Instructional Message Design: Theory, Research, and Practice
(Volume 3)

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Instructional Message Design: Theory, Research, and Practice (Volume 3)

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Preface

Message design is all around us, from the presentations we see in meetings and classes to the instructions that come with our latest tech gadgets to multi-million-dollar training simulations. In short, instructional message design is the real-world application of instructional and learning theories to design the tools and technologies used to communicate and effectively convey information. This field of study pulls from many applied sciences, including cognitive psychology, industrial design, graphic design, instructional design, information technology, and human performance technology, to name just a few. In this book, we will visit several foundational theories that guide our research, look at different real-world applications, and begin to discuss directions for future best practices. For instance, cognitive load and multimedia learning theories provide best practices, virtual reality and simulations are only a few of the multitude of applications. Special needs learners and designing for online, e-learning, and web conferencing are only some of many applied areas where effective message design can improve outcomes. Studying effective instructional message design tools and techniques has and will continue to be a critical aspect of the overall instructional design process. Hopefully, this book will serve as an introduction to these topics and inspire your curiosity to explore further!
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Chapter 1: Message Design for Instructional Designers - An Introduction

Miguel Ramlatchan, PhD
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I would like to thank my wife and kids for their patience and support, Andy, John, Ginger, and Anne at ODU for your encouragement and opportunity, the experienced and talented instructors I have had along the way, and a special thanks to our contributors, proofreaders, editors, and reviewers!

Citation:

1. Message Design for Instructional Designers: An Introduction

Miguel Ramlatchan, PhD

Key Points:

- Instructional design is determining the need for an instructional solution, analyzing needs, defining learning objectives, and developing a solution to meet those objectives.

- Instructional message design is the application of theory and techniques to communicate with learners as part of that solution.

- Message design through visual communications can include static art (illustrations, diagrams, photographs) or dynamic art (animation, video, virtual reality, and simulations) with or without accompanying audio.

Abstract

Instructional message design is the use of learning theories to effectively communicate information using technology. Design is guided by theories including gestalt, cognitive load, multimedia learning, media selection, media attributes, and general communication systems. Our communication designs can be based on a wide variety of technologies or a combination of technologies. Technology in the form of tools and techniques includes, among others, the study and the use of typography, color, illustrations, photographs, modeled graphics, augmented reality, animation, video, video games, simulations, and virtual reality. This introduction serves
as a brief overview of these theories, tools, and techniques, while subsequent chapters in this book will dive much deeper into practical applications in instructional design.

**Introduction**

Message design is all around us. From the logo on the coffee cup beside me here on my desk, to the layout of your car or truck’s dashboard, to the street signs you will pass to and from the grocery store; we see hundreds of examples of message design every day. Message design is the use of text, graphics, and/or pictures to communicate and to specifically address a need or solve a problem (Fleming & Levie, 1993). Thinking back to the dashboard on your car, it communicates your speed, fuel level, and general system status; all important pieces of information that are vital for your trip. That dashboard represents the efforts of the engineers (human performance technologists) who wanted to design a system that communicates to you (the driver) that essential information. This is the essence of message design.

While there are many great references for message design, especially in the context of marketing, advertising, web design, and graphical design, the specific focus of this book is message design in the context of instruction, learning, and education. Instructional design, in a single sentence, is the process of determining the need for an instructional solution, assessing and analyzing the learning needs of a user/client/student group, defining learning objectives, and developing a solution to meet those learning objectives (Reigeluth, 1999; Richey et al., 2011). The focus of this book is on the latter aspect of this operational definition, the arena of designing, developing, and implementing an instructional solution.

**Instructional message design is the real-world application of instructional and learning theories to effectively design the tools and technologies used to communicate, purposefully convey information, and to transfer knowledge to learners.** Similar to Fleming and Levie’s (1978; 1993) foundational work in instructional message design, this book also assumes that the reader has a background and is familiar with instructional needs analysis and the basics of instructional design. An excellent reference for the
instructional design process is Morrison, Ross, Morrison, and Kalman’s (2019) Designing Effective Instruction. The contents and guidance of this book fall within the “Designing the Instructional Message” phase of the Morison, Ross, and Kemp model, or developing how to best present and communicate the information that the learner needs.

Following Fleming and Levie’s original guidance, this book focuses on four key objectives (1978). The authors in this book present empirical research, from the early foundations of each topic to the latest theory and findings. The chapters of this book also focus on the practical application of theory and research. While each of the talented authors in this book have an applied research background, the authors take a non-technical writing approach in each chapter (with some noticeable deviations from classic, academic APA style). The fourth and final objective of this book is to present practical examples and real-world best practices for anyone who plays a role in instructional design.

Instructional designers have a wide range of tools and techniques to design instructional messages. Gestalt theory, cognitive load, dual coding, working memory, and multimedia learning theory are some of the many theories that can be applied as design heuristics. Text, typography, graphics, diagrams, animation, video, multimedia, and simulations are among the many options to present information in our instructional messages.

**Instructional Message Design Theory**

There are several key theories that guide our instructional message design. These selected theories help describe the cognitive processing of our learners and thus can be used to define guidelines and best practices.

**Gestalt Theory**

Gestalt (German for ‘shape’ or ‘form’) theory states that individual components of a picture do not communicate much by themselves, it is only when these individual components are combined
do they form a picture (Wertheimer, 1944). A complete image is only able to communicate an idea when the components of that image are integrated and presented together.

Gestalt theory has evolved to now include five key principles (Lohr, 2008). The first principle is **Closure**, or humans will see the whole of an image before we will see the parts (see Figure 1). The second principle is **Contiguity**, or the human eye will tend to follow a path when a path is presented in an image. The third principle is **Similarity**, or the human mind will seek and look for patterns. The fourth principle is **Proximity**, or we will integrate image components into the complete image based on how close or far those components are displayed. The final principle is **Experience**, or we will see an image and tend to relate it to something that we are already familiar with. This principle is very similar to schema theory, which states that when presented with new information, humans will tend to look to connect that new information to previously learned ideas, concepts, or patterns (Bartlett, 1936). Gestalt theory helps explain the cognitive processes that occur in the working memory of our learners when they are presented with instructional message designs.

**Figure 1**  
*Gestalt Theory*

*Note.* In this classic example of Gestalt theory, which do you see first, the two human faces? or the vase?
Cognitive Load Theory

Our learners have finite short-term or working memory resources. While there may be some debate as to the true quantitative measures of working memory, an early insight put these resources somewhere in the range of seven plus or minus two units of memory (Miller, 1956). This limitation on short-term or working memory was supported by research that would eventually evolve into cognitive load. Work to identify the difference between novice learners and expert learners realized that the distinction could be that inexperienced students may be expending their cognitive resources early during problem-solving exercises (Sweller, 1988). Experts have previous schema, or learned patterns, principles, ideas, and concepts, to pull from long-term memory to help when problem-solving. This schema occupies only one of those five to nine working memory units allowing the learner to focus their remaining cognitive resources on solving the problem. Novice learners have not yet developed this schema and so have to use all of their cognitive resources to solve the problem.

Cognitive load theory continued to develop and is composed of three basic principles (Pass & Sweller, 2014). Cognitive load theory assumes that learners have limited working memory resources, that the contents of working memory fade after a short time, and that humans have a capacity for nearly infinite long-term memory because of schemata, or the storing of information as patterns. Cognitive load describes the capacity of a learner’s working memory resources in terms of germane resources, extraneous load, and intrinsic load (Ayers, & Kalyuga, 2011; Sweller et al., 2011). Extraneous cognitive loads are distracting aspects of instructional message design that divert attention, annoy, or confuse learners. Reducing extraneous cognitive load is the primary means by which designers can reduce overall cognitive load and increase learning effectiveness in technology-assisted instruction (Sweller, 2019). Intrinsic cognitive load is the actual message and the inherent difficulty of the subject matter. Intrinsic load can be managed and minimized through strategic chunking techniques, development of schema, and scaffolding (Sentz et al., 2019). Germane resources (often also referred to as germane cognitive load) are the cognitive resources that are available after
extraneous load that the learner has available to apply to intrinsic load. The effects of extraneous and intrinsic cognitive load are accumulative and together reduce the germane resources available for processing new information in our learner’s working memory. The goal of instructional designers is to minimize extraneous cognitive load, manage intrinsic cognitive load, and to maximize available germane resources to focus on that intrinsic load.

**Multimedia Learning Theory**

Multimedia Learning Theory evolved from experiments with random treatment groups who looked at digital multimedia with static illustrations with and without text (Mayer & Gallini, 1990). These early results indicated the unique advantages of using multiple media technologies at the same time in the same presentation (see Figure 2). Mayer’s cognitive theory of multimedia design evolved from this use of text and illustrations and was first based on the dual-coding findings of Paivio (1991), and then integrated the working memory and cognitive load findings of Baddeley (1992) and Sweller (1991). Dual-coding theory states that humans will process video, slides, or animation separately from audio and narration. Learners cognitively combine that information in working memory, then store that information in long-term memory for future retrieval. Humans also have finite short-term and working memory resources, and these limited germane cognitive resources should be guided to focus on intrinsic content rather than extraneous design distractions.
Multimedia learning theory describes two cognitive processing channels available to our learners, one for processing auditory information and one for processing visual information, and the result is the modification or development of new schemata in long-term memory, or learning (modified from Mayer, 2014).

The basic guidelines defined by multimedia learning theory can be summarized into three key ideas (Clark & Mayer, 2016). In general, presenting pictures and text together will be more effective than presenting pictures alone or text alone. Next, instructors and instructional designers should look to reduce or eliminate as much extraneous and nonessential information or distractions from multimedia presentations as possible. Also, to further aid learning effectiveness, multimedia can be personalized using polite, conversational human voices integrated with visuals. Understanding and applying these concepts, especially when looking to effectively deploy multimedia, is a critical aspect of instructional message design.

The Message and the Media

While the affordances of different technology or media allow for different aspects of communication, the instructional message is more important than the media, technology, or vehicle used to deliver
that message. For instance, consider a unit of instruction that describes
the inner workings of an electric motor. In this context, an animation
that shows the cross-section of the motor and what happens inside that
motor when it is in motion may be more effective than showing a
series of still slides. In this example, an animation may be more
effective, though we cannot generalize this conclusion to say that
animation is a better tool than static PowerPoint slides. This would be
like saying hammers are better tools than screwdrivers. In practice,
both tools can be effective depending on the context, application, and
the available resources.

Rather than comparing technologies and tools to each other (as
in a media comparison study), it is more important to study the
efficient and effective use of each tool in a message design context
(Clark, 1983). It is also important to focus on which media or
technology has features that differ from other options or earlier
versions, such as if the new technology offers immediate feedback,
user input, customization, ease of implementation, and/or better
technical support (Morrison, 1994). The analysis of what technology
to use to deliver our message should now also include the heuristics of
multimedia learning theory, implications of cognitive load (especially
extraneous load), the equivalency to other options, and
cost-effectiveness (Clark, 2012). This aspect of cost-effectiveness is
also important to consider, especially from a human performance
technology perspective. In terms of instructional systems,
cost-effectiveness, student satisfaction, instructor satisfaction, learning
effectiveness, and accessibility are among the variables to consider in
high quality programs (Moore, 2002). In instructional message design,
it is important for us to be sure that the vehicle we are using to deliver
our message meets the needs of our learners, including accessibility,
ethics, equity, quality, cost-effectiveness, and learning effectiveness.

The Cone of Experience

The cone of experience describes the attributes of media and
technology in terms of the conceptual involvement of the learner
(Dale, 1946). While this model was developed in the context of the
technology available in the early 20th century, the concept of
engagement is still as relevant today as it was then. The model
describes a scale of learning engagement from concrete, cognitively tangible to abstract, intangible experiences. For instance, reading a textbook would be among the most intangible of learning experiences (near the top of the cone). A hands-on cognitive apprenticeship would be among the most tangible of learning experiences (near the bottom of the cone). A cognitive apprenticeship is learning directly from an expert, ideally in a one-to-one setting, in the authentic environment where the lessons learned will be applied (Brown et al., 1989; Collins, & Duguid, 1989). Learning from an experienced auto-mechanic in a professional garage will be a much more engaging experience than reading about changing an alternator from text in a book. In the context of message design, the affordances of a virtual reality simulation should be able to offer a richer learning experience than a PowerPoint presentation (assuming that the resources are available and that the learning objective will benefit from the use of a simulation). Note, this does not mean that one technology, tool, or technique is “better” than another - rather the use of different technology in our message designs will inherently introduce differing levels of direct or abstract engagement (see Figure 3).
Figure 3
The Cone of Experience

Note. The cone of experience can be used to describe how message design tools and techniques can be used to engage students in terms of indirect and direct experiences (modified from Dale, 1946).
The General Communication Systems Model

Signs and symbols are fundamental aspects of human communication (Bruce-Mitford, 1996). Symbols are used by humans to make understanding out of intangible ideas. The letters of the alphabet are symbols for sounds; signs are used to represent an object or idea, such as the physical signs we see along a highway or logos that we see on objects and in marketing. A signal can be a method of cueing or gaining attention (Richey et al., 2011). Or, in technical telecommunications terms, a signal is the transmitting and receiving of symbols and signs between a sender and receiver, see Figure 4 (Shannon & Weaver, 1949). In either case, in terms of instructional message design, the success of the message depends on the system used to convey signs, symbols, and signals between our instructors and our learners.

Figure 4
The General Communication Systems Model

Note. The general communication systems model describes how a message in the form of an information source is sent and received by a
destination. Noise can be introduced in the form of technology issues, system design issues, or actual, physical background noise, interference, and interruptions.

A complete communication system consists of three components: the accuracy of the symbols being received, the accuracy of the symbols delivering the message, and the understanding of the message (Shannon & Weaver, 1949). The communication process begins with an information source, or a message. The message is encoded; in today’s digital communications systems, this encoding takes that message and converts it into 1s and 0s. Those 1s and 0s are carried by a signal to their destination. For instance, our message can be converted into digital 1s and 0s and carried by a signal, over a network to the Internet to another network and then to the person who we are sending the message to. There is a receiver at the destination that converts those 1s and 0s back into something that should look like the original message. Along the way, that signal can encounter “noise” or interference that can damage the signal and the message. For example, if there is a network or Internet connection issue, the signal from our transmitter to receiver could be disrupted. The messages in our designs can be impacted by physical, physiological, organizational, cultural, psychological, semantic, as well as technical noise (Oaks, 2023; Smith-Downing, 2023).

In terms of instructional message design, the general communication model describes how the message is sent and received. In conceptual terms, the “signal” could be a live, interactive web conferencing protocol that is transmitting our audio, video, and visual slide presentation, or it could be a textbook or research poster that we have designed. In either case, the noise encountered by our image could be extraneous cognitive load erroneously introduced by an instructor or instructional designer, a bad Internet connection, or both. The intended message sent may not be the message received or understood at the destination. A goal in instructional message design is to create, design, and utilize a system that would be robust to both technical and cognitive communication issues.
Instructional Message Design Tools and Techniques

Text and Typography

Text can be operationally defined as the main set of written words in a body of writing. A font is a computer-generated text style, and typography is the study, design, and application of text and fonts (Lohr, 2008). Legibility and readability describe how easy it is to read different types of fonts. Legibility is the ease of reading a short set of text. It can be made easier with the use of a more modern sans serif font like Helvetica. Readability is the ease of reading long sets of text, which can be improved by using a classic serif font like New Times Roman. A serif font has small strokes at the ends of letters, while a sans serif font does not (Lohr, 2008). Text can also be arranged and organized by headings to guide and ease the readability of content.

