiment condition rated the instructional modules as more difficult (*M* = 5.33, *SE*= .453) than those in the non-personalized text condition (*M* = 4.82, *SE*= .453), personalized text condition (*M* = 4.68, *SE*= .453), and personalized voice condition (*M* = 4.82, *SE*= .453). There was no significant interaction effect of averseness of information and multimedia instructional style on participants' rating of the difficulty of the instructional module, $F(3, 56) = 1.342$, $p = .270$, *partial* $\eta^2 = .067$, observed power = .338.

Motivation. The results indicated that there was no significant main effect of averseness of information on participants' motivation level, $F(1, 56) = 1.269$, $p = .265$, *partial* $\eta^2 = .022$, observed power = .198. That is, there was no difference between the participants' motivation level in the emotionally neutral ($M = 5.58$, $SD = 2.55$) and emotionally aversive ($M = 5.87$, $SD = 2.74$) content areas. However, there was a significant main effect of multimedia instructional style on participants' motivation level, $F(3, 56) = 3.635$, $p = .018$, *partial* $\eta^2 = .163$, observed power = .769. The follow-up Bonferroni post-hoc analysis indicated that participants' motivation level was significant higher in the non-personalized text condition ($M = 7.13$, $SE = .60$) compared to the personalized voice condition ($M = 4.40$, $SE = .60$) ($p = .012$). There was no significant interaction effect of averseness of information and multimedia instructional style on participants' motivation level, $F(3, 56) = .942$, $p = .686$, *partial* $\eta^2 = .026$, observed power = .144.

Interest. The results indicated that there was no significant main effect of averseness of information on participants' interest level, $F(1, 56) = .906$, $p = .345$, *partial* $\eta^2 = .016$, observed power = .155. That is, there was no significant difference between participants' interest level in the emotionally neutral ($M = 5.37$, $SE = .28$) and emotionally aversive condition ($M = 5.56$, $SE = .30$). There was no significant main effect of multimedia instructional style on participants' interest level, $F(3, 56) = .798$, $p = .500$, *partial* $\eta^2 = .041$, observed power = .211. However, the means indicated that participants reported having highest level of interest in the non-personalized text condition ($M = 6.03$, $SE = .54$) and lowest in the personalized voice condition ($M = 4.88$, $SE = .54$). There was no significant interaction effect of averseness of information and multimedia instructional style on participants' interest level, $F(3, 56) = 1.400$, $p = .252$, *partial* $\eta^2 = .070$, observed power = .352.

Learning Outcomes

Retention of knowledge. The results indicated that there was no significant main effect of averseness of information on retention of knowledge, $F(1, 56) = .129$, $p = .721$, *partial* $\eta^2 = .002$, observed power = .064. That is, there was no statistically significant difference in the means of retention scores for the emotionally neutral condition ($M = 1.28$, $SE = .106$) and emotionally aversive condition ($M = 1.33$, $SE = .121$). Also, there was no main effect of multimedia instructional style on retention of knowledge, $F(3, 56) = 1.365$, $p = .263$, *partial* $\eta^2 = .068$, observed power = .344. However, the means indicated that participants had the lowest retention scores in the non-personalized text condition ($M = 1.00$, $SE = .180$) and highest retention scores in the personalized voice with embodiment condition ($M = 1.47$, $SE = .180$). Additionally, there was no significant interaction effect of averseness of information and multimedia instructional style on retention of knowledge, $F(3, 56) = .512$, $p = .676$, *partial* $\eta^2 = .027$, observed power = .148 (see Figure 6).

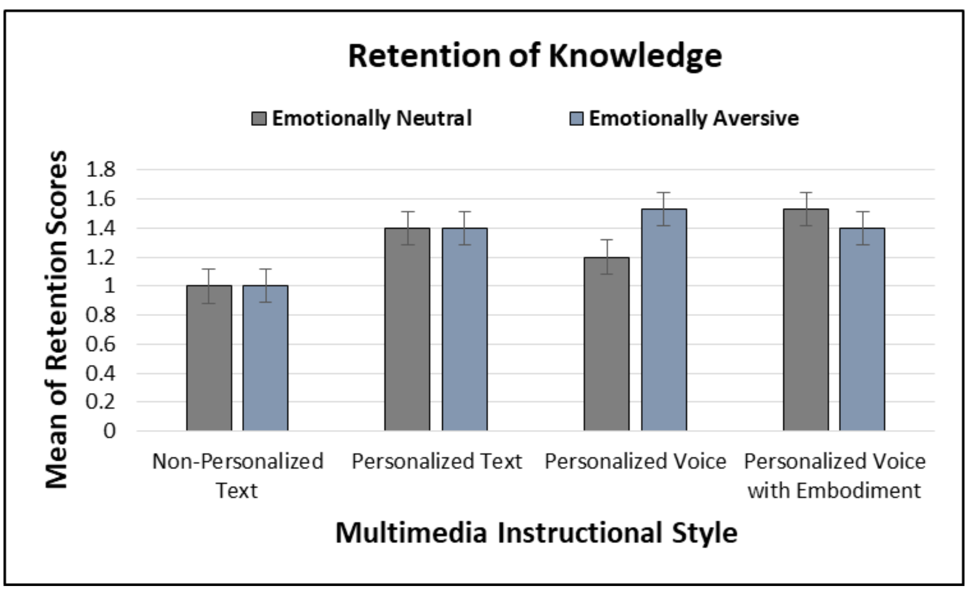

Figure 6. Mean of retention of knowledge scores across multimedia instructional style conditions.

