Multimedia: Learner Preferences For Multimedia Learning

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ABSTRACT: *Today's learners are using multimedia on a daily basis. From computers to cell phones, it's very difficult to get through a day without being exposed to multimedia. Prior research from Mayer and colleagues has revealed the multimedia principle, which communicates that two representations that explain for one another are better for learning than just one. While much of this research focused on cognitive load and learning, it did not focus on learner preference. As a result, a survey was presented to learners to discover their preferences for the multimedia, modality, redundancy, and coherence principles in a multimedia environment. Overall, participants agreed that they preferred multiple representations to a single one. However, the most surprising results were found when learners were presented redundant representations and irrelevant details. Learners indicated they preferred redundant text and sound with images to image and text or images and sound and that they preferred highly detailed and colored images to simple images. This indicates that while learners may learn better if we following the multimedia principles, they might decrease learner interest or motivation, which could have an impact on instruction.*

Keywords: Multimedia Learning, Learning, Motivation, Multimedia learners

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1. Introduction

Computer based training (CBT), gaming, simulations, online learning, and video based learning (as well as many other means of delivering instruction) rely on a foundation of research based on multimedia. Multimedia is defined as a combination of verbal and nonverbal representations that support learning or communication (Clark and Mayer, 2011; Mayer, 2009). Media in the form of multimedia is used in many learning environments – corporate, educational, and governmental. It is delivered using various hardware technologies including computers, mobile devices, tablets, and even virtual and augmented reality devices. As a result, research that exams how to best design multimedia for learning has been crucial for multimedia designers. The basis for this research on multimedia stems from Mayer and colleagues multimedia principle.

The multimedia principle suggests that we learn more from a combination of verbal and nonverbal representations, that explain for one another, than just a single representation by itself (Clark and Mayer, 2011). This idea has led to a myriad of research studies on multimedia and learning (Mayer, 2005). From these studies a number of multimedia principles have been developed,

for instance the redundancy, coherence, modality, and split-attention principles (and many more). They are each designed to aid instructional designers in the design of instruction by reducing the burden on working memory and thus supporting learning. These principles have been examined time and time again in order to determine how they best support learning (principles utilized in this study are described in detail in the next section of this paper). This has led to a number of recommendations that designers can use to improve instruction while reducing working memory load. However, while many of these research studies examined the role that the multimedia principles had on learning, very rarely, were students' preferences for these principles examined. Do students enjoy these presentation methods? Should designers care about learner preferences for media? These kinds of questions need to be explored to aid instructional designers in training design and development. As a result, this study seeks to determine what learners' perceptions are of the multimedia principles (redundancy, modality, split attention, and coherence principles).

1.1 Multimedia principles

Dual coding theory (DCT) implies that our working memory is comprised of two memory channels, verbal and nonverbal, that process information separately. Thus our working memory handles verbal (logogens) and nonverbal (imagens) representations in separate memory channels, each having a certain capacity for processing information (Paivio, 1979). Verbal representations consist of words, text, and narration whereas visual representations consist of images, icons, charts, and graphs. Pavio describes each of these channels (verbal and non verbal) as functionally independent from one another so that they can be activated independentally or at the same time (Paivio, 1991). Additionally, as connections between the two channels are activated, learning is improved, which reduces load on working memory and thus is a goal for curriculum developers and instructors to achieve. As a result, presenting dual channels simultaneously is preferred to just one. This phenomenon is explained in the multimedia literature.

Multimedia refers to a combination of verbal (words, narration, or text) and non-verbal (images, icons, graphs, or charts) representations (Clark and Mayer, 2011; Mayer, 2005) used for learning and/or communication. Studies show that multimedia instruction can aid student learning and is an effective means of content delivery (Pastore, 2010; Mayer, 2001). From this concept, formed the multimedia principle (described later in this paper) and the idea that using multiple external representation (MERs) support learning. This idea comes from Mayer and colleague's cognitive theory of multimedia learning (CTML), which is based on Paivio's dual coding theory (Mayer, 2005). The CTML hypothesizes that one can process MERs simultaneously in working memory (Mayer, 2005). As a result, representations are created and then stored in long-term memory for later use (Seufert, 2003). The CTML is based on three assumptions (1) working memory is made up of a dual modality (dual coding) input channel system, (2) there is a limited capacity in working memory, and (3) that learners engage in active processing. As a result of the CTML, Mayer and colleagues developed the multimedia principle, which led to a series of principles of design aimed at increasing learning while decreasing memory load for multimedia instruction. These principles include redundancy, modality, split attention, and coherence, which are described further in this paper. While there are other principles that resulted from CTML, they were not utilized in this research paper and thus will not be discussed.