There are several other characteristics of a font that contribute to its legibility and readability (Bringhurst, 2004). A font’s x-height (the height of the lowercase letter “x” in that font), ascenders and descenders (how much of letters extend above and below the line of text), counter (the filling inside letters), and kerning (the amount of space between letters) can all impact the ease of reading that font (see Figure 5). Other common variables in terms of writing for instructional designs include font size, line spacing, and the selection of a serif or sans serif font. In addition to the many serif and sans serif options, there are decorative fonts resembling elegant and informal handwriting. However, many of these font types lack legibility and readability in instructional applications. Before the inherent resolution of today’s devices and displays, we were taught as instructional designers to never use fonts much smaller than 24-point in virtual classroom applications. While we do not want to make our text illegible, today’s high-definition displays now give us the ability to decrease our font sizes to increase the information that we are able to display. When considering message design for mobile devices, if learners cannot control the amount of text on their screen, then it is best to err on the side of lower text density (Ross et al., 1988).

Traditionally, serif fonts are thought to be easier to read in print, while non-serif fonts are considered easier to read on digital screens.

Hierarchy is used to create headings that organize blocks of text into main sections and subsections (Lupton, 2010). White space
between headings, bold and italicized text, capitalized letters in words, and indentations can be used to organize bodies of text and cue readers. Hierarchy in short bodies of text can be accomplished with bullets that create a list of ideas, thoughts, or concepts. This typographical signaling aids in browsing, searching, skimming, and gaining the reader’s attention (Waller, 1979).

**Figure 5**
*Font Design*

![Font Design Diagram](image)

*Note.* Several aspects of font design can be seen when comparing Times New Roman and Helvetica, this figure was made with PowerPoint and a 191-point size for both fonts, note the design differences in caps-height, x-height, and descender.
Color

The use of color in message design will have direct and indirect psychological and cognitive implications. For instance, in educational or business contexts, I am sure we can all recall the ill-advised use of text color against background color during a presentation. The body of advertisement and marketing knowledge also recognizes the impact of color in message design. Color can be used to gain attention, project professionalism and quality, and induce unconscious decision-making (Mohebbi, 2014). Color hue (the color’s specific color family) and saturation (the intensity or purity of hue) can enhance positive or negative intentions of message design (Labrecque et al., 2013). In instructional message design, color can also be used to distinguish different aspects of a diagram, for measurement and quantities as in a chart, for representing reality as in a photograph, and for creating aesthetic appeal (Tufte, 1990).

Another review of the color and psychology research results in a summary of the emotional and potential cognitive implications of different colors in instructional design (Lohr, 2008). Lohr compiles and presents several communicative properties of color. For instance, dark grays and black are thought of as somber or elegant shades, while white and light colors signify purity and innocence. It is thought that red signifies passion or power, while orange signifies happiness and warmth, and yellow signifies brightness and idealism. Greens suggest growth and nature, blues represent tranquility and dependability (and sometimes sadness), violets suggest royalty and nobility, and browns represent duty and reliability. Thus, using a light blue background in web design or for slides could elicit a sense of calmness during a presentation (see Figure 6). While the colors in Figure 6 may have some level of implied meaning in western cultures, specific colors could and would have other meanings in other cultures and contexts. It should also be noted that to remain accessible for our learners, components of our message design elements should complement and support each other. Designers should not try to communicate through color alone.
Figure 6
Color and Perceived Meaning

Note. The choice of color in instructional message design can communicate emotion and elicit perceived meanings based on the customs and backgrounds of the reader (Lohr, 2008).
Text and the color of text inherently work together. In a multi-year study with 218 online participants in the United States, researchers found that the color (black, white, red, orange, yellow, green, blue, purple, or brown) of the text and the font used (Courier, Times New Roman, or Phosphate) together impacted readers’ perceptions of how a message communicated friendliness, funnness, boringness, dependability, reliability, and prestige (Ramlatchan, 2021). For instance, participants felt that short messages in black Courier communicated dependability, reliability, and boringness, while messages in orange Phosphate were perceived as fun and friendly.

**Graphics**

Instructional graphics should communicate and reveal data (Tufte, 2001). This operational definition is especially true in instructional design. Visual elements beyond text can be categorized into two main types: static art or dynamic art (Clark & Lyon, 2011). Static art is graphics that do not move, such as illustrations, photographs, and three-dimensional computer models. Dynamic art is visuals that move, change over time, and do not remain static, such as animation, video, and virtual reality. Also, as multimedia learning theory would predict, including narration and sounds in animations, video, and other dynamic visual applications will further enhance learning.

**Illustrations.**

Graphics, or visual elements designed or constructed to present data, ideas, or concepts, can take the form of diagrams, charts, and pictures. While there is merit to decorative graphics that aid in the professional appearance of a message, or to serve as a cueing aid, care must be taken to avoid adding distracting extraneous load (Morrison et al., 2019). Along with avoiding “chart junk and PowerPoint Phluff” that unintentionally distracts from the content of the graphics, ethical designers should never manipulate the message and graphic design to mislead learners (Tufte, 2003). Well-designed charts and illustrations should show data comparison, causality, multiple variables, integration of multiple data types (words, numbers, images,
diagrams), documentation and references, and maintain a faithful focus on the content (Tuft, 2006). Diagrams and text should be integrated as much as possible, and diagrams within a text should be positioned as close as possible to the paragraph that describes that diagram (Mayer & Moreno, 2003).

**Photographs.**

Photographic art is still life, realistic images taken with a film or digital camera (Clark & Lyons, 2011). While the same can be true for complex diagrams and digitally constructed models, photographs are inherently composed of depth, texture, and shade that can be used to direct attention (Lohr, 2008). There may be authenticity implications and benefits of using color photographs in instructional designs as opposed to black and white or grayscale illustrations. However, there could also be cognitive load consequences, especially for novice learners. Photographs have the fundamental attribute of the instructor or students being able to zoom in and see subjects or objects in greater detail (Kemp, 1975). Digital photographs can be used to provide learners with a view of the authentic environment that they will be performing in or learning about (Lohr, 2008). The authenticity of photographs are in line with other learning theories, such as situated learning which focuses on the unintentional aspects of education due to the realism of the learning experience (Lave & Wagner, 1990). For instance, a recent study indicated that narration while viewing realistic photographs dramatically influenced viewers in a way that narration (or narration with diagrams) could not (Salerno & Phalen, 2020). Photographs can also provide a cultural and historical context that a diagram or illustration would not.

**Modeled Graphics and Augmented Reality.**

Modeled graphics are static visuals that are three-dimensional and have been created digitally (Clark & Lyons, 2011). Augmented reality applications would fall into this category. Computer generated images may be more effective than actual photographs, especially when lighting is poor or when backgrounds behind the subject of the photograph can be distracting (Greitzer, 2002). In an augmented reality application, the learner is typically able to manipulate a
three-dimensional, computer generated object against a realistic space or background (Azuma, 1997). Augmented reality allows users to see the unseen, engage in gamification and learning challenges, make connections to other content or previous learning, and compare and contrast content (Dunleavy, 2014; Yoon & Wang, 2014). For instance, in an educational setting, learners can point their mobile devices at an image and be presented with additional information about that object. Augmented reality can reduce cognitive load when reducing the spatial effect in instructional lab environments (a college lab environment being essentially a simulation of a real-world environment) (Thees, et al., 2020). Other applications of modeled graphics would include contexts where the learning object cannot be easily photographed and when details beyond typical illustrations are required.

**Animation.**

An animation is a series of simulated images that change over time, such as at a rate of 30 images per second, to simulate motion (Ainsworth, 2008). Note, this operational definition is different from video, which is a series of real images that when moving at 24 to 30 frames per second is perceived as motion. Animation is helpful when the instructional objectives require learning about an object, concept, or principle that inherently moves or changes over time. As compared to trying to learn from a series of static images, learning about an object over time or that is in motion should be cognitively easier when learning from animation. Also, with all other aspects of instruction being equal, animation with narration will be more effective than animation on its own (Mayer & Anderson, 1991; 1992).

**Video.**

Similar to the use of static photography for authenticity and realism, video can also be used to record authentic environments, especially when audio is also recorded. Video can be used to enhance social presence, for virtual field trips, and to record and collect data (recorded audio and video) from locations that would be logistically challenging or inaccessible. Video in instructional applications will be more effective in terms of social presence when students are able to
see video of their instructor in online classes (Jayasinghe, et al., 1997; Ramlatchan & Watson, 2018; Ramlatchan & Whitehurst, 2019). Video can also be useful for novice learners of a process or procedure due to the richness of detail, though video may be less effective with more experienced students (Ganier & de Vries, 2016). Experienced students may not need the details, and so the video may introduce extraneous load from this perspective. Also, the moving images in full motion video are also most effective when that video is also accompanied with its associated audio. Other video applications include tours, whiteboard drawings, portrayals, point of views (such as “how-to” videos), and highlighting (such as the use of digital pens, slow motion, and zooming) (Schwarts & Hartman, 2007). Other research has pointed out the potential fallacy in the assumption that all instructional content can be pre-packaged (Bishop, 2013). Rather, synchronous video and audio collaboration and engagement can be used to foster teaching and learning through social interaction and social presence in online environments. Synchronous online web conferencing also allows instructors and teachers to adjust the agenda of the class in real-time based on live feedback, engagement, and class discussion. The cost-effectiveness, access to, and availability of video applications was especially instrumental for successful online programs during the 2020-2021 COVID-19 pandemic.

**Video Games, Simulations, and Virtual Reality.**

Several tools and techniques fall into this generalized category of dynamic, computer generated visuals.

**Video games.** Successful instructional game play using personal computers, game consoles, or mobile devices involves higher-order thinking and learning skills, as well as collaboration skills that transfer into real-world situations. Playing and learning from early video games involved hand-eye coordination, reflexes, concentration, and visual perception (Heinich et al., 1989, Molenda, & Russell, 1989). As the processing power of devices improved, video games evolved to take advantage of those affordances. Video games soon also included more complex problem-solving challenges and strategic planning (Gee, 2003). Video games that involve problem-solving now often require players to analyze situations,
synthesize solutions, and test the validity of those solutions to be successful. Digital natives, or learners who have never known a world without mobile devices, the Internet, and complex video games, may benefit from neuroplasticity (Prensky, 2006). Neuroplasticity describes how the human brain adapts to stimuli, or how digital natives adapt to and learn from video games. In addition to higher-order thinking skills, many video games also now include aspects of research, creativity, communication, and social collaboration with other players (Qian & Clark, 2016). Or basically, all the major 21st century skills required by a modern workforce.

**Simulations and virtual reality.** Simulations do not need to be computer generated (such as in classroom case studies and role plays). However, in the context of this book, a simulation is the creation of a virtual environment for the integration of learners into a learning situation. The learner is immersed into an authentic problem, where they have to generate and test a solution, and reach a conclusion (Heinich et al., 1982; Molenda, & Russell, 1982). For instance, learning on simulators is less expensive and introduces less risk than initial learning on actual aircraft. The skills learned in high-fidelity simulators transfer to more advanced learning in actual aircraft (Hays et al., 1992). Some training programs now require that when a simulation can accomplish the same training objective as live flight, it must be used in place of live flight. Hardware simulators, such as aircraft and motor vehicle systems, use displays, hydraulics, and the physical interiors (including the control panels or dashboards) of the systems that they are imitating to simulate the actual system (Gawron et al., 1995; Bailey, & Lehman, 1995; Kuhl et al., 1995). Also, when combined with other techniques, the impact of virtual reality can be further emphasized. For instance, a learning activity with virtual reality can be enhanced by the thoughtful inclusion of text (Albus, et al., 2021). Though care must be taken to not overwhelm and distract learners.

There is ample evidence for the general effectiveness of simulation and simulators, especially in support of other instructional strategies (Rutten, et al., 2012). Additionally, simulations are extremely advantageous when other strategies, such as lab work online and teaching healthcare providers, pilots, and drivers, are unavailable, logistically challenging, or would otherwise be physically
dangerous for the learner or patient. Emerging, cost-effective, high-resolution, head-worn technologies promise to be a new arena in immersive simulations and message design (Hupont et al., 2015). Virtual reality can employ head worn devices to immerse learners in artificial, computer generated environments or worlds (Freina, et al., 2016). In an instructional context, virtual reality systems can be designed to simulate real-world environments to prepare learners and allow for practice.

**Instructional Message Design Applied: PowerPoint**

A discussion on instructional message design would be incomplete without a discussion on Microsoft PowerPoint given its ubiquitous use in academia (and business, and government, and any formal application where information is shared via presentations in meetings). The use of PowerPoint may induce negative opinions and connotations (think the common euphemism “death by PowerPoint” in business meetings). It has even been blamed for the 2003 NASA Columbia space shuttle disaster (Tufte, 2003). According to the classic 6x6 rule, a PowerPoint slide should not have more than six words in a line and no more than six lines (Lohr, 2008; Zimmerman, B. & Zimmerman, S. 2009; Zimmerman et al., 2014). However, PowerPoint is a message design tool, and as with any tool there are those who use it well and those who do not use it well (Gabriel, 2008; Herting et al., 2019). This could be especially true for modern iterations of PowerPoint that include the ability to apply many of the text, typology, graphics, and multimedia heuristics described in this book.

There is a lot more that can be done with PowerPoint besides extraneous cognitive load inducing templates and bullets. When it is thought of as more about “design, not software” it can be used to guide a lecture, deliver an effective business presentation, or develop engaging, interactive e-learning modules (Bozarth, 2008). However, PowerPoint can also become a crutch for a presenter and distract from substantive content. A presenter should avoid the urge to read verbatim from slides, avoid irrelevant images, and avoid too many decorative “bells and whistles.” Deviations from the traditional 6x6 rule can also be made to allow for a focus on content and when the slides will also serve as a reference or job aid for the learners.
However, care should be taken to avoid extraneous load, such as sounds and overly animated bullet points that do not cue but distract. The intent of this book is to help other instructional designers use tools like PowerPoint, Google Slides, Keynote, Canva, and Prezi more effectively. PowerPoint does not have to be relegated to extraneous cognitive load inducing templates and bullet points.

Conclusions and Future Directions

These are only some of many learning theories and applications of instructional message design and only serves as an introduction to the topic. Subsequent chapters in this book delve much deeper into the theoretical frameworks and evidence-based best practices associated with the tools and techniques briefly introduced here. Along with the ability and affordances of newly emerging technologies, there are a number of other aspects of message design that can be explored. Future research directions could continue to explore the social presence implications of message design, how motivation can be enhanced through message design, applications in online and distance learning, and customizing learning for differing cultures, age groups of learners, and learners with special needs.

Instructional design is an applied science where theories and models have practical, real-world applications that benefit learners. Instructional message design draws from several areas and fields of study and describes how designers can create systems, programs, and products that effectively communicate information. Readers and researchers are encouraged to follow-up on the studies presented in this book, either to replicate or to extend these formative message design findings with new research on contemporary tools and technology with samples of today’s digital natives.
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Chapter 2: Multimedia Learning Theory and Instructional Message Design

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Citation:

2. Multimedia Learning Theory and Instructional Message Design

Miguel Ramlatchan, PhD

Key Points:

- Multimedia learning theory describes the use of multiple simultaneous techniques in instructional message design, such as combining narration and animation in a presentation.

- 1) Dual coding, 2) limited working memory capacity, and 3) the need to maximize cognitive resources for learning are fundamental principles.

- The key to effective multimedia design is to minimize extraneous processing, manage essential processing, and maximizing working memory resources available for generative processing.

Abstract

Multimedia learning theory describes how the designers of instructional messages, systems and learning environments can optimize learning. The principles and heuristics of multimedia learning theory have application in traditional and online environments, with young and adult learners, in K-12, higher education, military, corporate, government, and informal learning environments. This diversity of application is based on the foundational premise that all learners can independently process auditory and visual information, have limited working memory resources, and require cognitive resources to process new information and to learn. This chapter describes the basic tenets of multimedia learning theory, best practices that can improve our message design
and communication, and exciting future directions that we can take new research.