Transfer of knowledge. The results indicated that there was no significant main effect of averseness of information on transfer of knowledge, $F(1, 56) = .000$, $p = 1.00$, *partial* $\eta^2 = .000$, observed power = .050. That is, there was no significant difference between participants' retention of knowledge in the emotionally neutral condition ($M = 1.33$, $SD = .933$) and emotionally aversive condition ($M = 1.28$, $SD = .825$). However, there was a significant main effect of multimedia instructional style on transfer of knowledge, $F(3, 56) = 2.854$, $p = .045$, *partial* $\eta^2 = .133$, observed power = .653. Participants had the highest transfer knowledge score in the personalized text condition ($M = 1.03$, $SE = .139$) and the lowest transfer knowledge score in the personalized voice condition ($M = .567$, $SE = .139$). The pairwise comparison revealed that participants in the personalized text condition ($M = 1.03$, $SE = .139$) had significantly higher transfer knowledge scores than participants in the non-personalized text ($M = .633$, $SE = .139$) ($p = .046$) and personalized voice conditions ($M = .567$, $SE = .139$) ($p = .021$). Additionally, participants in the personalized voice with embodiment condition ($M = .967$, $SE = .139$) had significantly higher transfer knowledge scores than participants in the personalized voice conditions ($M = .567$, $SE = .139$). The repeated measures ANOVA analysis indicated no significant interaction effect of averseness of information and multimedia instructional style on transfer knowledge score $F(3, 56) = 1.989$, $p = .126$, *partial* $\eta^2 = .096$, observed power = .485 (see Figure 7).

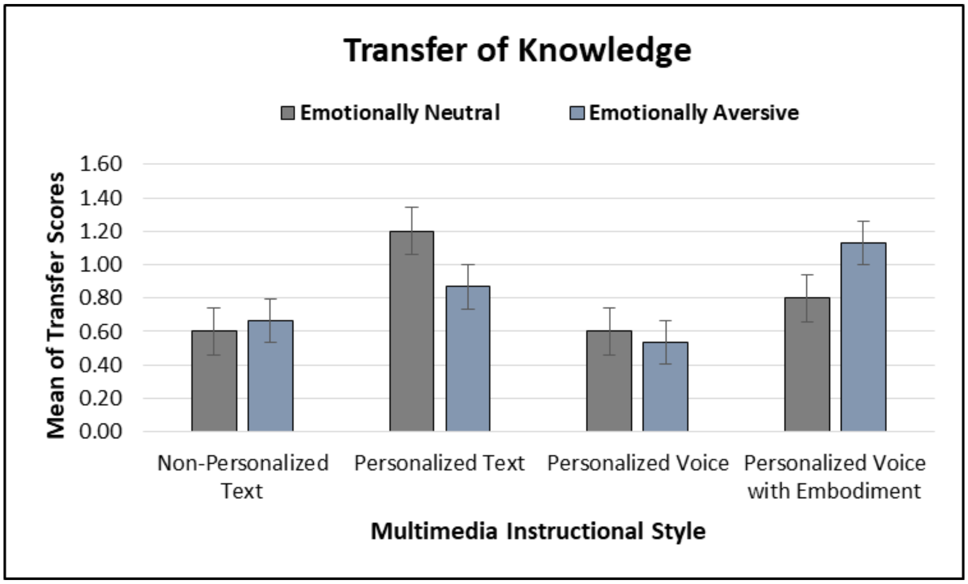

Figure 7. Mean of transfer of knowledge scores across multimedia instructional style conditions.

CHAPTER IV

DISCUSSION

The purpose of this study was to investigate whether there is an additive effect of employing personalization, voice, and embodiment design principles on learners' cognitive load, emotions, time on instructional module, attitude, and learning outcomes (i.e. retention and transfer of knowledge). The findings for each research question are discussed in the following paragraphs.

Research Question 1

In this study, the time that participants spent on each instructional module was calculated to address research question 1 that is to what extent do instructions containing personalization, voice, and embodiment principles (i.e. social cues) collectively have an additive effect on the time that learners spend on the instructional modules to learn the information? This was an exploratory research question and therefore, there was no specific hypothesis for this research question. Hence, the discussion of the results for this research question is limited to this study. The results indicated that both averseness of information and multimedia instructional style had a significant effect on the time that learners spent on the instructional module. It was found that learners spent more time on the emotionally neutral (i.e. how the human respiratory system operates) instructional module than on the emotionally aversive (i.e. cerebral hemorrhage) instructional module. Specifically, participants who received instructions in the personalized voice with embodiment spent more time on the emotionally neutral instructional module than the emotionally aversive instructional module. Additionally, participants in the personalized voice with embodiment instructional condition spent more time on the instructional units compared to those participants in the other three multimedia instructional style conditions.