Before discussing these principles the reader should be made aware that these are guidelines for creating effective instruction and reducing load in working memory. They are not rules that must be followed – thus they are not set in stone. There may be instances when breaking the rules may benefit the learners more than following them, for instance when there are technical limitations, client demands, or learner disabilities.

1.2 Multimedia Principle

Multiple external representations (MERs) aid student learning (Schnotz & Lowe, 2003). MERs are often preferred and recommended to an individual representation for use in media learning environments. This design recommendation stems from the multimedia principle, which states that a combination of verbal and non-verbal representations that explain for another is better for learning than just one (Clark and Mayer, 2011; Mayer, 2001). This theory was derived from dual coding and the cognitive theory of multimedia learning (Paivio, 1991; Mayer, 2005). It suggests that learning from images and text that explain for one another can better utilize working memory and lead to high level learning more effectively than just images or text alone. Multiple research studies have confirmed this principle (Ollerenshaw, Aidman, and Kidd, 1997; Eilam and Poyas, 2008) and it is from this principle that the multimedia principles discussed further in this paper were derived from. For instance, Eilam and Poyas (2008) investigated the role that multiple representations (text and picture) and single representation (text only) groups had on student achievement in a university level course. Participants were presented with content on cell phone use, given three homework assignments that pertained to the content, and then assessed via recall and transfer. On all three measures, homework, recall, and transfer, the multiple representation condition scored significantly better, thus supporting

the dual coding hypothesis and the use of multiple representations. However, all methods of dual presentation (multimedia) do not share the same effects on working memory. As a result, the following principles were derived.

1.3 Modality Principle and Split Attention Principle

The split attention principle occurs when learners need to split their attention between text and images that explain for one another, which is referred to as representation holding (Sweller, Ayres, and Kalyuga, 2011). Thus when learners read text, they need to hold the concepts from the text (representation holding), while they examine the image. This has been shown to unnecessarily increase learners working memory load (Mayer & Anderson 1992). As a result, the modality principle suggests that presenting verbal audio and images offsets this additional burden and can further increase learning (Low & Sweller, 2005). Thus, learners can focus on both representations at the same time without the need to split their attention between a text and visual representation. This decreases the burden on working memory and can increase learning. This has been confirmed in multiple studies (Scheiter et al. 2014; Pastore 2012; Fiorella, Vogel—Walcutt, and Schatz 2012). For instance, Ginns (2005) conducted a meta-analysis of 43 studies, which revealed that audio and visual representations were better for learning than text and visual representations, thus confirming the modality effect. This was again confirmed by Fiorella, Vogel—Walcutt, and Schatz (2012) who presented 60 participants with either visual images with narration, visual images with printed text, or visual images with no text or narration. They found that participants in the visual image and narration conditions scored significantly higher than the other conditions are on low and high-level comprehension tests thus confirming the modality effect.

1.4 Redundancy Principle

The redundancy principle occurs when redundant forms of information are presented to the learner at the same time, which increases the burden on working memory and inhibits learning (Sweller, 2005). For example, being presented both duplicate text and narration at the same time rather than just one, can interfere with working memory and negatively affect learning. According to Sweller (2005) there are two types of redundancy that can occur 1) two types of media that contain the exact same information (this is the type used in this study) and 2) two types of media where one contains elaborate text and the other is summarized. This principle has been examined in a number of studies (Pastore, 2012; Pociask and Morrison 2008; Mayer, Heiser, and Lonn 2001).

For instance, Pastore (2012) sought to discover the effects of redundancy on multimedia and time compression. 154 university students were presented with technical content on the human heart and its parts and placed into conditions that consisted of redundant text and narration or narration only and then compressed at speeds 0%, 25%, or 50% time compression. Results of the study revealed that participants presented redundant instruction performed worse on tests measuring problem-solving knowledge than participants presented narration only. This effect got larger as the speed of the instruction was increased. Mayer, Heiser, and Lonn (2001) found similar results when they conducted several experiments, which examined the redundancy principle to see if duplicate representations would aid or hinder learning. In their first experiment, participants (78 university students) were presented with conditions consisting of animations with audio and either on-screen text that summarized the narration or extraneous details. Findings of the study revealed that students presented with redundant text and audio performed significantly worse on tests measuring retention and transfer. In their second experiment participants (109 university students) were placed into conditions consisting of animation with narration and either no text, summary text, or full text. Participants in the summary and full text groups did not differ on retention and transfer tests. However, participants in the no text group scored significantly higher on each test. As a result, redundancy should be avoided as its been shown to increase working memory load.