**Introduction**

When teaching students, what is better, textbooks or iPads? (iPads are better, right?). When developing my PowerPoint slides for class, I should include a lot of color and animations and sound effects to keep my learners’ attention, right? As an instructional designer, should I work to include animation or video in my project, and do those visuals require the added time and expense of narration?

Designers and instructors have access to an ever increasing multitude of software functionality, online resources, and ever evolving toolsets. Though where are the research-based best practices that can guide instructional message design with these resources? Subscribing to the heuristics and principles of multimedia learning theory is one option. Multimedia learning theory provides evidence-based guidelines that can be used to take technology and create and foster effective communication and learning. The results of nearly three decades of research can be used to help guide and inform instructors and instructional designers as they navigate the many available tools, techniques, and technologies in the search to enhance learning effectiveness.

Multimedia is the use of multiple presentation tools or techniques to deliver information. Audio and visual presentation technologies provide an effective set of tools for instructors and instructional designers to communicate with learners. Mayer’s multimedia learning theory provides an informative set of principles that can be used to create effective instructional message design. It is helpful to understand the origins of multimedia learning from the original sources to also understand how to best apply the theory in practice and plan for future research. Several other theories, models, and many other research studies informed the evolution of multimedia learning theory. However, the main contributions come from Paivio’s dual coding theory, Baddeley’s working memory model, and Sweller’s cognitive load theory (Mayer & Moreno, 2003).
**Dual Coding Theory**

Paivio’s dual coding theory evolved from Paivio’s research on noun-adjective pairs, noun-noun pairs, and how these aspects of language appeared to evoke mental images (Paivio, 1963, 1965). In several of these early experiments, images were evoked by ‘peg’ words (or words intended to be used to recall other words). The general findings of these studies also suggested that concrete nouns appeared to generate related images more reliably than adjectives or abstract nouns. These vocabulary and imagery findings would evolve into Paivio’s dual coding theory, which describes specialized cognitive resources used by learners to process verbal and nonverbal information (Paivio, 1969, 1971, 1986). Humans appear to have independent systems for the processing of verbal and nonverbal information. Interconnections between verbal and nonverbal information are also made and aid in knowledge recall. For instance, images can be given verbal names, and names can be associated with images. Also, single images can be associated with multiple names, and a name can be associated with multiple images (Paivio, 1991). The theory also describes what can be considered units of working memory resources called “logogens” in the verbal processing system and “imogens” in the nonverbal processing system (Clark & Paivio, 1991).

Logogens are specialized for linguistic information and imogens are specialized for nonverbal or imagery information. For instance, the spoken word “telephone” would be processed by linguistic logogens in the verbal processing system (Clark & Paivio, 1991). This processing would suggest associated imagery of telephones as well as associated sounds of telephones; this recalled nonverbal information would be processed by imogens. The two systems are able to create referential connections between logogen and imogen processed information. The result can be described as a verbal stimuli trigger to recall an entire telephone schema from long-term memory into working memory. This schema is a pattern of related ideas, words, sounds, and images that have been stored and modified over time in long-term memory. The idea that images and spoken words can be processed separately but associated together by a learner had a significant influence on multimedia learning theory (Mayer & Anderson, 1991, 1992, Mayer & Sims, 1994).
**Working Memory**

Baddeley’s working memory model evolved out of research into words, word length, general recall, and visual recall. It was found in a series of ten experiments that participant understanding and recall of verbally presented information was negatively affected by also having to remember six other items, but not as affected when having to recall lists of fewer than three items (Baddeley & Hitch, 1974). Baddeley & Hitch also suggested that short-term memory was in actuality doing more than storing information; these cognitive resources were also being used for information processing. Thus, Baddeley and Hitch (1974) began to use the more accurate “working memory” description for cognitive resources that are apparently allocated for both short-term recall and processing. It was also found that if experiment participants rehearsed the words for themselves then they could retain those words in short-term memory for an even longer length of time (as compared to not rehearsing). This result suggested a cognitive “loop.” Baddeley would describe this as a phonological loop, or cognitive resources that appeared to be reserved for processing of verbal information (Baddeley, 1986).

Research into the visual aspects of working memory also began to yield similar insight into another subsystem of working memory (Baddeley, Grant, Wright, & Thomson, 1975). It was found during this set of experiments that visual memory processing tasks did not detrimentally interfere with phonemic-based recall. These early studies also suggested the potential for a “common central processor” (Baddeley and Hitch, 1974, p. 80). This central processing could be an aspect of working memory that synthesized processed information from the visual and phonologic subsystems into chunks or relationships for storage into long-term memory. Further research from these early findings continued to strongly suggest that learners could independently process both visual and phonological information and supported the existence of a central processing function (Baddeley, 1992). By the mid-90s, Baddeley’s working memory model had evolved to describe two independent subsystems and central integration of these subsystems (Baddeley & Hitch, 1994). The model included a phonological loop subsystem that processes audio, a
visuospatial sketchpad subsystem that processes visuals, and a central processing system for control of attention and subsystem integration.

Baddeley would specifically recall the work of Miller’s seven plus or minus two units of working memory, and the use of ‘chunks’ to describe units of working memory (Baddeley, 1994; Miller 1956). The ‘episodic buffer’ aspect of central processing was later added to the model to more specifically describe the processing of visual and auditory information into chunks or ‘episodes’ for storage in long-term memory (Baddeley, 2000). The model that humans have limited working memory resources, used for both short-term storage of information and used for actively and independently processing that information, had a substantial impact on the development of multimedia learning theory (Mayer & Moreno, 1998, 1999, 2001, 2003; Mayer, Heiser, & Lonn, 2001).

Cognitive Load Theory

Sweller’s cognitive load theory began with work on trigonometry word problems and the realization that students appeared less cognitively overwhelmed when they were given an example to follow during the problem-solving process (Sweller, 1988). To describe what Sweller called “cognitive processing load,” Sweller notes numerous problem-solving experiments when students were more successful as the goals of the problems were simplified (Sweller, 1988, p. 263). Using a variety of physics, geometry, and maze problems, Sweller found that eliminating the implicitly stated end goal resulted in students exploring the problem and finding the solution on their own. It appeared that not having to store problem-solving rules in working memory freed cognitive resources for working on the problems. It also appeared that the reduction of cognitive load could describe earlier experiments when learning effectiveness appeared to improve when students were given worked examples during their learning (Sweller & Cooper, 1985). Learners in these experiments did not have to store problem-solving rules in working memory (as they referred to the given example) while occupied with problem-solving.

An expert has schemata stored in long-term memory that they can recall when problem-solving, novices do not and thus have to rely on inefficient “means-ends” analysis, or they focus more on the end
goal (Sweller, 1989). It appeared that when students only focused on the step-by-step rules to solve the problem with only the solution as the end goal, they tended not to form the intrinsic schemata required to become experts. Bartlett’s classic experiments indicated that humans develop schema or patterns of ideas that are stored together in long-term memory as a single unit (Bartlett, 1932). It was found that when given new or unfamiliar information, such as when asked to comprehend the story of the “War of the Ghosts,” listeners compared the new information into their existing schemata or patterns of existing memory.

Schema is a single pattern of memories that can be recalled and stored in working memory and will only occupy a single unit of working memory resources. This is analogous to Miller’s also classic description of a ‘chunk’ or unit of working memory that is also a pattern of related memories or elements also stored together as a single unit of long-term memory (Miller, 1956). Sweller uses both ‘chunks’ and ‘schema’ to describe and further an important aspect of his developing cognitive load theory, specifically that schemata storage renders human long-term storage virtually limitless (Sweller, 1994; Mousavi, Low, & Sweller, 1995).

Sweller’s work in the early 1990s focused on what would become extraneous cognitive load, and the need for instructional designers to reduce the split attention effect and the redundancy effect (Sweller, 1991). The aspect of eliminating split attention effect would become an especially important component in what would eventually become multimedia learning theory. Split attention is the creation of extraneous cognitive load by separating relevant content in an instructional design, forcing learners to use cognitive resources to actively combine or recombine these elements in working memory. An example of reducing split attention and extraneous cognitive load would be to integrate worked examples with problems to be solved. Another classic example of the split attention effect is having a diagram on one page of a book and the text describing that diagram on another page, requiring the learner to flip back and forth between pages. This misguided instructional message design practice forces the learner to utilize cognitive resources as they flip between pages in the text, thus adding extraneous cognitive load.

The term “intrinsic load” was soon added to the theory to describe the inherent difficulty of content, especially content where
elements interact with each other (Sweller, 1994b). An example of high intrinsic load would be complex math problems where learners have to arrange, organize, and interact with multiple variables, and relationships between those variables, to arrive at a solution. By the late 1990s, cognitive load theory included all three of the now familiar major components of cognitive activity including extraneous load, intrinsic load, and now germane load which described the resources remaining to process relevant information (Sweller, van Merrienboer, & Paas, 1998). This revision to cognitive load theory described a learner’s working memory resources as a function and combination of extraneous, intrinsic, and germane cognitive load. For instance, an instructional designer could work to reduce split-attention effects and redundancy in instructional designs and thus reduce extraneous load. At the same time, the designer could also chunk difficult content into simpler elements in an effort to also manage intrinsic cognitive load. The result of minimizing both extraneous and intrinsic load would maximize resources for germane load, or processing of relevant information.

Sweller would continue to revise cognitive load theory, specifically revising and renaming the idea of germane cognitive “load” into germane cognitive “resources” (Sweller et al., 2011, p.57). This subtle change more effectively communicates that intrinsic and extraneous processing inflicts an actual load on working memory in the form of accessible resources available for germane or relevant processing. In other words, available germane resources are a function of intrinsic and extraneous load. The theory that learners have germane resources used to process both intrinsic and extraneous information, and that a split attention effect will increase extraneous load, would be incorporated into the evolving theory of multimedia learning (Mayer et al., 1996; Mayer & Moreno, 1998, 1999; Mayer et al., 1999).
The Evolution of Multimedia Learning

Mayer’s multimedia learning theory developed from research into text and illustrations and experiments that suggested that illustrations with integrated text improved learning effectiveness (Mayer, 1989). In the early 1990s, Paivio’s work on dual coding theory began to inform Mayer’s research with narration and animation. Mayer’s results indicated that learning was most effective during treatments where the participants were able to see the animated visuals as well as hear the integrated audio narration of those visuals at the same time (Mayer & Anderson, 1991). Animation without narration and narration without animation treatments were not as effective. A further set of experiments yielded similar results when narrated animation was compared to trials of animation then narration, narration then animation, only animation, and only narration (Meyer & Anderson, 1992; Mayer, & Sims, 1994). As dual coding describes, the learners’ audio system processed the narration while the learners’ visual system independently processed the animation, and central working memory resources integrated visual and narrated information into schemata. These findings were similar to the independent phonological loop and visuospatial sketchpad described by Baddeley.

Sweller and his colleagues found similar results when comparing audio integrated with visuals, as compared to the visuals alone or the audio alone (Mousavi et al., 1995). Mayer integrated these findings, along with the implications of split-attention effect into another series of experiments. In a series of experimental trials, participants who viewed and listened to animation and narration outperformed participants who viewed the same animation with the text equivalent of the narration also on the screen (Mayer & Moreno, 1998). These findings were further supported by Paivio’s dual coding theory and Baddeley’s working memory model. Learners appeared to use dual sensory channels to process animation and available narration, though only used their visual channel when processing animation and on-screen text.

Similar findings also resulted when using different animated content, and trials with narration, integrated text, and separated text (Mayer & Moreno, 1999). This study specifically looked for results predicted by Sweller’s split attention effect, or a temporal example.
described as a contiguity principle. The contiguity principle states that learning will be more effective when narration and visuals are timed and presented together, thus reducing or eliminating extraneous load caused by the split attention effect. The results provided further examples that narrated animation was processed more efficiently than animation with integrated text and animation with separated text.

Mayer, Baddeley, and Paivio all provide strong evidence that learners are able to process visual and audio information independently (Baddeley, 1994; Mayer & Moreno, 1999; Paivio, 1991). Mayer, Baddeley, and Sweller all provide empirical results that suggest that learners, even with independent processing, still have limited working memory resources (Baddeley, 1994; Mayer & Moreno, 1999; Sweller et al., 1998). Mayer and Sweller provide evidence that presenting information with both visuals and narration can be more effective and efficient in schema creation than the same content presented with just visuals or just audio (Mayer & Moreno, 1999; Sweller et al., 1998). Taken together, these theories, experiments, and models provide the background and basis for multimedia learning theory.

Multimedia learning theory describes a series of processes that are taking place as a student is creating a new schema (Mayer et al., 2001). The first step in the learning process is the initial viewing and listening to instructional content and the immediate storage of that information in short-term memory. In this step, text is essentially visual words that when presented with diagrams then both the diagrams and the text are processed by the visual processing channel. When words are presented via audio, the narration is instead processed by the audio processing channel, while visuals are processed by the visual channel. The intrinsic content is separated from the extraneous content in the first phase of working memory. Next, the remaining germane resources in working memory create relationships between the visual and verbal information and recalls associated previous knowledge from long-term memory. Recalled schema is then compared to new information where the learner creates understanding. Finally, new schema can be created, or existing schema modified, and stored in long-term memory (see Figure 1).
Note. Multimedia learning theory describes two cognitive processing channels available to our learners, one for processing auditory information and one for processing visual information, and the result is the modification or development of new schemata in long-term memory, or learning (modified from Mayer, 2014).

By the early 2000s, Mayer’s cognitive theory of multimedia learning had solidified into three main principles (Mayer & Moreno, 2003). The first principle is the assumption that learners have independent channels for verbal and visual information and using both channels simultaneously is more efficient than using either channel alone. The second principle is that the two processing channels in working memory have limited capacity for both short-term storage and active processing. The third principle is that for learning to occur, working memory must actively process, pull previous information, and create and store new or modified schema into long-term memory (see Table 1 for a summary).
Table 1
Foundational Principles

<table>
<thead>
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<th>Foundational Principles:</th>
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<tr>
<td>1. The <strong>Dual Channels principle</strong>, states that our learners have two independent cognitive systems for processing visual and auditory information,</td>
</tr>
<tr>
<td>2. The <strong>Limited Capacity principle</strong>, states that our learners have limited working memory resources, and</td>
</tr>
<tr>
<td>3. The <strong>Active Processing principle</strong>, which states that to learn students need to focus on relevant information, organize that information for themselves, and relate that information to previous schemata.</td>
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*Note. The three foundational principles of multimedia learning theory (Clark & Mayer, 2016; Mayer & Moreno, 2003)*

As with early work with new animation technology in the 1990s, Mayer continued to explore new instructional message design tools and early virtual reality applications using new multimedia learning predictions (Moreno & Mayer, 2002). Treatments using desktop monitors were compared to groups using head-mounted displays; the narrated presentations resulted in greater learning outcomes than groups viewing animations with text. These findings continued the dual coding assumptions of multimedia learning theory, and also showed that the specific technology or media used is less important than the instructional techniques and how the technology and media are used. Desktop monitors produced comparable or slightly superior results as compared to new wearable technology, and the use of visuals and narration together were still more important in
these experiments.

**Media and Methodology**

As in early research studies, multimedia learning theory can also apply to the use of text and diagrams (Mayer, 1989). A series of media comparison studies found that good instructional design was applicable independently of the media or the technology used to deliver that message (Mayer, 2003). Dual channel processing, limited working memory, and the need to actively create schema applies to the use of computer or paper-based message designs. In another study, it was found that when both the media and the design methodology are varied, user-controlled text with diagrams can be more effective than narrated animation without user controls (Mayer et al., 2005). The ability for participants to review and re-review the diagrams with text was compared to treatments where participants were not able to control the playback of the narrated animation. Both the media and the design methodology were different in these experiments. However, when the media is held constant, the methodology can be adjusted to find the optimal learning effectiveness of the media.