The results indicated that participants spent the least amount of time on instructional units when the instructions were presented in non-personalized text format. Therefore, it can be concluded that using personalized instruction helps increase time spent on instructional modules. It was also found that as the number of social cues (i.e. personalization, voice, and embodiment) increases, the time spent on instructional module also increases for emotionally neutral contents. This is probably the reason why personalized voice condition had higher score for time spent on instructional module than the personalized text condition and the personalized voice with embodiment condition had higher score for time spent on instructional module than the personalized voice condition.

The findings indicated that employing personalization, voice, and embodiment principles together had an additive effect on the time that participants spent on instructional modules to learn the information. Such that, in the personalized voice with embodiment instructional condition, participants spent highest amount of time on the instructional modules specifically, if the information in the instructional module was emotionally neutral. Hence, personalization, voice, and embodiment principles could be additively used to make the learners spend more time on the instructional units and to thereby increase the time they spend interacting with the learning materials.

Research Question 2

Participants' perceived cognitive load was determined using the NASA-TLX questionnaire to address the second research question that is to what extent do instructions containing personalization, voice, and embodiment principles (i.e. social cues) collectively have an additive effect on learners' perceived cognitive load? The results indicated that there was no statistically significant effect of averseness of information and multimedia instructional style on participants' perceived cognitive load. However, the means suggested that participants reported having higher cognitive load in the non-personalized text condition compared to the other three personalized instruction conditions for both emotionally neutral and emotionally aversive instructional content conditions. Participants experienced lowest cognitive load in the personalized text condition. These results supported the findings reported by Park (2015) that employing personalized instructions help reduce learners' cognitive load and thereby, help improve cognitive processing of the information. The results of this study did not support the hypothesis that participants in the personalized voice with embodiment condition will have lower perceived cognitive load than the students in the other treatment groups across instructional content conditions (elaborated from Park, 2015). However, the hypothesis was partially supported as the participants in the personalized voice with embodiment condition reported having lower cognitive load than the participants in the non-personalized text condition.

The results indicated that participants' cognitive load increased as the number of social cues were added to the personalized instructions. That is, participants in the personalized text condition had lower cognitive load than those in the personalized voice condition; and participants in the personalized voice condition reported having slightly lower cognitive load than those in the personalized voice with embodiment instructional condition. The plausible explanation for this is that in the personalized voice with embodiment condition participants had to process more number of elements (i.e. personalization, speech narrations, and embodied agent) in the instructional module than those in the personalized voice condition (i.e. personalization and speech narrations) and in the personalized text condition (i.e. personalized text alone). More number of elements in the instructions could have led to the increase in the participants' extraneous cognitive load. However, it is worth noting that even-though participants in the personalized voice with embodiment condition had more elements to process, they still reported having lower cognitive load than the participants in the non-personalized text condition. This ascertains that non-personalized instructions are detrimental for learning as it increase learners' cognitive load.

Research Question 3

Participants' scores on the emotion questionnaire were assessed to address the third research question that is to what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' emotional state? The findings suggested that participants in the emotionally aversive condition reported feeling more intense feelings of disgust and depress than in the emotionally neutral condition. Participants were also more likely to avoid thinking about certain aspects of the topic in the emotionally aversive condition than in the emotionally neutral condition. The findings of this study was similar to the one reported by Kühl and Zander (2017) that participants had higher avoidance scores in the emotionally aversive (i.e. cerebral hemorrhage) condition than in the other non-aversive (i.e. respiratory system and acoustic organ) conditions.

The results indicated that participants felt least disgusted in the personalized voice with embodiment condition compared to that in the other conditions. Participants in the personalized voice with embodiment condition had lower avoidance scores than those in the other personalized instructional conditions. However, there was no difference in the avoidance scores between the non-personalized text and personalized voice with embodiment conditions. Despite the fact that participants in the personalized voice with embodiment condition had lower scores for anxiousness than those in the non-personalized text condition, participants in the personalized voice with embodiment condition still had higher anxiousness scores than those in the personalized text and personalized voice conditions. Similarly, participants in the personalized voice with embodiment condition felt less depressed than those in the non-personalized text condition. However, among the personalized conditions, participants in the personalized voice condition felt least depressed. Additionally, there was no difference in participants' anxiousness scores across instructional conditions. Overall, it seems that personalization, embodiment, and voice social cue principles additively worked to reduce the feelings of disgust when learning both emotionally neutral and emotionally aversive information. Therefore, the hypothesis that participants in the personalized voice with embodiment condition will have a more positive emotional state than the participants in the other treatment groups across instructional content conditions (elaborated from Kühl & Zander, 2017) was partially supported by the results.

Research Question 4

Participants' responses on the attitude questionnaire were assessed to address the fourth research question that is to what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' attitude towards learning the material? The results indicated that participants in the non-personalized text condition reported the instructions to be more friendly and helpful and had higher motivation and interest levels in the non-personalized text condition compared to those in the other conditions. The results contradicted the findings reported by Moreno and Mayer (2004) that learners perceive the personalized instructions to be friendlier and helpful than the non-personalized instructions.