1.5 Coherence Principle

When representations in a multimedia environment have too many details the learning process can be hindered. This is referred to as the coherence principle, which theorizes that learners may be distracted by unnecessary information, details, or colors (Issa et al. 2013; Mayer, Bove, Bryman, Mars, & Tapangco, 1996). These extra details can overload working memory and lead to a decrease in comprehension. This was demonstrated in a series of four experiments by Harp and Mayer (1998) who presented students with material on the formation of lightning that contained varying degrees of irrelevant details. In all four experiments, participants in the irrelevant details groups scored significantly lower on both recall and problem solving tests. Similar findings have been illustrated throughout the literature (Mayer, 2010; Mayer, Heiser, and Lonn, 2001; Moreno & Mayer, 2000). Thus, multimedia should be designed so that representations do not contain unnecessary detail. Dwyer (1972) suggests that "Highly realistic illustrations may contain so many stimuli that the student will experience difficulty in identifying those essential learning cues with which he should interact" (p. 5). Therefore, it is important to understand when it's appropriate to present simple and/or complex representations in order to support student learning.

1.6 Learner Preferences of Multimedia

Much of the literature on multimedia has focused on the ways that design affects cognitive load and achievement. While there has been some discussion of motivation in multimedia learning, this research has not focused on students' preferences for multimedia learning. Plass, Chun, Mayer, and Leutner (1998) sought to discover students' preferences and learning outcomes when presented with media consisting of either text, picture, video clip or all. The study found that regardless of media preference, those that preferred multimedia scored higher on recall tests than those who preferred the single medium presentation. This meant that there were students that preferred a single medium presentation to the multimedia environment and that learning was not affected by preference type. This indicates that motivation and preference may not negatively affect learning outcome. However, would this result be different if the content changed and could this result be repeated? Yue, Bjork, and Bjork (2013) found similar results in their study which revealed that learners preferred identical on-screen text and narration to other media formats even though they performed worse when it was presented. Thus preference may not have a large impact on learning outcomes for adult learners. However, motivation is still certainly important in design and development as there is always a desire for instructional designers to make stakeholders and users are happy. In another study on learner preferences of multimedia, Toomey (2013) found that learners would switch their preference based on the content type indicating that variables like content type, time to complete, and motivation could have impacts on performance not seen in a research environment (unless motivation was controlled for) thus more research is needed in this area. Yu, Zhang, Zhou, and Li, (2005) support this notion and argue that learners should be able to choose their media delivery format, however, in many cases only one version of training can be developed due to time/money restraints. Toomey (2013) suggests that future work in this area examine multimedia preferences in different environments to determine if there are preferences based on content/media type and how those affect learning and motivation. Thus it would appear useful to examine how type of content affects learners' preferences for multimedia.

1.7 Purpose

As a result, the following research study seeks to examine students' preferences for the multimedia principles. The multimedia (and media) being examined in this study include image only, sound only, text only, images with text, images with sound, images with redundant text and sound, black and white images with detail, color images with detail, black and white images with no detail, and color images with no detail.

2. Methodology

2.1 Participants

There were 114 undergraduate participants from a mid sized university utilized in this research study. 23 were male (20%) and 91 (80%) were female. 90 (79%) were 18-22 years old, 14 (12%) were 23-30 years old, and 10 (9%) were older than 31 years old. All students were education majors enrolled in an educational technology course. 97% of the students had their own laptop, 91% own a smartphone, 79% own an mp3 player, and 59% own a gaming console.

2.2 Survey

The survey consisted of 19 questions. The first set of questions (9) consisted of demographics information, disability information (hearing and seeing), as well as questions about technology experience. The final set (10 questions) consisted of questions which asked participants their preferences towards the following media: image only, sound only, text only, images with text, images with sound, images with redundant text and sound, black and white images with detail, color images with detail, black and white images with no detail, and color images with no detail. Each of these 10 questions was broken up into 7 Likert-scale questions (5 point scale) asking participants how much they would prefer the media type for entertainment, school lectures, computer based training, books for entertainment, books for learning, on a mobile device for entertainment, and on a mobile device for learning. Thus students would be asked how much they would or would not prefer that media type (as the only form of media presented).