Multimedia learning theory and the use of both audio and video can inform and predict the successful application of multimodal interactive learning environments. Results from asynchronous narrated animation or presentations should be generalizable to synchronous conferencing and online distance learning applications where audio and video are shared to and from all participants (Moreno & Mayer, 2007). When audio and video web conferencing is the communication medium and the method of presentation (i.e. shared slides) is unchanged, then learners should benefit from the efficiency of dual coding. All things being equal, the learning effectiveness of an online synchronous presentation should be the same as an online asynchronous presentation. Unless the instructor takes advantage of the real-time technology and fosters dialog and discussion with learners. Similarly, if the method remains constant, the use of different media such as comparing desktop and mobile device screens should not matter as long as students can see and hear the presentation. For instance, a specific comparison between electronic textbooks on mobile devices and traditional hardcopy, paper textbooks found no
significant difference in learning effectiveness (Rockinson-Szapkiw et al., 2013).

Multimedia learning theory provides results supporting instructional methodology being more important than instructional media. For example, adding chapters and headings to a presentation improved learning effectiveness for both desktop and mobile device treatments groups, and both groups performed equivalently (Sung & Mayer, 2013). This study found that while students may have different preferences, learning effectiveness should not be impacted by device type but can be impacted by methodology and message design changes. Interestingly, the cultural context of instructional methodology or message also has a significant impact on the effectiveness of instructional media or technology (Sung & Mayer, 2012). The common thread through these studies is that multimedia learning theory can be successfully applied using a variety of technologies. The specific technology used to deliver an instructional message is less important than the message being communicated unless that technology allows for an affordance that the instructor can use to improve the message (Fiorella & Mayer, 2016; Mayer, 2018).

Processes, Principles, and Instructional Methods

The current iteration of multimedia learning theory advises heuristics beyond its foundational principles with three base processes and several guiding best practices. Multimedia learning theory is based in part on cognitive load theory, though while cognitive load can be described by extraneous load, intrinsic load, and germane resources, multimedia learning theory can be described by analogous cognitive processing. These processes are described as extraneous, essential, and generative processing (Clark & Mayer, 2016). Extraneous processing is the active use of cognitive resources to process and filter redundancy or distractions from multimedia designs. Essential processing is the utilization of cognitive resources that are used to process and simplify the complexity of a multimedia design. Generative processing is the process of analyzing, synthesizing, and organizing relevant information into schemata. In practice, all three forms of processing occur during learning. However, the goal of good instructional message design using multimedia learning theory is to
minimize the resources consumed by extraneous and essential processing and to maximize the resources available for generative processing.

In addition to foundational dual channel, limited capacity, and active processing principles, an additional series of principles can be thought of as evidence-based instructional methods or design best practices (Clark & Mayer, 2016; Mayer, 2018).

To minimize extraneous processing:

1. The **Coherence principle** advises designers to avoid the use of unnecessary words, sounds, or graphics. Superfluous or irrelevant text, sound, and graphics will require unnecessary processing and use of cognitive resources.

2. The **Spatial Contiguity principle** advises designers to put text and graphics related to that text near each other in instructional message designs. The classic example of text on one page of a book and the figure being described by that text on a different page of that book causes unnecessary extraneous processing.

3. The **Temporal Contiguity principle** advocates synchronizing audio and video in presentations. Presenting audio before video or video before audio, or video and audio that are not in sync confuses and distracts learners.

4. The **Redundancy principle** states that on-screen text is distracting when audio and graphics are also used. Learners can be distracted by the redundancy of focusing and refocusing between the text and narrations when graphics are presented with text, and that text is read verbatim by a narrator. It is less distracting for a narrator not to read the on-screen text word-for-word.

5. The **Signaling principle** states that essential content can be highlighted to draw the learner’s attention to it. Signaling can be used to cue learners to important content and can be highlighted text, the use of bold or italics, or visuals of an instructor pointing to specific content on a whiteboard.
To optimize essential processing:

6. The **Worked Example principle** states that a step-by-step demonstration can help reduce complexity when problem-solving. Giving students an example to follow when working through similar problems gives them guidance to refer to and focuses their essential processing.

7. The **Segmenting principle** states that a continuous complex presentation should instead be broken down into shorter more management chunks. Complex content can be simplified by breaking that complexity down into easier components.

8. The **Pre-training principle** suggests that key, unfamiliar terminology and definitions be given and discussed before an instructional unit. Similar to segmenting, students can be prepared for learning by first presenting them and discussing key concepts and definitions.

9. The **Modality principle** suggests the use of audio rather than on-screen text during video, animations, or presentations. Presenting on-screen text with graphics only utilizes the visual processing capabilities of learners while using graphics with narration is more efficient as it utilizes both the learner’s visual and auditory processing capabilities.

To increase resources for generative processing:

10. The **Personalization or Voice principle** advocates the use of a more conversational tone when narrating visuals as opposed to a formal, academic tone. A friendly narrative tone fosters social presence which enhances motivation for learning.

11. The **Embodiment principle** suggests the use of human-like gestures when including on-screen agents in multimedia designs. The human-like gestures and personifications enhance the perception of virtual social presence and also increases learner motivation.
12. The **Multimedia principle** suggests presenting relevant graphics with text rather than just text alone. Static or dynamic graphics combined with text can often communicate more effectively and efficiently than just text alone by presenting concepts and principles as a visual schema.

13. The **Engagement principle** suggests that instructors and teachers actively involve students by asking them questions during presentations. Students will learn better when actively involved in a discussion vice passively listening to a lecture.

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**Emerging Technologies and Applications**

While multimedia learning theory was born of experiments with text and graphics, the principles can likely apply to a number of new and emerging technologies. Emerging instructional message design technologies include mobile devices, virtual reality, e-learning and online education, virtual reality, augmented reality, and digital whiteboards. Building on the philosophy of instructional methods being more important than instruction media, comparing learning on a PC workstation and learning from an Apple iPad should not make a difference. As expected, experiments with iPads have shown motivational differences over workstations, likely because learning with mobile devices means students do not have to be confined to computer labs (Sung & Mayer, 2013). However, learning effectiveness was statistically equivalent. Similar results were found in research with virtual reality headsets; the use of immersive virtual reality enhanced motivation though did not enhance learning effectiveness (Parong & Mayer, 2019). The novelty of the headsets and hand controllers could have increased motivation as compared to the more common use of PowerPoint.

E-learning and online education are now commonplace in K-12 (primary and secondary education), higher education, and government, military, and corporate training. Multimedia learning theory can be used to guide and improve these learning environments through effective instructional message design (Clark & Mayer, 2016; Mayer, 2018; Sung & Mayer, 2013). These guidelines can also be
used to effectively use drawings on traditional and digital whiteboards (Fiorella et al., 2019). In addition to enhancing social presence, especially in online environments, handwritten drawings appear to foster generative learning by building on the signaling and embodiment principles, or the use of human gestures to highlight content. The use of a transparent whiteboard that allows the instructor to look into the camera while drawing enhances social presence, though does not appear to impact learning effectiveness as compared to the use of a traditional whiteboard (Stull et al., 2018a).

**Future research directions**

Multimedia learning theory can be used to guide and predict the usefulness and learning effectiveness of visual and verbal presentations. It is critical that instructional message design is based on research and applied science and not fads, marketing, hype, opinion, and intuition (Mayer, 2018b). As seen in previous multimedia studies, the technology or delivery media used by instructors or instructional designers is less important than what the technology conveys. As a result, paper illustrations with audio narration, animation with audio narration, static slides with narration, video with audio, or virtual reality with narration should all be effective ways to communicate and trigger efficient dual coding. The use of simultaneous verbal and visual information in a presentation is an effective communication technique regardless of the specific technology used. Thus, the principles of multimedia learning theory should be applicable to video with audio, and video with slides and audio.

Future research studies could use multimedia learning to guide the design of treatment groups in quantitative experiments that could extend the findings and applications of the theory. For instance, versions of multimedia presentations can be compared to each other to inform the use of audio and video in online courses delivered online, to mobile devices. A version of an online presentation with narrated slides can be compared to a version with the instructor’s video in a window with the narrated slides in a larger window on the screen, the narration and just the instructor video, and a narrated version where visuals switch between instructor video and slides. Potentially, these
four treatments can be compared to a group who only listens to the narration without the visuals of the slides and a group who only has access to the slides without narration. Mayer’s multimedia learning theory would predict that the narrated visual groups will perform best on comprehension post-tests, but which of the four versions will perform best? Other potential experiments could add real-time engagement with the instructor, variations of visuals of the instructor and visuals of presentation content, and study the social presence implications of longer presentations at digital and traditional whiteboards, writing tablets, and document cameras with and without a view of the instructor. These future study variations could serve to fill gaps in the multimedia knowledge base or to specifically test the potential benefits and optimal variations of integrating audio with both video and presentation content. The results of this series of studies could be used to guide and inform future instructional design techniques intended for augmented reality, virtual reality, and mobile applications.

Future multimedia studies will also benefit from new ways to measure load and processing in experiments. Self-reporting surveys and questionnaires offer an indirect means to measure load and processing. While it is possible to individually measure extraneous, intrinsic, and germane loads and resources (and thus potentially extraneous, essential, and generative processing), these measures remain indirect (Deleeuw & Mayer, 2008). The emergence, affordability, and accuracy of eye-tracking systems offer an emerging and direct means to measure cognitive load and extraneous, essential, and generative processing (Li et al., 2019; Stull et al., 2018; Xie et al., 2019). In addition to potential direct measures of load and processing, eye-tracking can also inform designers on the effectiveness of signaling and the potential distractions of design decisions.

**Conclusions**

Multimedia learning theory builds on a number of previous theories and applies best practice heuristics that can be used to create successful instructional message design. Dual coding, working memory, and cognitive load theories, as well as early experiments comparing text and graphics, have developed into the foundation of
multimedia learning theory. These foundational principles include the concept that humans have dual processing capabilities for auditory and visual information, have limited working memory resources, and require working memory resources for the processing of information and for learning. Working memory is also allocated to three cognitive processes when learning: extraneous, essential, and generative processing. Extraneous processing is the resources required to filter distractions, essential processing is required to analyze and sift through the complexity of a presentation, and remaining cognitive resources are allocated to generative processing for the creation of new schemata and learning. These multimedia learning processes are analogous to the extraneous load, intrinsic load, and germane resources described by cognitive load theory. The goal in instructional message design is to reduce the need for extraneous processing, manage essential processing, and maximize generative processing. Multimedia designs can be optimized by evidence-based best practices such as maintaining contiguity in design elements, avoiding redundancy, signaling learners, segmenting complex content, combining and using both audio and visual design elements, using a conversational tone in narrations, and engaging learners by involving them in the presentation.

The principles of multimedia learning theory can be used to enhance and improve the ways that instructional message design is used to provide learning opportunities and communication. We know that the message being conveyed to our learners by technology is more important than the technology itself. For instance, reading from a textbook should be just as effective as reading from a digital tablet like an iPad. Only when the affordances and advantages of the technology are used by the instructor or designer, do the choice and use of one technology over another become significant. Or, when the iPad users are able to take advantage of different online resources not available in the textbook, does the use of different technologies become effective? Comparing different technologies to each other when teaching the same way is futile. However, learning how different technologies can afford new and more effective ways to teach and communicate is much more beneficial and relevant. It is hard to estimate the number of instructional message designs in K-12, higher education, military, corporate, government, and informal learning environments that have benefited from the results of nearly
30 years of multimedia learning research. However, given the multitude of poor examples of design in these same environments, and the continued advance of technology, there are still many opportunities for designers to apply multimedia learning principles to help learners learn.
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Citation:
3. Message Design for Instructional Designers – Audio and Video Best Practices

Shelby Taylor

Questions to Consider:

- Why are Cognitive Load Theory and Multimedia Learning Theory critical theories to consider when looking at audio and video best practices in instructional message design?

- How should videos and audio be incorporated into the learning design?

- How can you accommodate learners who have auditory deficits?

Abstract

Instructional message design is the way that information is delivered to users or the learners. Learners have short-term and long-term memory. Cognitive load theory and multimedia learning theory are two theories that can be applied to best practices in audio and video. Audio and video can range from speeches, podcasts, DVDs, and streaming videos. Both can enhance learning but should not drive the instruction. Segmenting video and audio is one of the many best practices as it allows learners to chunk the information and process it
in small bits. There are learners who have auditory and visual deficits and instructional message designers need to be aware of these deficits and accommodate them. One major accommodation is the use of closed captioning, which can be turned off and on. When using closed captioning you must make sure that the words are matching the audio and at the right time.

**Introduction**

Instructional message design can best be described as the way information is delivered to the user, or in this case, the learners. It takes into account various elements such as font types, font sizes, colors, background, and distractions, as well as the learner’s working memory and cognitive load (Ramlatchan, 2023). There are various types of audio and video that can be used, such as podcasts, speeches, musical backgrounds and clips, “how-to” videos, virtual field trips, and exploration of particular topics to name just a few. It is important to remember that audio and video should enhance the learning experience of the learner, not drive it. When it comes to using or creating audio and video, the length of the audio or video should be considered. If longer length is used it should be modified with some type of activity to assist the learner in remembering what they have learned.

Learners who have auditory or visual disabilities require accommodations. Not only is the design for inclusion best practice, but the Americans with Disabilities Act requires appropriate accommodations be made for these learners and failure to do so can have legal consequences (Americans with Disabilities Act, 2020). Closed captioning is a way that you can accommodate these learners but it does have some drawbacks. Instructional message designers need to make sure that font type, font size, and colors of the background and the text, do not distract the learner and cause an increase in extraneous cognitive load. YouTube auto-captioning should be avoided whenever possible as there are still too many issues with text not matching what is being said and also at the correct time (Parton, 2016). Numerous errors with closed captioning is distracting to the learner and the increase in extraneous cognitive load could cause communication breakdowns in the information that is conveyed.
High quality audio helps achieve highly accurate captions when using popular speech to text services and content providers.

**Instructional Message Design and Theories Related to Audio and Video Best Practices**

**Memory and the Learner**

When looking at learning and retention of information of learners in our instructional message design, we need to consider their memory. Every learner has long-term and short-term memory, with short-term memory being thought of as working memory used for learning. Working memory is only temporary and if it is not transferred eventually to long-term memory, then working memory processing is lost. Long-term memory on the other hand has an infinite amount of storage capacity (Roblyer & Hughes, 2019). Research has shown that the amount of resources working memory can accommodate is “seven plus or minus two units of memory” (Miller, 1965). Think of a learner’s memory being a computer. Working memory is like temporary storage files, if it is not saved and the program closes out, the information is lost. However, if we attach the new information to our previous knowledge, or schema, it is like saving the file to a hard drive. Schema can best be defined as previous knowledge stored as patterns that a learner has that is used to help organize the new information so it can be transferred to long-term memory (Mayer, 2021).

**Cognitive Load Theory**

Cognitive load theory takes into account how learners’ working memory is used in processing information, resources used, and how those cognitive resources are used. Cognitive load theory is broken down into different categories that work in conjunction with each other. The three categories are extraneous, intrinsic, and germane cognitive load (Ramlatchan, 2023; Sweller, 2005). Extraneous
cognitive load is best described as anything that is used to distract, aggravate, or even confuse the learner (Ramlatchan, 2023).

Figure 1
Working Memory Capacity


Extraneous cognitive load could be things such as text color, font size, font type, and/or background color to name a few. Intrinsic cognitive load is the actual information and the level of difficulty of said information that is being presented to the learner (Ramlatchan, 2023). Germane cognitive load, simultaneously referred to as germane resources, are all cognitive resources that are left to be used to process intrinsic cognitive load, after extraneous cognitive load has been
applied (Ramlatchan, 2023). It is important to note that when designing instructional messaging the main goal is to allow for optimal available germane resources for processing of information in working memory by balancing cognitive load. This can be done by regulating intrinsic load and reducing extraneous cognitive load.