Additionally, participants in the personalized voice with embodiment condition found the instructional materials to be more difficult than the participants in the other instructional conditions. The score on difficulty scale represents the cognitive capacity available for deep processing of information (Moreno & Mayer, 2004). Therefore, the results indicated that because participants in the personalized voice with embodiment condition reported the instructional materials to more difficult for both emotionally aversive and non-aversive contents than participants in the other instructional conditions, participants in the personalized voice with embodiment condition would have less cognitive capacity available to engage in deep processing of information than those in the other instructional conditions. Hence, personalized voice with embodiment instructions may have hindered the cognitive processing of information for meaningful learning and thereby, may have impacted participants' performance on transfer of knowledge test. Therefore, the results do not support the hypothesis that participants in the personalized voice with embodiment condition will have more positive attitude towards learning than the participants in the other treatment groups across instructional content conditions (elaborated from Wang & Crooks, 2015).

Research Question 5

Participants' learning outcomes were assessed using their scores on the retention and transfer knowledge tests to address the fifth research question that is to what extent do instructions containing personalization, voice, and embodiment (i.e. social cues) collectively have an additive effect on learners' learning outcomes (i.e. retention and transfer test scores)? The findings indicated that there was no statistically significant effect of multimedia instructional style and averseness of information on retentions scores. However, the multimedia instructional style condition had a significant effect on the transfer knowledge scores. The hypothesis that participants in the personalized voice with embodiment condition will have higher learning outcomes than the participants in the other treatment groups across instructional content conditions (elaborated from Lusk & Atkinson, 2007; Wang & Crooks. 2015) was not statistically supported. However, the means indicate that participants in the personalized voice with embodiment condition had the highest retention scores and participants in the non-personalized text condition had the lowest retention scores. Overall, participants who learned the information using personalized instructions had higher retention scores than those who learned using non-personalized instructions. Therefore, these results contradict the findings reported by Mayer et al. (2004) and Kühl and Zander (2017) that personalized instructions do not have a significant effect on learners' retention scores. Participants in the personalized voice with embodiment condition outperformed the participants in other personalized conditions (i.e. personalized text and personalized voice condition). Therefore, the findings of this study are similar to those reported by Wang and Crooks (2015) that learners who receive instructions using personalization and embodiment outperform the learners who receive instructions using personalization alone on retention test.

Participants had the highest transfer knowledge score in the personalized text condition and the lowest in the personalized voice condition. The results indicate that participants in the personalized text condition and personalized voice with embodiment condition outperformed the participants in the non-personalized text condition on transfer knowledge test. The results of this study to some extend contradict the findings reported by Reichelt et al. (2014) that personalized instructions do not have significant effect on transfer of knowledge. Additionally, participants in the personalized voice with embodiment condition had higher transfer knowledge scores than the participants in the personalized voice condition. This result was similar to the findings reported by Lusk and Atkinson (2007) that participants who were in the minimal embodiment instructional condition had higher learning outcomes than those who were in the voice only instructional condition. This shows that personalized instructions could be helpful to increase transfer of knowledge. However, based on the results it is indicated that if voice instructions were to be employed to present instructions, then it should be accompanied with an embodiment to increase the performance on transfer of knowledge.

Implications for Instructional Design

Instructional designers are tasked to design effective instructions that help improve learning. The findings of this study have valuable implications for the field of instructional design as it provides empirical evidence for instructional techniques that are effective for fostering learning. Based on the findings of this study, instructional designers could utilize the personalization, voice, and embodiment principles additively to create personalized voice with embodiment instructions and could use this type of instruction to allow learners to spend more time interacting with the learning materials. Spending more time on the instructional modules could help learners comprehend the information at a deeper level.

In this study, participants in the non-personalized instruction condition had higher perceived cognitive load than those in the other personalized conditions. This shows that using personalized conversation style to present instructions could help reduce participants' cognitive load. Instructional designers and educators could use personalized conversation style to present instructions as personalized instructions present information in the second person point of view which may be easier for learners to comprehend rather than the instructions that are presented in the third person point of view. Hence, using personalized conversation style could help direct instructions towards the learners using second person point of view and could thereby, help reduce extraneous load. Therefore, instructional designers should refrain from using non-personalized conversation style to design multimedia instructions to help manage learners' cognitive load and to foster learning.

The results of this study indicated that use of personalized voice instructions led to participants experiencing higher levels of disgust and avoidance when interacting with the learning materials than participants in other instructional conditions. Therefore, it is implied that using personalized voice instructions could induce negative feelings of disgust among learners. This could lead to learners trying to avoid thinking about certain aspects of the topic or instruction to help themselves diminish the feelings of disgust. Hence, instructional designers should be cautious when employing personalized voice instructions. Similarly, participants in the non-personalized text instruction condition felt more anxiousness and depressed compared to the participants in the other conditions. This indicates that when designing instructions, if instructional designers decide to employ non-personalized text instructional style, then they should be cognizant of the impact it may have on the learners' emotions.