2.3 Procedure

Prior to participating in study, participants were given an 85-minute presentation on media types and the multimedia principles. his was an in class lesson that included lecture and discussion on each of the multimedia principles and the theories they were derived from. The principles discussed during the class session included the multimedia, redundancy, split attention , modality, and coherence principles. This lesson also included discussion on dual coding, cognitive load, working memory, and long-term memory. As a result, a limitation of this study is that participants knew the multimedia principles prior to stating

their preferences, which could have influenced their perceptions. Participants then completed the survey, their next class session, via Survey Monkey during an educational technology undergraduate class in the Spring 13 and Fall 13 semesters.

3. Results

Descriptive statistics were calculated via SPSS 16 and can be found in Table 1 and Table 2. Additionally the results are displayed visually in Figure 1 and Figure 2.

	Image Only		Sound Only		Text Only		Images with Text		Images with Sound		Image with Redundant Sound and Text	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Entertainment Purposes	3.18	1.06	2.88	1.06	2.61	1.00	3.87	.89	3.76	.87	4.09	1.00
School and Lectures	3.05	1.11	2.77	1.13	2.93	1.09	4.07	.85	3.8	.82	4.22	.90
Computer Based Instruction	3.2	1.06	2.74	1.18	2.8	1.08	4.03	.78	3.78	.81	4.15	.988
Book for enterta inment	3.15	1.02	2.95	1.07	2.96	1.08	3.79	.89	3.57	.90	3.98	1.06
Book for learning	3.02	1.01	2.88	1.08	2.92	1.07	3.95	.79	3.63	.82	4.12	.99
Mobile for entertai nment	3.22	1.03	2.78	1.02	2.66	1.05	3.75	.84	3.6	.96	4.02	1.05
Mobile for learning	3.05	1.02	2.72	1.08	2.76	1.06	3.96	.81	3.63	.90	4.13	1.01

Table 1. Descriptive statistics of student preferences for the multimedia, modality, and redundancy principles

3.1 Single Media

The results of the single media preferences (image only, sound only, and text only) sections were very similar to one another. Participant scores hovered between 2 and 3 out of 5, which indicated that while they did not prefer single media they also did not mind it either and supported a neutral stance. The image only group was slightly preferred to the other two single media options scoring .5 higher for each media/content combination. While image only did score the highest for each single media type the sound only and text only scores were very nearly identical for computer based instruction (sound only – 2.74, text only – 2.8), book for entertainment (sound only – 2.95, text only – 2.96), book for learning (sound only – 2.88, text only – 2.92), and mobile for learning (sound only – 2.72, text only – 2.76). The biggest observable differences were seen in preferences for entertainment purposes (sound only – 2.88, text only – 2.61), school lectures (sound only – 2.77, text only – 2.93), and mobile for entertainment (sound only – 2.78, text only – 2.66).

3.2 Multimedia, Modality, and Redundancy

Not surprisingly, the scores in the multimedia groups were higher than the single media groups. This is inline with the multimedia principle, which states that verbal and non-verbal representations that explain for one another are better for learning than just one. The image with text and image with sound media/content combinations each scored above 3.5 for every media/content combination. This indicates that multimedia is preferred to single media presentation format. It should be noted that the images with text media/content combination was slightly preferred over images with sound, which in not inline with the modality principle. While it is not inline with the modality principle it does show that learners' preference for narration and images vs. text and images does not differ that much. Most surprisingly, the media combination that scored the highest, above 4 out of 5, for each content combination except *book for learning* (3.98) was the redundant group. This is not inline with the redundancy principle, which states that learning is decreased when redundant media representations are presented. This group scored the highest for each media/content combination and was the only option to score above 4 out of 5.

3.3 Coherence

The results of the content combinations were very similar to one another (i.e., no difference within the color image with detail), however, there was observed difference between each media type presented. Participants indicated that they prefer color images to black and white. They also indicated that they prefer extraneous details to no extraneous details. All of the media/content combinations, except for color with details, scored below 2.5 indicating that participants did not prefer it (black and white image with detail: 2.36 - 2.55, color image with detail: 3.38 - 3.46, black and white with no detail: 2.02 - 2.08, and color image with no detail: 2.46 - 2.56). The color image with details group was scored nearly 1 point higher for all options and thus was the most preferred choice. The scores for the color image with detail combination ranged from 3.38 to 3.46 indicating a preference for color and details regardless of the activity taking place. Figure 2 more clearly shows this preference. This is not inline with the coherence principle, which states that learners may be distracted by unnecessary information, details, and colors.