Think of a presentation that was used in a conference session or class that you were sitting in. What did the slides of the presentation look like? Did they have a lot of pictures on them with words? Was there a lot of information on each slide? What was the background color or background image in the slides? What was the font size or type of font used on the slides? What did you learn from that presentation? All those different questions look at what the learner is having to process with the information that you are trying to present to them for them to learn. This is why it is important to make sure we look at reducing the extraneous cognitive load for our learners when we are designing our instructional messaging.

**Multimedia Learning Theory**

Multimedia is the presentation of two or more information sources at the same time. Multimedia learning theory looks at the cognitive processing of information in relation to auditory and visual presentation of information and how it is processed by the learner. In cognitive processing there are two channels that are available to learners, one that processes information coming in from auditory senses and one that processes information coming in from visual senses (Ramlatchan, 2023). According to Mayer and Moreno (2003), learning from words and pictures defines multimedia learning and the way words and pictures are presented to the learner to foster their learning defines multimedia instruction. Mayer and Moreno (2003), go further to discuss how words can be text or spoken and pictures can be in the form of static or dynamic images.
Supporting and Enhancing the Learning Experience through Audio and Video

Think back to when you were in school and learning. For some you might have memories of the audio-visual cart (filmstrip projector, TV/VCR, or TV/DVD) being wheeled into the classroom. Sometimes it meant you had a substitute teacher and you were going to watch an educational video for the day. Other times it was the teacher who was going to show you an educational video to support a class. How about learning history or musical appreciation? Was there a recorded speech that was made by a historical figure or from a particular event in history? What about music class and learning about various musical instruments, periods of music, or type of music? Now think about the part it played in your learning. Did it help you better understand concepts or skills better, or did it make it harder for you to understand the concepts or skills? How could the teacher have more effectively used video?

Audio and video should be used to enhance the learning experience of the learner, not drive it or be used solely for teaching the concept. While the person on the video may be best at teaching the concept to the learners, any misunderstandings or difficulties the learners are having cannot be addressed by the person in the pre-recorded video itself, as they are not there in real-life. Audio and video can be used to introduce concepts or skills, and can be used as an anticipatory hook to increase or drum up the learner’s interest in the concepts. There are various types of audio and video that can be used to help learners in the learning process.

Types of Audio Used

Audio can come in many different forms. Recorded speeches, podcasts, musical pieces, and familiar songs are just a few examples. Tone, inflection, and pace are important to help the listener determine the message that the speaker is trying to convey and the importance of it.

Think of one of the most iconic historical speeches in American history, such as Reverend Dr. Martin Luther King, Jr.’s “I Have A Dream” speech. This is a speech that is well played and recited in
American schools, especially when celebrating Dr. Martin Luther King, Jr’s birthday. That speech is not only powerful but some would consider it to be a universal message. It is impactful about events going on in a period of American history. When looking at world history, how about speeches from Nelson Mandela, Gandhi, or even Winston Churchill? Recorded speeches from different periods of history speak volumes because it helps the listener or learner understand the context of what is being said and the authenticity of it actually being said by that person. Depending on where the speech was recorded and being given, you could possibly hear crowd noise in the background giving social presence to when and where it is happening, like a public rally over civil rights.

Podcasts are another type of audio recording that could be used. Podcasts can cover a variety of topics and are becoming more popular everyday. Educational podcasts are audio-only short broadcasts that cover a wide range of content information that learners are passionate about or are interested in (Taylor & Clark, 2010). Educational podcasts could cover material that is to be presented in the next class or give supplemental information. For higher education learners, this could mean that a professor could prepare an introduction for the next class. Taylor and Clark (2010) conducted a study looking at the design of educational podcasts and the experiences that the teachers and students had. They found that short educational podcasts were relatively easy to create and allowed the teachers to give much needed information that may not have been able to be given in class. Students had positive outcomes from the podcasts, especially when given the ability to pause, rewind, and play. These features gave them user-centric controls that helped them process and absorb the information. For some students, it was useful to rewind and replay to reinforce the main points that the teacher was trying to convey to them (Taylor & Clark, 2010). Educational podcasts could be more beneficial in instructional message than audio and video when the design is more lecture or reading based, as the learner would be more focused on what is being said and not focus on extraneous information from the images or videos. It would also be more beneficial in terms of portability, as educational podcasts could be played in the car or while working out in the gym.

In music courses and classes you learn about different periods and styles of music, as well as various different composers and artists.
Now, I want you to put yourself in the position of the learner, learning about the different music styles of the different eras and composers. Let’s say the music lesson today is on George Frederick Handel. If the instructor stood in front of you and just lectured and showed you a picture of George Frederick Handel, how much information would you retain from learning about this composer? Would you really remember any of his pieces that you were taught about? that he composed? Now, what if the instructor incorporated some sound clips of some of his works like *Messiah* (1741) or *Water Music* (1717)? Would you better remember more of the learning because you could pair that sound clip with what you just learned?

**Figure 2**
*Handel’s Messiah Hallelujah! Chorus performed by Royal Choral Society*

![Handel's Messiah Hallelujah! Chorus performed by Royal Choral Society](https://c1.staticflickr.com/5/4058/4489992140_248800e366_b.jpg)

*Note. All Creative Commons: Flicker [https://c1.staticflickr.com/5/4058/4489992140_248800e366_b.jpg](https://c1.staticflickr.com/5/4058/4489992140_248800e366_b.jpg)*

Familiar songs could help your learners remember what they have learned, which could help with transferring information into long-term memory while helping manage cognitive overload (Sweller, 2023). Look on YouTube or even TikTok and look up different teachers and the methods they are using. One TikTok teacher, *Mr. C.*, has students use a Taylor Swift song to recite and remember math facts like *skip counting*, as well as teaching students about *regrouping*. This same teacher on TikTok also used the New Kids on the Block...
song, *Step-by-Step*, to learn and remember the order of operations. Mr. C. has other math concepts set to songs. You can find out more about how he uses songs for teaching and other resources he has at his linktree at https://linktr.ee/teachwithmrc.

**Types of Videos Used**

Videos can come in different forms. Video can be how-to’s, virtual field trips, exploration of particular topics, or even allowing your learners to interact in real-time with an expert. Gone are the days of just watching videos by filmstrips, VHS tapes, or DVDs. Thanks to the internet, we now have streaming sites such as YouTube, Vimeo, TED Talks, Dailymotion, The Open Video Project, and other various social media platforms. When using streaming videos sites for videos, you need to be very careful on choosing the video from the site to show. The video needs to be looked at so that it fits your content, is appropriate for your learners, and needs to be from a safe site. A safe site is where when you go to the site, your data is safe, it has encryption, and is secure from malware and adware. For some you also have to consider if it is a site allowed by school, university, or business.

How-to videos are growing more popular today as individuals look at trying to do more do it yourself (DYI) projects and education looks at trying to prepare their learners for the real world. Corporations have come out with them to help make it easier for their customers to assemble furniture or items that they have bought. How-to videos can also incorporate virtual reality in which the user can actively participate in the how-to. Online how-to videos are a great way for those in trades classes to learn how to properly use tools and how to create different types of things. Outside of the education realm, how-to videos are used to help the user and/or learner know how to put purchases together. An example is a piece of IKEA furniture, see Figure 3.
Figure 3
Picture of Assembly Instruction for an IKEA Bekant Storage Unit

To put together this cart, the instructions primarily consist of pictures. There are some brief numbered text instructions, but the job aid is primarily simplified diagrams. However, going to YouTube, one could do a simple search and find someone walking through how to put it together step-by-step. An example could be putting together the Ikea bekant storage unit. The video allows the users to also be able to pause and go back if they need more clarification or to rewatch.

Before COVID-19, some learners in K-12 primary and secondary education could go on field trips to different places to enhance their learners' learning. For some districts, field trips were sparse because of funding and the costs, even before the pandemic. After COVID-19 and while educational institutions were shut down, virtual field trips were and are now even more in demand. Virtual field trips can be to different historical places and can even be interactive. Colonial Williamsburg is one such example. You can tour two buildings online, which are the Capitol Building and the Governor’s Palace, see Figure 4.

**Figure 4**  
*Virtual Tour or Capitol Building and Governor’s Palace in Colonial Williamsburg, VA*

![Capitol Building](image1) ![Governor’s Palace](image2)

*Note.* Images taken by S. Taylor

When you go to the building, there are features where you can move about the building and click on interactive options that tell you
about a particular room and what went on during that period of time. You can even look and get information on period-type furniture and the research done to reproduce that furniture. There are even virtual trips that can be taken to museums such as an international art museum that would be difficult to physically visit as a class such as https://www.louvre.fr/en/online-tours.

Video conferencing has opened up a world where learners can interact with and learn from experts and explore particular topics all over the world. Skype, Zoom, and Google Hangout are just three examples of video conferencing software that can be used to connect learners with experts and allow for the exploration of particular topics. Say, for example, your learners are learning about space exploration. As the instructor, you could reach out and might be able to set up a meeting with your learners and a former NASA astronaut or even a NASA astronaut at the International Space Station. Now your learners are not only able to hear about space exploration but can also be able to interact with the astronaut and ask questions in real-time. These types of interactions can make the concept that your students are learning more real to them as they see and hear about it in real time and in real life. It could even motivate some learners to really want to learn more about a particular topic because they may consider that job interesting and something that they would want to pursue.

**Incorporating Audio and Video into the Instructional Design**

Audio and video are wonderful educational tools that can help enhance the learning of your audience. They can help learners make bridges between the concepts that they are learning and what they already know. Some educational digital asset repositories that can be used are Khan Academy, eMedia VA, and Discovery Education to name just a few. You also have Blu-Ray and DVDs as well (these can be very cost effective options to streaming subscriptions). For instance, Bill Nye the Science Guy was a well produced television show popular in the 1990s and covered many topics that remain very relevant.
In those classic videos he would cover topics, show experiments, and even go to segments to get the viewer to ponder certain topics. It even provided fictional science ads that went along with the concepts in the video. Figure 5 lists this and several other examples of videos that can support different subjects.

According to a study done by Deng and Gao (2023), educational videos have the capacity to facilitate the learner’s deeper learning. Imagine trying to read 1.8 million words and how long it would take to read all those words and for the learner to process all of that information. What would the cognitive load be to the learner, especially one that may have some type of deficit? Now, what if I told you that 1.8 million words worth of information could be conveyed to a learner in about 1 minute? What do you think of that? According to Sheninger (2019), a one-minute video equals about 1.8 million words. That is 1.8 million words worth of information, and the learner is able to pause and go back to it. In a one-minute video you can introduce a concept or skill to your learners and grab their attention. In a study
done by Gasuku (2021) it was discussed that when learners watched and listened to videos, it increased learners’ retention of information because the mixture of using “images and sound input” attracted the learners’ attention to the video and helped in easier recall of the information being presented. Gasuku (2021) found in their study that learners understand and can better recall the ideas when they are expressed with both pictures and words, instead of just words by themselves which supports Hede’s integrated model of multimedia effects on learning theory.

YouTube is another great video tool to use because it can be easily embedded into online slide presentations. According to Atherton (2018), YouTube can be used for homework and is an online resource that learners are already familiar with and use on their own. YouTube has even created an educational version called TeacherTube.

**When to Use Audio and Video**

Video and audio are tools that, when used correctly, can help learners acquire knowledge and understanding of content and concepts that are being taught and presented. Video and audio should be used to enhance learning by introducing unit topics or concepts, modeling of a concept, showing and telling about a concept, explaining and informing the learner of a concept or content, helping the learner with understanding difficult concepts, and bridging understanding (Di Paolo et al., 2017). Video and audio could also be used to breathe life into a concept, content, or skill being taught or presented. Knapp and Glenn (1996) discussed how videos should be used to “provide supplementary, visual information to a curriculum unit being covered by a class.” In this classroom context, video and audio should also be used to help reinforce the learning concept, not as a replacement for an experienced and effective teacher.
How Much to Use of Audio and Video

There is a debate on the length of audio or video that is appropriate to use with your learners in the presentation and instruction of concepts and new content. The spectrum runs from fifteen seconds to thirty minutes in these debates. Some researchers, such as Knapp and Glenn (1996), believe that segmenting videos and audio is better than just brief clips, and this segmenting will be discussed further in this section. There have been studies done looking at this very technique and best practices have changed over the years. Knapp and Glenn (1996) gave some guidance that an instructor or presenter could do for their learners to make incorporating video into learning activities more effective. Their suggestions include watching it first and creating questions to ask before and during the video, segmenting the video at different points to have discussions and emphasizing particular points. Engagement points and questions could also be included at the end of the video and support a discussion or debriefing on what they have learned from the video or audio. Knapp and Glenn further discussed how longer videos can cause the learner to become disengaged and lose focus on the main points, especially if it has information that is not relevant to the concept being taught. Researchers created eight guidelines based on research for designing instructional videos for conducting training for software. The seventh guideline they have is for videos to be kept short (Van der Meij and Van de Meij, 2013). They cited research from Plaisant and Shneiderman (2005) and Chan et al. (2010) on the discussion of video length. Plaisant and Shneiderman (2005) felt that videos should be kept between fifteen to sixty seconds in length as that would allow for keeping the learner engaged and reducing cognitive resources needed to remember the concept. Chan et al. (2010) discussed the usual length for problem-based learning in medical consultation is a video clip of an average of three minutes.

Mayer (2021), in his Multimedia Learning book, devotes a chapter to discussing the segmenting principle and what segmenting is in relation to the principle. He defined segmenting as a technique used by instructional designers to help manage cognitive load by breaking down video and information into small pieces to make understanding easier for the learner, especially learners whose cognitive capacity is more limited than others. Taking audio or video and strategically
segmenting them, you are giving the learners breaks at just the right time so that they may be able to process the information before moving forward. This principle can be applied by adding pauses after a certain amount of information has been presented. Segmenting could also be allowing the video that is being used by the learner to have a pause feature, and having the user know how to use the feature. Applied segmenting could also have the video or audio clip being played for a certain period of time and then at the pause having a reflective question or activity to help the learner process what they just learned. Research done and mentioned by Merkt et al. (2011) discuss findings that support small segments of video being shown that were beneficial to learners’ learning. They also brought up a point about how segmenting of videos could be more of a detriment to learners with higher capacities of working memory or experts compared to novice learners who have limited capacities.

Learners have so much competition for their attention and time. We are in a society where multitasking is the norm. Learners seem to do better with shorter audio and video clips than longer ones. If longer ones need to be done, then segmenting is the best way to accommodate the learners. Looking at the research and studies that have been done and are out there, using short video and audio clips are among the best practices to use in instructional message design and would benefit the learner the most. If a longer video is needed to be used because of the depth of concept, complex content, learner experience, and or procedural information that is needed to be conveyed to enhance learning, then segmenting is the best practice to use with those longer videos. When doing segmenting of videos at the pause, it would be good to include a reflection question or activity to help the learner process the information that they have just been given. Doing so can help the learner pull previous knowledge or experiences and connect it to new information.

Focus and Intent of Using Audio and Video

Expanding on Di Paolo et al. (2017) on suggestions on when video and audio should be used, the first one mentioned was introducing unit topics or concepts. According to Pitler et al. (2007), video should be used to build up learners’ background knowledge and
to engage them in the concepts being taught. Videos that introduce the concept can help the learner obtain a general understanding of what this particular unit is going to be covering or an overview of the concept. Introduction videos can help engage the learners and help them create “mental images” of what is going to be covered in the particular unit (Di Paolo et al., 2017). Think about math and abstract concepts that are taught and need to be understood; a short video introduction or a video with a relevant example could be used to prepare students for new content.