Additionally, the result trends indicated that participants rated the non-personalized text instructions to be friendlier, helpful, motivating, and interesting than the other instructional conditions. However, the retention and transfer scores in the non-personalized text instruction condition were not the highest among the instructional conditions. This shows that the type of instructions that seem to be friendlier, helpful, motivating, and interesting to the learners may in fact not be helping them learn the information. Therefore, instructional designers should be cognizant of evaluating the type of instructions that are actually effective in helping learners learn the information rather than just relying on learners' perception of what helps them learn.

Participants in the non-personalized instruction condition had lower retention scores than participants in the other personalized conditions. Personalized conversation style instructions put the learners in perspective and thereby, allow learners to engage with the instructions at a personal level. This could help foster deep processing of the information. Hence, instructional designers could opt for personalized conversation style instructions to improve learning and retention of information. Additionally, participants in the personalized text condition and personalized voice with embodiment condition had higher transfer knowledge scores than those in the non-personalized text condition. However, participants in the personalized voice condition had the lowest transfer knowledge scores. Therefore, instructional designers could use personalized instructions to present emotionally neutral and emotionally aversive content information. Additionally, if instructional designers need to use personalized voice narrations for their instructions, then it is advised that it should be accompanied with an embodiment for the instructions to be effective.

Summary of implications. The following list provides a quick summary of the implications for the field of instructional design based on the findings of this study:

- Instructional designers should use personalized conversation style to present instructions as it helps reduce learners' cognitive load and improves learning and retention of information.
- Instructional designers could create personalized voice with embodiment instructions to allow learners to spend more time interacting with the learning materials. Spending more time on the instructional modules could help learners comprehend the information.
- Instructional designers should be cautious when employing personalized voice instructions as it induces negative feelings and hinders performance on the transfer of knowledge.

- If instructional designers decide to use personalized voice instructions to present information, then these types of instructions should be accompanied with an embodiment to improve the effectiveness of the instructions.
- Instructional designers should evaluate what actually helps learners learn the information, rather than just relying on learners' perception of what helps them learn.

Limitations

This study was an attempt to further our knowledge about the design of multimedia instructions to foster learning in emotionally neutral and emotionally aversive content areas. Particularly, the goal of this study was to examine whether the social cueing principles (i.e. personalization, voice, & embodiment) have an additive effect on learners' cognitive load, emotions, attitude towards the learning materials, and learning outcomes. However, there were some limitations of this study. This study was conducted in a virtual online environment using a teleconferencing application. In this situation, participants in this study participated from different locations and environmental settings (i.e. home, office, & library, among others). Therefore, the environmental factors varied across participants. However, in doing so, the experimenter was able to capture how learners interact with the multimedia instructions during the learning process in a natural environment.

The instructional modules employed in this study provided information about cerebral hemorrhage and how the human respiratory system works. Both of these topics are health related topics. However, they are not necessarily considered to be from the same content areas. Cerebral hemorrhage module classifies as a disease content area, whereas the module on how the respiratory system works classifies as an anatomy content area. Acknowledging that this is a limitation of the current study, it was important to use these modules in this study as these topics have been empirically examined by Kühl and Zander (2017) to be emotionally aversive and emotionally neutral respectively.

The instructional modules in this study were self-paced to allow learners to complete the instructional module at their own pace without any time constraints. Also, the instructional modules employed in this study were relatively short. The instructional module on cerebral hemorrhage contained approximately 417 words and the instructional module on how the human respiratory system operates contained approximately 370 words. It is possible that the results may vary if the instructional modules were presented in an automated manner or if the modules were lengthy.

Most of the instructions that we interact in our everyday life are written in formal conversation style (e.g. textbooks). Therefore, participants may have been more accustomed to the non-personalized conversation style instructions than to the other types of personalized conversation style instructions. Therefore, it is possible that participants' prior experience and comfort levels with the instructional styles may have affected their attitude towards the learning materials and their learning of the information.

In this study, subjective measures were used to assess participants' cognitive load, emotions, attitude towards the learning materials, and prior knowledge. Therefore, these data were based on self-reported scores. Hence, there is no information regarding the accuracy of these data. Additionally, participants' perceived prior knowledge scores differed across instructional content areas as participants reported having higher prior knowledge for how the human respiratory system operates than for cerebral hemorrhage. Although prior knowledge was not found to have a significant effect on the learning outcomes (i.e. retention and transfer knowledge), it is important to acknowledge that the participants' prior knowledge scores differed and it may have had an underlying effect on the results.

In this study, transfer of knowledge was measured using an immediate transfer test. Researchers in the past have used this method for years to measure the transfer of knowledge (Mayer & DaPra, 2012; Mayer, Sobko, & Mautone, 2003; Moreno & Mayer, 2004). However, it is possible that delayed transfer of knowledge test may lead to different results. Measuring learners' transfer of knowledge by administering a delayed transfer test is beyond the scope of this research.