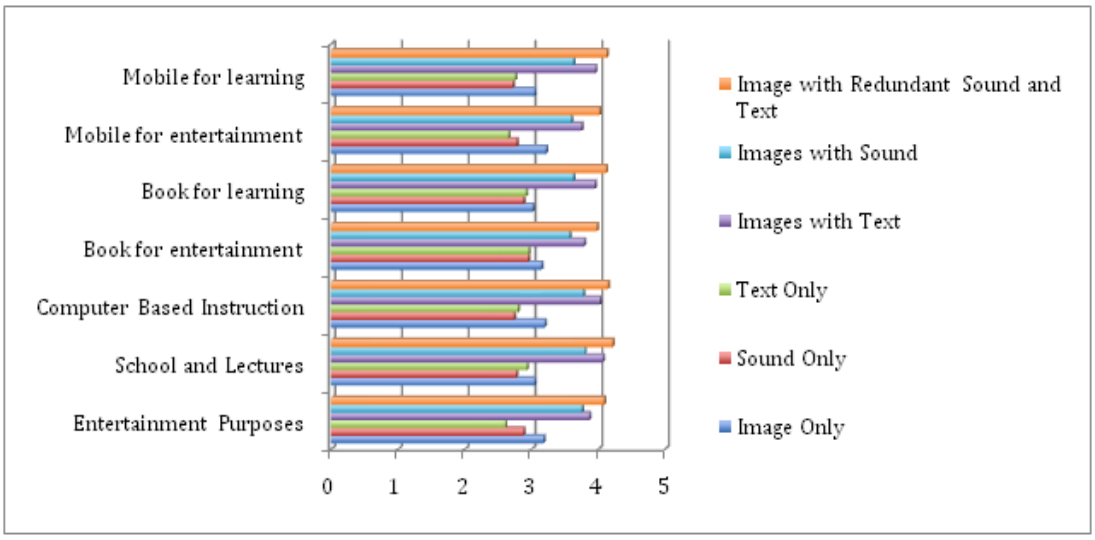

Figure 1. Descriptive statistics of student preferences for the multimedia, modality, and redundancy principles

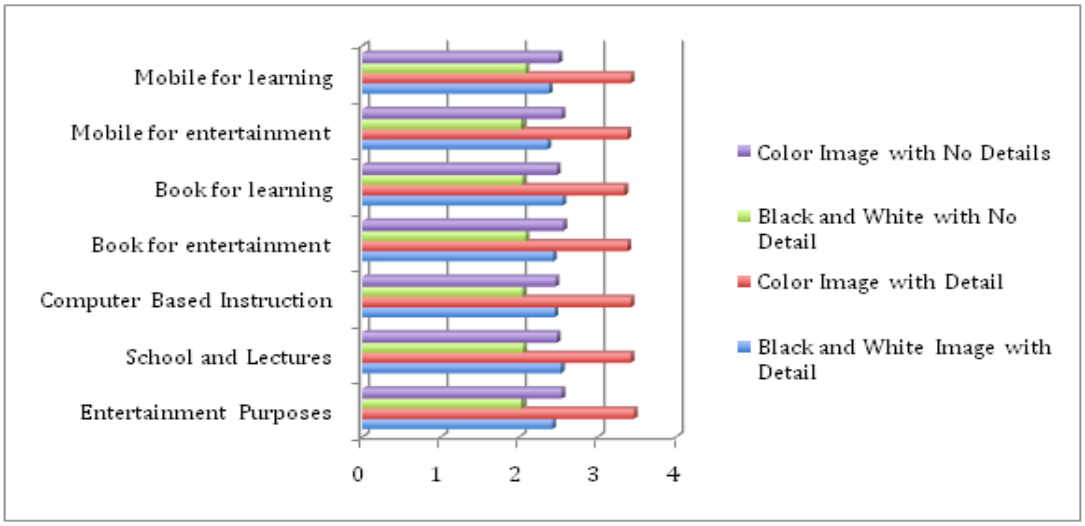

Figure 2. Descriptive statistics of student preferences for the coherence principle

4.Discussion

4.1 Multimedia Principle

Overall participants in the media groups indicated that they would not prefer to have a single media only presentation method for learning or entertainment. This falls inline with the multimedia principle, which states that verbal and non-verbal representations that explain for one another are better for learning than just a single representation (Mayer, 2009). Thus learners prefer multimedia to just a single media. This finding supports current design guidelines which support learning and helps to make a stronger case for a multiple representation environment.