A video with audio could help explain and break down complex mathematical concepts into simple steps. One could look at the computation of fractions. A video giving information about fractions and then breaking down the steps to add, subtract, multiply, divide, or simplify fractions could be done in a model video. Khan Academy produces a lot of videos modeling mathematical concepts and step-by-step on how to do them, such as Khan Academy’s basic trigonometry video.

Think about show-and-tell videos and how they could be used in a science curriculum. Think about experiments being done in the classroom laboratory. Not all schools have laboratories with all the high tech expensive equipment needed for complex demonstrations. Video demonstrating experiments that use unavailable equipment could help learners understand the science concepts by viewing the experiment. When I was attending one of my chemistry courses at the University of North Alabama (UNA), I remember my chemistry professor demonstrating the reactivity of pure sodium with water. He could only use a minuscule piece of pure sodium, to demonstrate it. Why was that? Because we did not have a laboratory that was equipped to carry out that demonstration on a bigger scale. Also, we all had to crowd around a small area to be able to see it. Had it been a video demonstration, we could have watched a full scale version of the experiment during the lecture part of the course or watched it before class.

Video and audio used for explaining and informing learners go hand in hand with understanding difficult concepts and bridging understanding of content and concepts. According to Di Paolo et al. (2017), they brought to light that videos could potentially help the learner develop a deeper understanding of the concept or content being presented and taught, as well as helping to provide clarity for
those more difficult concepts. Bridging understanding could help the learner gain a better and deeper perspective or understanding of content or concepts, including historical events and eras. Let’s look at several examples.

It was previously mentioned that a teacher used a popular song that learners knew and changed the words to help the learners remember how to understand fractions. For most of us, we were not alive during the Great Depression Era and the Dust Bowl, when people were starving and struggling. They were losing their jobs, their homes, and recovery took years. However, show a movie about it, stopping during different parts of the video and discussing what the learner is seeing, and even the emotions that they experience from the video, and that concept becomes more real to them (Roblyer & Hughes, 2019). Most learners in primary and secondary education (sixth or seventh through twelfth grade in the U.S.), may not have the ability to attend a symphony playing and a choir singing Handel's Messiah. However, there could be videos from a symphony performance of Handel’s Messiah that students could watch and get a sense of the period style of music or the various instruments that are being played. Another example is one that was created and done by myself when teaching my fifth grade class about severe weather, such as tornadoes and hurricanes.

My school was in the last stages of becoming an International Baccalaureate (IB) school for elementary school. I showed video clips and short videos about hurricanes, tornadoes, those who chase those storms, and the damage that could be caused. An example is one from The Weather Channel Why Hurricane Categories Matter. Another example is NOAA’s Hurricane Hunters. It piqued the learners’ interest in the subject, and I even had some students saying that they wanted to work for the Hurricane Hunters or be tornado chasers. The video and audio helped my learners understand the concepts and content about severe weather. I then took it one step further to help build that bridge even further by having my learners create a way to help prevent damage to buildings and homes from those types of storms. The learner had to choose which type of severe weather, hurricane or tornadoes, and then create their way to help protect homes and prevent damage. Learners understood with hurricanes that massive floods are prevalent and associated with hurricanes. All my learners chose hurricanes. Once they created their inventions, with research, they
drew out their design and then presented them to the class. Some tips for teachers who create their own videos is to make sure it is of interest to their learners, the right amount of length, have good audio, and also appropriate for their Zone of Proximity Development (or what students could accomplish with just a little more guidance).

**Accommodating Learners with Auditory or Visual Deficits**

When considering the best practice of audio and videos in supporting and enhancing the learning experience of the learner, it is important to consider your learners who have auditory or visual deficits. The needs of those learners need to be considered. Going back to looking at cognitive load and using germane resources, deficits add to using more germane resources because deficits add to making it harder for the information to be processed into memory (Sweller 2005). Adding closed captioning or descriptive audio can help a learner who has auditory or visual deficits, but it can also become an extraneous load for students who are distracted by it.

**Auditory and Visual Deficits**

Auditory deficits can be those who are hard of hearing or deaf, partially deaf, or completely deaf. Many students benefit from assistive technologies such as hearing aids or cochlear implants, others may read lips or require sign language. Visual deficits can be those who are blind or have some type of vision loss. The Americans with Disabilities Act requires accommodations for learners with special needs, to include both auditory and visual deficits (Americans with Disabilities Act, 2020). When it comes to using video and audio, it is important to use features such as closed captions, transcripts, descriptive audio, and even screen reading programs. Descriptive audio is when the image, pictures, or what is being displayed on the screen is described by a narrator. Service providers that can create descriptive audio files that play along with video include accessiBe, vicaps, 3 Play Media, and Vitac.
Closed Captioning

Closed captioning is something we have that we don’t think much about these days. Closed captioning is text of a video’s audio narration that is embedded back into that video, or any visual program that requires a decoder, and a viewer can often turn the captions on or off (Yager, 2021). Closed captioning is needed by those who are deaf and hard of hearing because it allows them to be able read what is being spoken. Studies have found that those without disabilities use and also found closed captioning helpful (Ozdemir et al., 2016.; Dallas et al., 2016; Stritto & Linder, 2017; & Morris et al., 2016). While it is an assistive technology needed for those learners, it is also very beneficial for those who do not have auditory deficits, as it can benefit those who prefer reading or who are working on their English proficiency. A non-profit organization, National Captioning Institute (NCI) was founded in 1979 to help with outreach and garner support for closed caption technology. The NCI was successful in promoting legislation that ensured access for those who are hard of hearing or are deaf, would be able to have equal access to television programs (AppTek, 2019, February 25). As the years have passed and technology has evolved, closed captioning has gotten better and has become more universal. In the United States, there have been legislations that have been passed over the years addressing access of closed caption by those with disabilities, including having to be in every television that is produced and sold. In 2019 a petition was created and sent to the FCC asking that they ask for lawmakers “to address caption quality concerns” (AppTek, 2019). Closed captioning is used to help all learners be able to access videos and audio by providing a way for them to be able to read what is being said.
Using Closed Captioning in Instructional Design

Languages, font type, font sizes, and colors are important in closed captioning. In the introduction chapter of this textbook, you read about text and typology. This is important when it comes to understanding the text in closed captioning. Hustwit et al.’s (2018) *Helvetica* documentary addressed fonts and colors, especially Helvetica. In this video, it mentions how it is a very clear font, and it is typically found in a lot of United States government forms. Helvetica is a san serif typeface font and has clean lines. When it comes to fonts, Helvetica is probably the best font that can be used in closed captioning. The size of the font is also important because of easy readability. If the size is too small, learners will be distracted from the concepts and content being conveyed in the video or audio because they will have to focus more on trying to read the text on the screen. If the text is too large, then it becomes a distraction because the learner is going to be focused more on that instead of what is going on in the video. The same applies to the color of the text and the background. The standard default is typically white text on a black background. If you have a color text and background that is distracting, then it is also a distraction to the learner because it draws their eyes to the color instead of what the text is trying to say. Too small or too large text and different colors of text and background can cause an increase in extraneous cognitive load, which would reduce the available amounts of germane resources the learner has to process the information from the video and audio. Ideally, each learner should be able to customize the display of the captions to match their needs.

Closed captioning does have some drawbacks, as sometimes the words in closed captioning do not match what is being said. YouTube was notorious for this in their YouTube auto-captioning feature. Parton (2016) did a research study on this. The researcher found that previous studies supported findings that YouTube’s auto-captioning feature was packed with so many inaccuracies that the text actively distracted from the audio and video. In the study, Parton (2016) reviewed 525 YouTube videos and found words that were put in closed captioning that were not said, including swear words that were never actually said. What was said was misrepresented. For example, the phrase “3 to 5 questions” was shown as “35 questions”. The study found that grammatical, syntactical, and phrase-level errors were
overwhelming and distracted learners. YouTube auto-captioning would display the text in abbreviated form or without the correct meaning. Furthermore, Parton (2016) found that “7.7 phrases per minute were unintelligible or the altered meaning of the message meant that the essence of the message was not understandable.”

The amount and frequency of any errors in closed captioning will be distracting and hinder the communication effectiveness of instructional video. For instance, researchers have found that the audio quality, accents of speakers, and the complexity of content, all impact the accuracy of automated speech to text services (Ramlatchan, 2020). In this study, three short videos of the same content from the same speaker were recorded on a cell phone, on a USB microphone, and in an audio production studio. YouTube, Kaltura, and Zoom were used to automate the captioning of each video. Each of the service providers were remarkably similar with the cell phone recording achieving about 80% accuracy, the USB microphone and laptop recording achieving about 90%, and the audio from the professional production studio achieving nearly 95% accuracy by each service. However, even at 95% accuracy, the captions could read like bad text messaging and would not be accurate enough for a learner to rely on. While technology has, and will continue to improve, to achieve 98-99% accuracy needed by students a professional, human-based, transcriptionist service is currently needed. The distractions the learner has to face in trying to decipher content from bad captions, increases extraneous cognitive load and decreases the germane resources that would be available for the learner in processing information.

There are many different services out there that can provide closed captioning for teacher created videos. Some other automated applications and services include Adobe Illustrator (AI), Adobe Premiere Pro, 3 Play Media, Cisco Webex, and Amazon Web Services, and professional services include Rev.com, AI-media.tv, Vitac, and Verbit amongst others. However, while these transcription services are critical for our learners, the costs are also a critical element. Whichever program or professional service you choose, you must always go back and watch it, with closed captioning on, to make sure that the captioning matches what is being said.
Conclusion

As instructional message designers using best practices for audio and video, two theories that need to be at the forefront of their minds are cognitive load theory and multimedia learning theory. These two theories go hand and hand. As instructional message designers, you need to try to reduce the extraneous cognitive load in message design. Designers also need to manage the intrinsic cognitive loads of learners in order to maximize the amount of germane resources that the learner can access to help with processing information. Multimedia learning theory needs to be considered by instructional message designers because it looks at cognitive processing of information in relation to auditory and visual presentations of information and how the learner processes that information.

Audio and video should enhance the learning process and learning experience of the learner and not drive it. Audio for instructional messages can be informal podcasts, formal speeches, or musical pieces or backgrounds. Videos can vary from “how-to’s,” virtual field trips, or even exploration of particular topics. Audio and video can not only help the learner with learning the concepts, content, or skills, but also help bridge understanding and process difficult concepts. Research supports short video and audio clips and if longer video and audio need to be used, then make sure to segment them, or at least allow learners to control the playback. During segmenting, you break down the video or audio and add pauses. During those pauses you can add a question or activity that could help the learner with processing information. Audio and video should be used to introduce concepts and units, support the learning curriculum, explain and break down more complex concepts, and build deeper understanding of concepts and content.

Instructional message designers also need to be made aware of and address our learners who have auditory and visual deficits when designing instructional messaging. Some learners may be hard of hearing or deaf while others may have difficulty seeing or are blind. Accommodations need to be made for these types of learners, as it is required by the law, and is part of effective and inclusive instructional message design. One of the best ways to do this is to use closed captioning and audio descriptions. Closed captioning can be found on
most television and in online video technology, and there are a variety of service providers who can take video or audio and create captions, transcripts, or audio descriptions.

Closed captioning is done by using some type of decoder and the viewer can switch captions on or off. Instructional message designers need to keep in mind font, font size, font color, and background. It seems like the typical standard is a sans serif font, with a size of 14, with a black background and text in white. The closed captioning needs to not be too much of a distraction to the viewer so that it does not increase extraneous cognitive load. YouTube’s auto-captioning feature, and other automated captioning tools, should be used with extreme caution and with the understanding that auto-caption results can vary. YouTube auto-captioning has issues with not matching what is being said and at the right time. It can also have difficulty with grammar, syntax, usage, and meaning of the words being used, as well as, abbreviating words being said. Those errors cause major distractions for the learner and increase their extraneous cognitive load because the learner is having to focus on making sense of what they are reading and could miss the point. However, there are now more options than ever before to effectively integrate audio and video into our classrooms to engage our learners.
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Chapter 4: Cultural Sensitivity, Inclusion, and Social Presence in Instructional Message Design

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Citation:


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Key Points:

● Social presence and cultural context are both critical elements of instructional message design.

● Scholars in Diversity, Equity, and Inclusion (DEI) recognize the importance of thoughtfully and intentionally integrating the tenets of DEIA+BA into message design.

● Diversity, Equity, Inclusion, Accessibility, Belonging and Accountability (DEIA+BA) can provide an effective lens to plan for cultural sensitivity.

● Future research should investigate the impact of culturally sensitive and inclusive language, iconography and images on social presence, audience satisfaction, and achievement outcomes.

Abstract

It is critical for Instructional Designers (IDs) and Human Performance Technologists (HPTs) to consider the backgrounds of the learner to help them plan, develop, and design relevant and appropriate content for the audience of focus. The interests, assets, and needs of the learner must be researched and studied so the designer is able to fully
know, empathize, understand, and design. Applying an audience centric approach equips designers to design culturally inclusive and sensitive instructional messages, as well as content that aligns with, are responsive to, and are respectful of diverse groups. In this way, IDs and HPTs can be able to craft culturally sensitive and inclusive learning materials. This message design objective integrates diverse artifacts that cultivate ‘Safe and Brave Spaces’, enhances the overall social presence of the learning environment, results in motivated and engaged learners, and increases learner achievement and performance outcomes.

Introduction

It is true that message design is all around us (Ramlatchan, 2023), it is ubiquitous, most obvious in marketing and design and the everyday experiences we encounter. Daily we are exposed to logos, jingles, and other images that attempt to communicate a response to a perceived need or problem. These messages are “dressed” (Hustwit et al., 2018) or should be in a way that accomplishes the goal of getting the audience to relate or connect in a visceral way. It is the hook that grabs us so that the information, knowledge, and solution transfer can occur.

As we move into the post-pandemic reality, the world continues to become a more globalized community. Now more than ever, there is a push to recruit more people of color to pursue university, health, and education disciplines with specific interest on science, technology, engineering, art, and math (STEAM) disciplines and career paths, (Status and Trends in the Education of Racial and Ethnic Minorities - Indicator 24, Enrollment). It is critical for IDs and HPTs to fully know and understand their audience as the return on investment includes strengthening social and emotional competencies, leadership and critical thinking, synergistic and creative teams, and even better health outcomes for workers (The Benefits of Socioeconomically and Racially Integrated Schools and Classrooms (tcf.org); Salehi et al., 2021). The benefit of culturally competent and sensitive designers ensures that culturally inclusive and sensitive instructional messages are designed in a way that aligns, supports, and is responsive to the needs and strengths of a diverse cohort of learners.
Beyond PowerPoint slides and Canva presentations, artifacts include instructional message design (IMD) tools such as the media, technology, or other vehicles used to deliver instructional messages (Ramlatchan, 2023). To be sure, these artifacts are generally not more important than the instructional design message, they serve as props in the instructional design creative moment. Artifacts can engage or repel, draw in, or distract from the overall intent of the message and the subsequent satisfaction of the learner, user, and their achievement level (Aragon, 2003).

IMD focuses on the tools and technologies that are used to communicate and purposefully convey information and transfer knowledge (Ramlatchan, 2023). For IMD to be effective, it is not enough to be aware of the effective and efficient use of these tools and how and when to use them. The savvy designer must apply cultural sensitivity and adeptness to their design process. Today more than ever, our messages must be packaged in a manner that reaches, appeals to, and communicates with the goal to engage and invite our intended audience to lean in and participate in the learning experience. This connection is intended to appeal to our individual social contexts, including at least 4 of our 5 senses of sight, touch, smell, and sound. In this way, IMD is intended to evoke a response from the learner so that they can affect a change in our thinking and behavior, to understand a concept more clearly, buy a product, assemble your kiddo’s new bike, or persuade them to shop at a particular store.