Future Research

There is a paucity of research conducted to investigate the additive effects of the multimedia design principles on learning. The present study attempted to investigate the additive effects of the personalization, voice, and embodiment principles on learners' cognitive load, emotions, time spent on instructional modules, attitude towards the learning materials, and learning outcomes (i.e. retention and transfer knowledge). However, additional research is warranted to further investigate the additive effects of these abovementioned principles as well as other multimedia design principles on learning. In this study, the additive effects of personalization, voice, and embodiment principles were assessed to investigate its impact on learning health related contents (i.e. cerebral hemorrhage and respiratory systems). Future researchers should expand the investigation by investigating the use of these principles to learn information in different content areas.

In this study, participants rated the non-personalized instructions to be friendlier and helpful than the other multimedia instructions. It is possible that learners felt this way based on their prior experience with this type of instruction. Therefore, researchers could investigate if learners' prior experience with the instructional styles have an effect on their attitude towards the learning materials and on their learning.

In this study, participants' perceived cognitive load was measured using a subjective measure (i.e. a questionnaire). Future researchers could use physiological measures like electroencephalogram (EEG) to assess brain activities to measure participants' cognitive load. This would help gain insight on what type of instructions actually increase learners' cognitive load. Along with cognitive load, learners' attention also plays a prominent role in learning. It is important for learners to attend to the information presented to them in order for them to learn the information. Therefore, future researchers could use eye-tracking to measures learners' visual attention. Conducting an eye-tracking study would help identify where and for how long do learners fixate their visual attention when different types of instructions are presented to them. Additionally, it could help identify if there are non-essential instructional elements in the instruction that are hindering learners from fixating their attention on the important instructional material. This could help identify and eliminate the non-essential elements from the instructional modules and thereby, promote efficient and effective learning.

Conclusion

The articulation of information dictates the ease of learning the information. The results of the present study suggested that the use of personalized instructions was more effective than the use of non-personalized instructions for reducing learners' cognitive load and improving learning outcomes. The personalization, voice, and embodiment principles additively helped improve retention scores. Personalized text instructions helped improve transfer knowledge scores. If personalized voice narrations were to be added to the instructions, then they must be accompanied with an embodiment to increase transfer knowledge scores. Instructions with personalized voice narrations alone could be detrimental for learning and could reduce learners' performance on transfer of knowledge tests.

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APPENDIX A
Background Information Questionnaire

1. Sex:
   - o Male
   - o Female

2. Age: ______________

3. Ethnicity:
   - o African American
   - o Asian/ Pacific Islander
   - o Caucasian
   - o Hispanic/ Latino
   - o Other

4. Do you have normal or corrected-to-normal vision?
   - o Yes
   - o No

5. Do you have normal or corrected-to-normal hearing?
   - o Yes
   - o No

6. Education level:
   ☐Undergraduate ☐Graduate

7. If undergraduate, then indicate your year in school
   - o Freshman
   - o Sophomore
   - o Junior
   - o Senior

8. If graduate, then indicate if you are
   - o Masters Student
   - o Doctoral Student

9. Have you taken a computer-based or web-based training before?
   - o Yes
   - o No

10. What is your preferred method of learning?
    - o Face-to-face
    - o Computer-based

- Text-based

11. Rate your knowledge regarding how the respiratory system works

    1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

12. Rate your knowledge regarding cerebral hemorrhage

    1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

APPENDIX B

NASA-TLX

Participant #________ Date:________ Time:________ Group: ________

Instructions: Place a mark (/) on each scale that represents the magnitude of each factor in the task you just performed.

Demands	**Ratings for task**
Mental Demand	Low [__________________________] High
Physical Demand	Low [__________________________] High
Temporal Demand	Low [__________________________] High
Performance	Excellent [__________________________] Poor
Effort	Low [__________________________] High
Frustration	Low [__________________________] High

Demands clarification:

Mental Demand – How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)?

Physical Demand – How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc.)?

Temporal Demand – How much time pressure did you feel due to the rate or pace at which the task or task elements occurred?

Performance – How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Effort – How hard did you have to work (mentally and physically) to accomplish your level of performance?

Frustration – How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

APPENDIX C
Emotion Assessment
Adopted and elaborated from Kühl and Zander (2017)

Please rate the following statements as they apply to you in the current situation. Circle the numeric value that best represents your experience

1. I am feeling disgusted

   1----- 2 ----- 3 ----- 4 ------ 5 ----- 6 ----- 7

2. I am trying to avoid thinking about some aspects of the topic

   1----- 2 ----- 3 ----- 4 ------ 5 ----- 6 ----- 7

3. I am feeling anxious

   1----- 2 ----- 3 ----- 4 ------ 5 ----- 6 ----- 7

4. I am feeling depressed

   1----- 2 ----- 3 ----- 4 ------ 5 ----- 6 ----- 7

APPENDIX D
Attitude Questionnaire
Adapted from Moreno and Mayer (2004)

Please rate the following statements as they apply to you. Select the numeric value that best represents your experience.

Friendliness

1) How friendly was the computer that you interacted with?
1----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7-----8-----9-----10
Not very friendly — Very friendly

Helpfulness

2) How helpful is this material for learning about human respiratory/ system/ cerebral hemorrhage
1----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7-----8-----9-----10
Unhelpful — Helpful

Difficulty

3) How difficult was the material?
1----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7-----8-----9-----10
Easy — Difficult

4) How much effort is required to learn the material?
1----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7-----8-----9-----10
Little — Much

Motivation

5) If you had a chance to use this instructional style with new instructional content, how eager would you be to do so?
1----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7-----8-----9-----10
Not Eager — Very Eager

Interest

6) How interesting is this material?
1----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7-----8-----9-----10
Boring — Interestin
g

7) How entertaining is this material?