	Black and White Image with Detail		Color Image with Detail		Black and White with No Detail		Color Image with No Details	
	M	SD	M	SD	M	SD	M	SD
Entertainment Purposes	2.42	.91	3.46	.86	2.02	1.10	2.54	.91
School and Lectures	2.53	1.01	3.42	.92	2.05	1.09	2.48	.93
Computer Based Instruction	2.45	.95	3.42	.85	2.04	1.08	2.46	.89
Book for entertainment	2.43	.89	3.38	.85	2.08	1.14	2.56	.91
Book for learning	2.55	.99	3.34	.96	2.04	1.08	2.48	.90
Mobile for entertainment	2.36	.95	3.38	.84	2.02	1.12	2.54	.97
Mobile for learning	2.38	.90	3.42	.92	2.08	1.12	2.5	.95

Table 2. Descriptive statistics of student preferences for the coherence principle

4.2 Modality and Split-Attention Principle

According to the modality principle, presenting learners with images and sound (narration) is better for learning than presenting images and text, as they do not need to hold representations in order to make the connections between representations. However, learners in this study indicated preferred images with text over images with sound for all media/content combinations. While it was only a small observable preference (.5), it is an important finding that should be explored further. Reasons for this finding include the need to have headphones, to be in a quiet area to listen, not being able to go through as fast (according to Pastore, (2010) listening takes longer than reading), or that they encounter images and text on both the PC and mobile device more often (familiarity). Finding out why this preference exists may help overcome motivation hurdles encountered when trying to deliver narration and images to audiences familiar with text and image based instruction.

4.3 Redundancy

The redundancy principle states that presenting redundant material, such as duplicate text and narration or full text and summary text, hinders the learning process. As a result it was expected that participants would not prefer redundancy for any media/content combination. However, participants preferred the redundant option for each option available, more than any other option. This could be due to the fact that they prefer more options and like to have both narration and text available on screen or that they believe that they would learn better with both (it should be noted that learners were familiar with the redundancy principle during the survey and still chose redundant representations). As a result this is something that should be explored further to see if these results are repeatable and how much this preference for redundant representations has on learning outcomes.

4.4 Coherence

The coherence principle states that extraneous details can inhibit learning. Thus additional distracting images, fonts, and colors should be avoided. Results of this study did not adhere to the coherence principal. In fact, students preferred images that were detailed and colorful. This is not surprising as the media culture is more familiar with seeing images on screen daily and they are usually not simple line drawings that are designed to increase working memory capacity. As a result, this finding should be examined further to explore how users preference affects working memory of simple and complex images. Much of the research on this topic was conducted at a time when users did not have access to laptop computers, cell phones, and tablets on a daily basis. Thus further inquiry is warranted.

5.Conclusion

Today's learners are using multimedia on a daily basis. From computers to cell phones and tablets, it's very difficult to get through a day without being on an electronic device. Thus society is constantly bombarded with representations in a multimedia environment. Prior research from Mayer and colleagues has revealed the multimedia principle, which demonstrates that two representations are better for learning than one. From this spawned many recommendations for multimedia development that enhance the learning experience by reducing the load on working memory and increasing learning. However, much of the

multimedia we see in training and everyday life does not always follow these prescriptive methods. Most often this is due to developers and designers simply not being aware of the research based recommendations. Additionally, much of the research on the multimedia principles never examined if learners actually preferred the methods that reduce working memory load and increase learning. As a result, the survey presented in this paper sought to discover if and when students preferred the multimedia, modality, redundancy, and coherence principles.

Overall, participants agreed that they preferred the multimedia principle. Thus presenting multiple representations is preferred to just one. Participants only slightly preferred text and images to the narration and images. These results indicate that both learning and preference are inline with one another. However the most surprising results were found in the redundancy questions, where learners preferred redundant text and sound with images, and the coherence questions, where learners preferred highly detailed and colored images. This indicates that while learners may learn better if we following the multimedia principles, they might decrease learner interest or motivation, which could have an impact on instruction. It is recommended from this survey that a follow up study be conducted on redundancy and coherence to see what these effects are on learning. These preferences also put designers into situations where clients, SMEs, and learners might prefer visuals that do not lead to better learning but increase their motivation.

A number of suggestions for future research have been recommended throughout this paper. They include looking at the effects of preference on learning, specifically the coherence and redundancy principle to see if motivation and preference have a large impact on learning. Additionally qualitative research exploring the experience of learners being exposed to multimedia which they may or may not prefer can help add to the literature base on multimedia learning and help designers make more informed decisions when choosing media type for instruction.

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