Not only do the artifacts matter but the climate in which these artifacts are used in support of the instructional design matter. One aspect that supports this climate is Social Presence (SP), one of the three presences of the Community of Inquiry (COI) model. SP contributes to fostering a sense of community among learners and is believed to be essential in supporting their learning experiences (Phirangee & Malec, 2017), and contributes to the social climate of the learner space (Short et al., 1996). Further SP is also resident within the medium itself and can impact the way the learner or user interacts (Gunawardena, 1995). That is, the educational materials, equipment and multimedia add life which contributes to the comfort level of the learner, how they feel, interact, and perform (Hustwit et al., 2018). If artifacts are the props, SP serves as a supporting actor of the production. While there are numerous presences beyond the three that traditionally make up the COI, SP figures prominently. There is
relevance for SP to be considered in message design, particularly if the ultimate strategy is focused on making connections with the learner and increasing their learning outcomes.

Before we proceed, it is vital that we clarify the use of a key term that will be used throughout this chapter. Borrowing a descriptive phrase from Dr. John Baaki, Graduate Program Director at Old Dominion University’s Department of Instructional Design and Technology, who states, “when we use the terms learner or user, we distance and objectify those whom we are designing for and exclude the human performance improvement aspects of our discipline.”

When we apply the term “audience of focus” (Baaki, 2023), we are designing and creating for people, therefore our efforts should humanize instructional design given that our work is people-centric.

This audience of focus is very often diverse but may not always feel included as part of the learning community. To ensure the content engages the audience of focus, values their lived experience, and promotes learning, requires us to design through a transformative Justice, Equity, Diversity, Inclusion, Belonging, Accessibility, and Accountability lens. When applying this cultural lens, we ensure that the content of our instructional message is appropriate, relevant, responsive, empathetic, and respectful of the audience of focus and the learning, organizational, and corporate environment. This understanding extends to our use of language, images, colors, graphics, and the multimedia we integrate into our design. All of these design elements matter in creating and maximizing the learning experience for the intended audience of focus (McAnany, 2009).

For this chapter, the proposed approach applies a Diversity, Equity, Inclusion, Belonging, Accessibility and Accountability lens to: 1) understanding culture in the context of IMD, 2) conducting culturally inclusive and sensitive audience analysis, 3) integrating a Social Presence framework that supports the Community of Inquiry model, and 4) incorporating culturally inclusive and relevant strategies to support Instructional Message Design.
The Context of Culture in Instructional Message Design

The tenets of culture include the practices, philosophies, beliefs, rituals, traditions, values, language, food, icons, emblems, patterns, and perceptions expressed by individuals, groups, societies, institutions, organizations, and communities. Culture is multi-layered, evolving, internal, and external to each individual and society, existing in space, time, place, and objects (Gay, 2018; Ladsen-Billings, 2017; McAnany 2009).

For instructional design technologists a critical requirement of 21st Century designers is the need to design within and for culturally diverse audiences with the understanding that culture is a part of learning and knowledge, and that knowledge and learning inform and impact culture (McAnany, 2009; Sakurai, 2002; Sieffert, 2006).

Not only must designers design with attention to culture but Sieffert (2006) concurs with McAnany (2009) who states that designers must know their learners in a deeper manner, in a way that reveals their particularities. Sieffert adds that designers must also know themselves as well as the learner. Having greater self awareness as a designer will help to expose your own biases, preconceived notions, and perceptions. Culture does not exist in a vacuum, it is affected and influenced, and it affects and influences. As such, IDs are affected by culture in the same way that their contexts affect culture and their cultural contexts influence the instructional designs they craft (Gay, 2018; Sakurai, 2002; Sieffert, 2006).

Social Constructivist Learning Theory

There are many theories of learning that apply an integrated approach to understanding how we learn, including heutagogy and connectivism. Heutagogy is a more recent adult learning strategy that gives the learner choice and autonomy to broker their learning plan. It focuses on self-determined, negotiated learning (Hase & Kenyon, 2001) while connectivism emphasizes learning as a network or a collective that brings together people to share ideas, facts, and communities (Siemens, 2005). These learner-centric approaches are situated on the belief that adult learners are agentic, self-directed, self-determined, and self-motivated by their internal drive and desire.
to perform and be acknowledged for their accomplishments (Hase & Kenyon, 2013).

While these learning theories have overlapping elements, the major thrust of this chapter is centered on social constructivist theory, which is foundational since it pertains to how learners construct meaning based on their experiences, lived experiences, and social and cultural contexts.

Constructivist theory is a social learning philosophy founded by Russian psychologist Lev Vygotsky, who asserts the belief that learners are actively engaged as participants in their own learning. This learning takes place in social and cultural spaces that rely on the interpersonal savvy of the teacher as facilitator and the intended audience of focus (our learners) (Schreber & Valle, 2013). What’s more, Vygotsky believed that instructors should come to the learning space considering what the learners already know so that they can build upon and apply it (Amineh & Asl, 2015). Taken together, it is valuable to consider that these theories are in support of inviting learners to ground their understanding in what they know and to expand upon new knowledge.

Since language and communication are tools used to bring about collaboration and shared vision, it naturally follows that the language and/or communication used in instructional message design plays a fundamental role in forming a person’s self-concept and their social category, such as whether they are members of an in-group, out-group, or audience of focus (Giles & Johnson, 1987; Kulkami & Sommer, 2015). How we communicate our messages can include or exclude people from participating. To do this message design requires thoughtful and intentional analysis of the audience of focus for which our messages are designed. It is this theme that we investigate next.

User-Centered Design Framework

The User-Centered Design framework (audience centered) is a multidisciplinary approach whose aim is to develop and design solutions, based on user analysis, which solve user problems (Garreta-Domingo et al., 2018; Silva & Teixeira 2019). An iterative process, User-Centered Design (UCD) keeps the user, learner, or audience of focus at the center of the design; they are the focus within
each step of the process, with their needs embedded throughout the design and development lifecycle. To be sure, crafting the goals and objectives are important but UCD transcends the utility and ease of use of training materials, performance support interventions and product or service development and extends itself into crevices of knowing the users/learner’s characteristics, competencies, needs, and habits.

To do this, audiences of focus are invited to participate in the design process or queried about the design process to assist in defining requirements, clarifying expectations, learning needs, and to refine the product or service itself.

The key to this framework are six elements that should be included within the process including: 1) initiate by defining the interaction, 2) investigate, 3) ideate by understanding users and prototype development, 4) adaptation, 5) reflection, and 6) evaluation (Garreta-Domingo et al., 2018).
Figure 1
Six-Elements of User-Centered Design Framework

Note. Adapted from HANDSON MOOC (Domingo et al., 2018; Turner & Turner, 2010)
As illustrated in Figure 1, the user or learner remains a central focus of the design and development process. Within this dynamic process, clarity of the interaction through initiation, investigation, and ideation refers to understanding the goal, intentions, and broad outcome of the product or service being developed. This phase of the process allows for intentional problem conception.

Gaining an understanding of the audience of focus through user analysis techniques assists designers as they relate and make connections to the user and visualize the user/learner’s needs, interests, and challenges. Table 1 presents examples of the different types of user/learner analytics tools and the key information or design stages they support (Kuniaysky (2023). The Research Basics tool was adapted from Mike Kuniaysky’s suggestion that conducting user research or audience analysis is a process that enables the design team to understand the impact of their design on the audience as well as understand the characteristics of the audience, their needs, interests, and associated gaps (Garreta-Domingo et al., 2018).
### Table 1
*Types of Audience/User/Learner Analysis-Research Basics*

<table>
<thead>
<tr>
<th>Methods</th>
<th>Know Audience</th>
<th>Content</th>
<th>Design</th>
<th>Test &amp; Refine</th>
</tr>
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<tbody>
<tr>
<td><strong>Cultural Analytics</strong>-Design team gathers information from various methods listed below including Big Data mining, participant, demographic, learner background/bio, language, customs and culture including learning style, assistive tech needs, accessibility and accommodation support</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td><strong>Contextual Interviews</strong> - Enable you to observe users/learners in their natural environment, giving</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
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you a better understanding into how they work and learn.

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<th>Method</th>
<th>YES</th>
<th>YES</th>
<th>YES</th>
<th>NO</th>
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<td><strong>Focus Groups</strong> -</td>
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<td>Moderated discussion with the</td>
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<td>audience of focus,</td>
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<td>allow you to learn</td>
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<td>about user attitudes,</td>
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<td>ideas, and desires.</td>
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<th>Method</th>
<th>YES</th>
<th>NO</th>
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<td><strong>Heuristic Evaluation/Expert</strong></td>
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<td><strong>Review</strong> -</td>
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<td>A group of usability experts</td>
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<td>evaluating your website</td>
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<td>against a list of established</td>
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<td>guidelines.</td>
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<td><strong>Individual Interviews</strong></td>
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<td>- One-on-one discussions</td>
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<td>with the audience of focus</td>
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<td>show you how a particular</td>
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<td>user works. They enable</td>
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<td>you to get detailed</td>
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<td>information about a user's</td>
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<td>attitudes,</td>
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desires, and experiences.

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<th>Personas</th>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>The creation of a representative user based on available data and audience of focus interviews. Though the personal details of the persona may be fiction, the information used to create the user type is not.</td>
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<th>Prototyping</th>
<th>NO</th>
<th>NO</th>
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<tr>
<td>Allows the design team to explore ideas before implementing them by creating a mock-up of the site. A prototype can range from a paper mock-up to interactive html pages.</td>
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**Surveys** - A series of questions asked to the audience of focus to help you learn about the people who visit your site.

| YES | YES | YES | YES |

**System Usability Scale (SUS)** - SUS is a technology independent ten item scale for subjective evaluation of the usability.

| NO | NO | NO | YES |

**Task Analysis** - Involves learning about user/learner/audience of focus goals, including what they want from the lesson, training, intervention or website.

| YES | NO | NO | NO |
### Usability Testing
Identifies user/learner frustrations and problems with your lessons, performance supports and website through one-on-one sessions where with the audience of focus performs tasks with website, product or training.

| Yes | Yes | Yes | Yes |

### Use Cases
Provide a description of how users/learners use a particular feature of your website or interact with a lesson.

| No | Yes | Yes | No |

Note: Adapted From *Observing the User Experience: A Practitioner's Guide for User Research* by Mike Kuniavsky

Prototyping refers to the actual construction of a frame of the model or paradigm that will be piloted by users. During the adaptation, reflection, and evaluation stages, continuous readjustments are made to the design activity to include assessment and reassessment of the actual product, service, or application (Garreta-Domingo et al., 2018).

To strengthen user, learner or audience analysis, I suggest including culture as a vital part of the investigatory stage of the
analysis process. This allows the facilitator or instructional designer to gain insight into the cultural nuances and particularities of their audience and develop appropriate, responsive, and respectful content. Consider the following case.

This case study resembles what some IDT and HPT professionals encounter as they attempt to deliver quality training. How would you plan and prepare for this type of diverse audience?

**CASE STUDY**

Juanita has been tasked with delivering a leadership training to product managers in China. She has been traveling across the United States for the last 2 months conducting this training to other product managers, but this is the first time she has delivered it outside the US. She decides to save time and just have the module translated to Mandarin. When she begins the training, she notices the audience consists of males only and throughout the training they seem to be disinterested in the audio content with lots of side talk. She asks the interpreter who is supporting her for insight. She is told that the men are not used to women, or African American women trainers. They are offended because the audio translation is in Standard Chinese [Mandarin] and they all speak and prefer English. Further, the background of her Canvas presentation was in red which is a symbol of bad luck (McAnany, 2009).
When working in the non-profit sector with communities, I encourage the message design team to do a culturally sensitive learner analysis. For instance, during the investigation phase for a particular videotaped training program, we asked the client about the attendees, their roles, challenges and needs. We learned that there would be deaf learners attending the 3-day training. This was invaluable information to learn and the team was able to adjust by making available closed captioning, screen reading technology, and an ASL (American Sign Language) consultant during the training to accommodate the needs and provide the learner with choice. The solutions were integrated in a manner that was not a distraction to the other participants and did not add extraneous cognitive load for any of the learners. Following the training, the client and learners were most appreciative that we made the necessary accommodations and several of the learners stated that they felt a greater sense of community and group cohesion because no one was left out.

Sieffert (2006) contends that because culturally diverse learners are increasing at a rapid pace, instructional designers must prepare and plan accordingly for these emerging audiences with careful consideration of backgrounds and culture. From an IMD viewpoint, doing so allows the designer to consider or reconsider their format and artifacts, including illustrations, colors, text, and icons, to assess and ensure cultural sensitivity for the audience.

In this case study, we see the importance of culture informed user/learner analysis even when using modules that have been delivered before. While the content of the training may be spectacular, knowing your learning and the cultural context in which the training is to be delivered is crucial. It is not enough to make assumptions about your audience of focus. In-depth research is required to ascertain the appropriateness of your presentation, including color, art, illustration use, and address issues of accessibility.

Community of Inquiry

The Community of Inquiry is a collaborative-constructivist framework and is defined as a theoretical approach where a collective group of people are engaged in intentional reflective examination, investigation, interrogation, and discourse intended to construct
meaning and understanding (Garrison et al., 1999). The way we learn has changed and there are growing online, virtual, and distance learning options as compared with traditional face-to-face activities. According to Krysti Phirangee and Alesia Malec (2017), this physical separation in online learning environments can cause “feelings of isolation and disconnection” which may contribute to students and learners dropping or opting out of a course (p.160).

To foster a community experience for the learner who attends a university, or the professional engaged in development training and continuous improvement initiatives, has led many educators and facilitators to adopt the Community of Inquiry framework. The Community of Inquiry framework is a collaborative-constructivist approach that “creates communities of learners who are actively engaged in exploring, creating meaning, and confirming understanding: (Garrison, 2009, p. 35).

Thinking about drawing in the learner or audience of focus is not restricted to the classroom, it has broad application and relates to the production floor and the boardroom, and non-traditional spaces where the people are involved in addressing ‘wicked’ social problems, community building, and civic engagement initiatives.

To create this collaborative learning environment, I propose cultivating a Community of Inquiry which consists of three overlapping presences-social, cognitive, and teacher. Herein lies its power to promote meaningful and inclusive learning collective (see Figure 2).
Figure 2
*The Community of Inquiry*

Garrison (2009) notes that the convergence of these three presences is crucial for a successful educational experience. Cognitive presence is the extent to which the participants can construct meaning through critically sustained communication. Teacher presence is defined as the direct or indirect role and influence of instructors in the design, facilitation, and direction for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes (1999). The third is social presence, which for Garrison et al. is the presence that has advanced the most since its original conception (2009). Social presence is the ability of participants to identify with the community, to purposefully communicate in a trusting space, and cultivate interpersonal relationships by sharing their authentic selves through a communication medium (Arbaugh et al., 2008; Garrison et al. 1999).

According to Rogers and Lea, group cohesion and richer discourse occurs when participants socially identify with a group, demonstrate satisfaction, perceived learning, and possess a sense of community (Rogers & Lea, 2005; Garrison & Arbaugh, 2007, p. 163). In fact, when group members are more focused on and are more attuned to the shared goals of the group in the absence of traditional cues, increased group identity is fostered.

This group identity lends itself to increased learner interactions, satisfaction, and improved learner experience. For example, when learners have a sense of belonging to the group and they see
themselves through the lens of the group’s identity, goals, and influence, then the group identity often supersedes the importance of their own individual identity, feelings, and sense of belonging (Rogers & Lea, p. 153, 2005). While each of the presences are critical in forming a Community of Inquiry, I submit that the human presence requires a very focused approach when integrating a more culturally inclusive and culturally sensitive instructional message design solution. Social presence improves learner interactions, satisfaction, and learner experience.

During a community convening focused on public safety, I include translators who provide support for non-English speaking community members. Providing this type of language support ensures an equitable, inclusive space where everyone comes together to share their lived experiences. There is a cadence to real time translations, one that requires the sender to speak so that their message can be translated and the receiver (translator) can translate it to the primary receiver and then communicate their response. However, this slowed pacing within the communication loop is important and positively impacts community organizing and increases diverse civic engagement.