1----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7-----8-----9-----10

Tiresome Entertaining

APPENDIX E
Learning Assessment: Cerebral Hemorrhage
Partly Adapted from Kühl and Zander (2017)

Retention Knowledge

1. What causes of cerebral hemorrhage? (Select all that apply).
   a) Having high blood pressure
   b) Head injury or trauma
   c) Having low blood pressure
   d) Ruptured cerebral aneurysm/blood vessel
   e) Abnormally formed cerebral blood vessels

2. Which of the following statements is true about cerebral hemorrhage? (Select all that apply).
   a) It is important that one seeks medical treatment within six hours of onset of the symptom
   b) It is important that one seeks medical treatment within three hours of onset of the symptom
   c) Controlling the diabetes if one is diagnosed to be diabetic can aid in preventing cerebral hemorrhage
   d) A clinical diagnosis is not needed to diagnose if there is a cerebral hemorrhage in the brain
   e) One can prevent cerebral hemorrhage by taking good care of themselves and by maintaining a healthy lifestyle
   f) Surgeries are the only option to relieve pressure on the brain.

3. Which of these is a symptom associated with cerebral hemorrhage? (Select all that apply).
   a) Tingling in the face
   b) Difficulty in listening
   c) Vision problems in one or both the eyes
   d) Experiencing confusion or delirium
   e) Difficulty in speaking
   f) Difficulty in breathing
   g) Loss of balance and coordination
   h) Experiencing sudden headache
   i) Loss of appetite

Transfer Knowledge

1. How can maintaining normal blood pressure affect the probability of suffering from cerebral hemorrhage?

2. What type of medical innovations could help prevent severe cerebral hemorrhage?

APPENDIX F
Learning Assessment: Respiratory System
Partly Adopted from Mayer, Fennell, Farmer, and Campbell (2004)

Retention Knowledge

1. Which of these are organs of the lower respiratory system? *(Select all that apply)*
    a) Pharynx
    b) Lungs
    c) Primary Bronchi
    d) Nasal Cavity
    e) Trachea
    f) Larynx

2. Which of the following statements is true about the process of respiration that takes place during the exchange stage? (Select all that apply).
    a) Oxygen moves from the air sacs to the bloodstream
    b) Air travels through the bronchi and larynx to the nose and mouth
    c) Air enters through the nose or mouth and travels down through the larynx and bronchi
    d) Carbon dioxide moves from the bloodstream to the air sacs.
    e) Diaphragm move up creating less room for the lungs.

3. Which of the following statements is true about trachea? (Select all that apply).
    a) Transports air from nose and mouth to the larynx
    b) Carries oxygenated blood to the heart
    c) Connects the larynx to bronchi of the lungs.
    d) Moisturizes and filters air that enters the body
    e) Prevents food and liquid from entering the lower respiratory system
    f) Transports air flow to and from the lungs for respiration.

Transfer Knowledge

1. Suppose you are a scientist trying to improve the human respiratory system. How could you get more oxygen into the bloodstream faster?

2. A researcher makes the claim that pollution causes heart disease. Explain why this would be true”

APPENDIX G
INFORMED CONSENT DOCUMENT
OLD DOMINION UNIVERSITY

PROJECT TITLE: Measuring the Additive Effects of Multimedia Social Cue Principles on Learners' Cognitive Load, Emotions, Attitude, and Learning Outcomes

INTRODUCTION
The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research, and to record the consent of those who say YES. This Project will be conducted online using teleconferencing tool (i.e. Google Hangouts).

RESEARCHERS
Responsible Principle Investigator
Dr. Tian Luo, Department of STEM Education and Professional Studies

Investigator:
Smruti J. Shah, M.S., Department of STEM Education and Professional Studies

DESCRIPTION OF RESEARCH STUDY
In the past, researchers have conducted several studies to investigate the individual effects of multimedia design principles (i.e. personalization, embodiment, & voice principles) on learning. However, not much is known about the combined effects of personalization, embodiment, and voice on learning, specifically when learning emotionally aversive health information. Therefore, the purpose of this study is to evaluate the additive effects of these principles on learners' cognitive load, emotions, attitudes, and learning outcomes when learning emotionally aversive health information.

If you decide to participate, then you will join a study involving research of instructional design. You will be asked to complete two short self-paced e-learning modules. Following this, you will be asked to complete a short achievement test for each module. Additionally, you will be asked to complete background and demographic information questionnaire, along with a few other questionnaires that will assess your perceived cognitive load, emotions, and attitude towards the learning material.

If you say YES, then your participation will last for approximately 30 to 45 minutes. The research will take place online via Google Hangouts. Approximately 76 college students from Old Dominion University will be participating in this study.

EXCLUSIONARY CRITERIA
All participants in this research study must be at least 18 old. To the best of your knowledge, you should have normal or corrected-to-normal vision and hearing. You should be able to read and comprehend English language. Also, you should have no known cognitive impairments.

RISKS AND BENEFITS
RISKS: If you decide to participate in this study, then you may face a risk of minor eye strain or

discomfort from using computer. There is also a possibility that you may experience some emotional discomfort. The researcher tried to reduce these risks by keeping the modules short and self-paced. And, as with any research, there is some possibility that you may be subject to risks that have not yet been identified.

BENEFITS: There are no direct benefits from the present study. However, your participation in the study will serve to enhance our knowledge regarding the design of instructional material.

COSTS AND PAYMENTS

The researchers want your decision about participating in this study to be absolutely voluntary. There will be no cost to you for participation in this research study. Upon completion of the study, each participant will be entered in a random drawing for a chance to win one of four $10 Starbucks gift card.

NEW INFORMATION

If the researchers find new information during this study that would reasonably change your decision about participating, then they will give it to you.

CONFIDENTIALITY

The researchers will take reasonable steps to keep all information obtained about you in this study confidential. The results of this study may be used in reports, presentations, and publications; but the researcher will not identify you. Of course, your records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with Old Dominion University, or otherwise cause a loss of benefits to which you might otherwise be entitled. The researchers reserve the right to withdraw your participation in this study, at any time, if they observe potential problems with your continued participation.

COMPENSATION FOR ILLNESS AND INJURY

If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of harm, injury, or illness arising from this study, neither Old Dominion University nor the researchers are able to give you any money, insurance coverage, free medical care, or any other compensation for such injury. In the event that you suffer injury as a result of participation in any research project, you may contact Dr. Tian Luo (Responsible Principle Investigator) at tluo@odu.edu or Smruti J. Shah (Investigators) at sshah011@odu.edu, Dr. Tancy Vandecar-Burdin the current IRB chair at 757-683-3802 at Old Dominion University, or the Old Dominion University Office of Research at 757-683-3460 who will be glad to review the matter with you.

VOLUNTARY CONSENT

By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them.

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802, or the Old Dominion University Office of Research, at 757-683-3460.

And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form for your records.

Subject's Printed Name & Signature	**Date**

INVESTIGATOR'S STATEMENT

Investigator's Printed Name & Signature	**Date**

I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.

VITA

Smruti J. Shah
Department of STEM Education and Professional Studies
Darden College of Education and Professional Studies
Old Dominion University

EDUCATION

May, 2020, Ph.D.	Old Dominion University, Norfolk, VA – Instructional Design and Technology
August, 2016, M.S	Old Dominion University, Norfolk, VA – Psychology - Concentration in Human Factors Psychology
May, 11th 2013, B. S.	Old Dominion University, Norfolk, VA – Major: Psychology; Minor: Biology *(Magna Cum Laude; Collegium Honorum)*

SELECTED PUBLICATIONS

Luo, T., **Shah, S. J.**, & Crompton, H. (2019). Using Twitter to support reflective learning in an asynchronous online course. *Australasian Journal of Educational Technology, 35*(3), 31-44. https://doi.org/10.14742/ajet.4124

Peck, L., Stefaniak, J. E., & **Shah, S. J.** (2018). The correlation of self-regulation and motivation with retention and attrition in distance education. *Quarterly Review of Distance Education, 19*(3), 1-15.

Shah, S. J. & Stefaniak, J. E. (2018). A Review of the Effectiveness of eLearning on Knowledge and Skill Acquisition in Medical Education. Proceedings of the *Association for Educational Communications and Technology (AECT) 41st Annual Convention, 41*(1), 160-168. Kansas City, MO.

Shah, S. J. & Bliss, J. P. (2017). Does accountability and automation decision aid's reliability affect human performance in a visual search task? *Proceedings of the Human Factors and Ergonomics Society 61st Annual Meeting, 61*(1), 183-187. Austin, Texas.

Shah, S. J. (2016). *Effects of visibility and alarm modality on workload, trust in automation, situation awareness, and driver performance* (Master's thesis). Available from ODU Digital Commons (ISBN No. 9781369170993).

Strater, L., Frederick, C. M., Vaughn-Cooke, M., Bliss, J. & **Shah, S.** (2016). Me and my VE: Part 4. *Proceedings of the Human Factors and Ergonomics Society 60th Annual Meeting, 60*(1), 2088-2092. Washington, D.C.

Shah, S. J., Bliss, J. P., Chancey, E. T., & Brill, J. C. (2015). Effects of alarm modality and alarm reliability on workload, trust, and driving performance. *Proceedings of the Human Factors and Ergonomics Society 59th Annual Meeting, 59*(1), 1535-1539. Los Angeles, CA.

HONORS AND AWARDS

Alan Mandell Endowed Award Instructional Design and Technology (ODU)	May, 2019
Association for Educational Communications and Technology (AECT) Design & Development Competition 2018 Finalist award	October, 2018
AECT Design & Development Showcase award	October, 2018
Honors College "Collegium Honorum" (ODU)	May, 2013
Magna Cum Laude (ODU)	May, 2013