**Social Presence**

Garrison, Anderson, and Archer (1999) incorporated social presence into their conceptual framework, Community of Inquiry, (COI) to assess and improve on the education learning experience and highlight the interconnectedness between creating communities of learners. These audiences of focus are engaged in creating, exploring, and confirming a shared understanding, are critically reflecting, and constructing knowledge (Garrison, 2009).

Online social presence is a significant factor that contributes to improving learner interactions, perceived learner outcomes, learner retention, and learner satisfaction in online learning environments (Ramlatchan & Whitehurst, 2016, p. 221; Sung & Mayer, 2012; Wei et al., 2012). Social presence was introduced by Short, Williams, and Christie (1976) who contend that within social presence, intimacy, and immediacy, exercised through verbal and non-verbal cues, are the two core components that are closely related and complementary of the
other. In this case, intimacy refers to the connectedness a participant feels to another, and immediacy is the psychological distance that occurs during the interaction.

Throughout the years, scholars have worked to change perceptions towards social presence (specifically intimacy and immediacy). Researchers have explored applying more of a social-collaborative-constructivist lens to address how social presence can be cultivated and developed to support learner engagement, interactions, and their ability to project their authentic personalities through the computer mediated communications (CMC). However, alternative positions have been advanced by Rogers and Lea (2005) who suggest technologies that emulate face-to-face encounters do not necessarily support or promote increased social presence.

They provide evidence that shared identity with the group and not personal identity is the crucial connector for group cohesiveness. Moreover, their research is suggestive that anonymity in online learning environments has the ability to strengthen performing groups because individual identities become secondary to group identity.
In contrast, Rice (1993) asserts that social presence is the degree of awareness of another person in an interaction and subsequent appreciation of their individuality and the interpersonal encounter that for Chun-Wang Wei, et al., promotes an emotional sense of belonging (2012). Correspondingly, Sung and Mayer (2012) theorize that course design strategies and instructors can also contribute to this sense of belonging and cohesiveness through the selection of culturally appropriate artifacts. However, Sieffert cautions that including cultural content and materials in a perfunctory way should be avoided as the artifact or cultural content will be seen by the learners as superficial and hollow (Sieffert, 2009).

According to Arbaugh et al. (2008), there are three categories that operationalize social presence: open communication, group cohesion, and personal/affective projection. These modes help us to dive deeper into our understanding of the internal and external dynamics of inclusive and collaborative learning experiences (Arbaugh et al., 2008). Instructors can positively create inclusive and safe learning spaces by integrating course design strategies that include welcome messages, profiles, incorporation of collaborative learning activities, and limiting class size.

According to Charlotte Gunawardena, social presence, intimacy, and immediacy can be communicated through the affordances and capabilities of the technical medium that is used. That is, the quality of the medium and the artifacts (pictures, stories, multimedia, and language) used to convey the message can cultivate intimacy and immediacy (Argyle & Dean, 1965; Short et al., 1976; Wiener and Mehrabian 1968). The instructor can complement course design strategies by sharing personal stories, providing prompt and frequent feedback and response, participating in discussion and reflection boards, and using humor, emoticons and emojis (Wei et al., 2012).
CASE STUDY

Duc, 18 is away from home for first time, the first in his family to go to college. It is refreshing to finally be in an actual classroom since the COVID-19 Pandemic caused all his classes to be virtual. He is excited about starting his first year at university and is eager to meet new people and be exposed to new concepts. He is surprised that several of the articles and books on the reading list don’t include people from diverse backgrounds, let alone anyone who looks like him. The only reference to Vietnam and his heritage was negative and highlighted war and poverty along with the historic Pulitzer Prize winning photo “Napalm Girl.” Sadly, there was no mention that a Vietnamese photojournalist with the Associated Press, Nick Út actual took the photo in 1972. Duc, wonders if he should drop the course and go back home, he is an outsider.

We see manifested in the case study above how intimacy and immediacy, shared group identity, and group cohesion are impacted by the learning artifacts. In this case, the textbook did not include diverse representations of people or only featured them in less than favorable ways. Instructional Message Designers and Human Performance Technologists who are aware of these factors are better positioned to create enhanced collaborative and safe learning spaces where everyone can engage.

The importance of positive representation is evident during a recent training that I conducted for Foster Care and Adoption parents. One of the comments from the evaluation related to the use of pictures that included mixed race families. The participant shared that this helped them to digest the materials because they saw a positive representation of a family that resembled their own. The picture supported and complimented the content in a manner that helped them to be more fully engaged in the workshop and with the other learners.
In the next section, we will examine instructional message design through a Diversity, Equity, Inclusion, Accessibility, Belonging and Accountability (DEIA+BA) lens and look at lessons learned along with some best practices.

**Message Packaging Matters: Language, Icons, Symbols, Graphics, Colors, Multimedia and Access**

Culturally inclusive and sensitive instructional message design: Applying a Diversity, Equity, Inclusion, Accessibility, Belonging and Accountability (DEIA+BA) lens is not a trend, though many have asserted as much. Most recently, practitioners and scholars in the Diversity, Equity, and Inclusion (DEI) field recognize the importance of thoughtfully and intentionally integrating the tenets of DEIA+BA into our policies, practices, institutions and organizations.

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**CENTERING DEIA+BA IN IMD**

Centers justice, equity, diversity, inclusion, belonging, access and accountability within learning theories and design approaches to effectively communicate information using technology in culturally appropriate, accessible, and relevant manner.

Those of us committed to this movement contend that DEIA+BA cannot merely be a fad or a statement on our website. If we are to bring about systemic change in how we work and engage with others as we work, no matter the discipline, then DEIA+BA must be inculcated and woven throughout everything we do and evident in who we are.

Following this reasoning and applying it to IMD, an Instructional Designer and Human Performance Technologist committed to their craft can see the value in practicing and promoting inclusive, culturally responsive IMD that is reflective, respectful and
responsive to all people allowing them to feel included, heard, seen, and valued. The matrix below serves as a cultural sensitivity rubric and suggests how IDT designers can assess their design messages to center DEIA+BA (see Table 2). Accountability ensures that we do it. As Peter Drucker says, “What gets done gets measured” and establishing metrics to track and assess culturally sensitive and inclusive IMD is a critical component to include.

Table 2.

*Diversity, Equity, Inclusion, Accessibility, Belonging and Accountability: DEIA+BA terms, definitions, and examples*

<table>
<thead>
<tr>
<th>DEIA+BA TERM</th>
<th>DEFINITION</th>
<th>EXAMPLE</th>
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<tbody>
<tr>
<td>Diversity</td>
<td>Composed of different elements or that which contains variety</td>
<td>Multimedia and other source material that represents all people; gender/gender identity, race, nationality, age, religions, neurodiverse and those disabled</td>
</tr>
<tr>
<td>Equity</td>
<td>Justice and rightness</td>
<td>Bicycles that allow amputees to pedal with other limbs</td>
</tr>
<tr>
<td>Inclusion</td>
<td>Providing equal access; to engage and include part of a whole</td>
<td>Linguistic justice/language and translation support services that invite non-English speakers to participate in a dialogue</td>
</tr>
<tr>
<td>Access</td>
<td>Freedom to and the act, right, or ability to use, enter, or go or come into a space or place</td>
<td>U.S. Department of Labor's Section 503 compliant presentation materials for individuals with</td>
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To do this, there must be an understanding of the terms that confront us and require us to use them to integrate the work we do. In the context of IMD, we apply this lens from the beginning to the end of the design process.

Good design is informed by a robust audience/learner analysis informed by culture. As stated earlier, applying cultural analytics informs the designer about user/learner characteristics, needs, accessibility/accommodation issues and context. We design and produce good designs based on the more we know about the learner. That said, Debbie McAnany suggests overall, as designers, we should embrace a “do no harm” approach when creating instructional messages and avoiding using “phrases or images that may evoke an unwanted emotional response in people from different cultures” which may diminish and distract from their learning experience (McAnany, 2009, p. 2). Chapter 8 in this volume offers a good example of what happens when designers are not cognizant of these DEIA+BA principles (Smith-Downing, 2023). Examples of strategies include refraining from using images of drugs and alcohol, personification of animals, or video, multimedia, or gamification strategies of war all of which may be triggering to those in recovery, people of the Muslim faith, or those who live or have lived through war or experienced violence (Dyjur, 2004; Murrell, 1998).
Through Diversity, Equity, Inclusion, Access, Belonging and Accountability designers can cultivate social presence which promotes a learner's sense of belonging. When a person perceives that they are a part of the setting, that is when they feel part of the ingroup, they are seen and they interact, engage, and participate in discourse as part of the community of inquiry. Belonging is key to IMD as the ID tools that are used can help to foster and sustain a positive learning climate.

**Language, Icons, Symbols, Video, Access, and Place**

Presenting information in an inclusive format draws the audience in. Using language, icons, images, symbols, video, and considering accessibility and place speaks positively about the institution, organization, or company as well as their services, products, cultural philosophy, and people.

What follows is a discussion on some historical missteps and examples of messaging done well in various industries.
Language

Word choice matters. For example, when using certain images, icons, colors, language, photos, and even art, one must recognize how cultural sensitivity to the audience of focus’ cultural context can impact self-perception and their sense of belonging and inclusion. That is, when writing about groups of people it is important to use the appropriate language to describe them, such as when talking about adult females, it is more appropriate to refer to them as women not girls. In this way the designer is cultivating learning and a culture of engagement that calls the audience into the learning environment rather than pushing them to the margins. Instructional designers are not just designing for classrooms and the organization, they also assist with the design for messages that market products and services to the public.
CASE STUDY

José and Marisol are newlyweds. Six months in they are settling in to married life in their small town in Barcelona, Spain. José’s father has helped them with the down payment for their home, which is perfect timing because they just found out they are pregnant, and Marisol is busily preparing for the baby. Her Tía María was kind enough to purchase the baby a crib and it has just arrived. Though neither are handy, José is a doctor and Marisol is a nurse, the plan is for José and Marisol to go home and put the crib together. When they arrive home, they see the box for the crib has been delivered. Eagerly, they tear into the box and begin to look at the instructions just to learn they are in Mandarin and there are no pictures or YouTube video to support the assembly. José believes he can figure it out, but Marisol knows this is not her hubby’s superpower. Overwhelmed and deflated, they both collapse on the floor in frustration.

The above case is an example where language, not simply the words that are selected but the actual translation used can often influence an audience's ability to interpret meaning. In this instance the instructions were only available in Mandarin with no pictures or associated YouTube video or job aid to assist José and Marisol assemble the crib. What could the manufacturer have done to prevent this breakdown in communication?

A vintage example can be found in a marketing campaign from the late 1970s and early 1980s when Hamburger Helper included the jingle “Hamburger Helper Helped Her Hamburger Help Her Make a Great Meal.” (https://youtu.be/Hsx-ftPkAz8). This advertisement serves as an example of how a prominent company, General Mills’ Betty Crocker brand now owned by Eagle Brand Foods incorporated a sexist jingle into their marketing strategy to reach stay at home moms. The jingle has since been changed to “…help you make a great meal.”
However, the image perpetuates a heteronormative, gender stereotypical image of women in the kitchen as homemakers and caretakers of the children and husband to the exclusion of other groups.

Icons, Images, and Photographs

While overt stereotypical language like the one referenced above is on the decline, we continue to see genderism, sexism, and exploitation in images and photographs through the objectification of women as sexual objects. Consider this 2019 advertisement, what does this image convey and how does the audience process what it is selling?

![Image of an advertisement promoting weight loss products.](image)

How designers incorporate images into their designs is critically important. Hence, the reason for doing in-depth user analysis. There are numerous examples of how companies have historically misrepresented, slandered and harmed people of color in devastating ways. The Pearl-Milling company featured the iconic image on the ready-mix pancake, syrups, and other products depicting the stereotypical “mammy”, an insulting image from the Jim Crow
When Quaker Oats purchased the rights, they pledged to remove the image and in 2021 when PepsiCo acquired the company they officially removed Aunt Jemima brand name, but the tagline remains “same great taste as Aunt Jemima” on the product. However, the damage was done and many African Americans continue to overcome the effects of this demeaning representation and the negative message it conveyed and image it portrayed.

Today, when using representations of people, it is critical to choose the right images. To do this the Instructional Design team must consider the type of images in relation to the audience and to do so in a balanced manner. Mark Parsons, a graphic designer/Instructional Designer and graduate student at Old Dominion University, recommends IDT professionals should add some graphic design tools to their IDT tool box (Parsons, 2023). Some of the tools include gaining an understanding and appreciation for the use of positive and negative space. The Instructional Design Technologist and Graphic Designer are partners, both conjoined to ensure the instructional message is accurately conveyed and received to realize positive learner outcomes (Parsons, 2023). Knowing the power and message influence of positive and negative space is just one of many graphic design tips and tools presented in Chapter 7 of this text.
Instructional designers must be aware to balance the use of images, specifically be alert that the images used are not biased towards one group or gender identity. Also, designers must be conscious of the manner that they portray a person, and the positive or negative message conveyed by the photo, image, or illustration as it contributes to social presence and enhanced learning experience. A final word about the accurate presentation of people in photographs concerns lighting. When presenting photos of people of color, designers should include photos that use the appropriate lighting to capture the features and essence of the person photographed. Graphic designers recommend that you ask questions to ascertain the purpose of the design and message and who the audience of focus is including their needs and expectations (Parsons, 2023). Often, Native Americans, Indigenous, African Americans, and LatinX people are photographed with poor lighting which can contribute and promote bias and stereotypical perceptions.

In 2017 a focus group was conducted as a follow-up to a study that looked at African American Social Work student's perspectives of images used on PowerPoint slides. The study presents insights into oversights on the part of professors who admitted they were unaware of how their privilege had blinded them to include images in their presentations depicting negative images that were stereotypical of African Americans, or perpetuated implicit bias (Davis & Talley, 2021). Students shared their thoughts and recommended that professors include positive images of African Americans and when discussing issues of crime, drugs or incarceration, share images that depict White people to debunk the stereotypical perceptions and confirm that White people commit crime, use drugs and are in prison. (2021). This bias should be avoided especially with the availability and accessibility of free stock photos (resources include iStock, Pixabay, Flickr, Shutterstock, and Google images) to locate diverse images.
Note. All races, ethnicities and cultures commit crimes, depictions of people as criminals or portrayals of negative images (as in this video game example) should be integrated carefully and also be diverse.

Symbols, Emblems, Logos, and Mascots

Here in Washington, DC, in the United States, nothing has drawn more controversy than the name, logo, and mascot for what is now the American football team now known as the Washington Commanders (also briefly referred to as the Washington Football Team, and were best known as the Washington Redskins). For years, many of us fought for a name change referencing the insulting and offensive way the original name depicted Native Americans and Indigenous people. Considered to be a racial slur and a pejorative term, the term Redskins was historically used as a reference to describe Native Americans.
According to Sherri Sieffert, of the College of Graduate Studies and Research Educational Communications and Technology, at the University of Saskatchewan contends even the most simplistic, innocuous symbols or gestures like a “thumbs up” sign, a child’s piggy bank, or a star could be offensive to those from Brazil, some Middle Eastern countries, or Sweden respectively (Sieffert, S., 2006, p.7). In 2022, the name of the football team was officially changed but it took over twenty years for the former owner, who said he would never change the name, to do so.

Access

When instructional designers commit to designing in a culturally sensitive and inclusive way they do so with consideration to accessibility. Accessibility increases social presence by ensuring that
the content and presentation method can be used by the audience of focus. There are numerous supports for IDT/HPT professionals to integrate into their designs. Broadly, Meaghan Mozingo of Old Dominion University contends that Universal Design for Learning (UDL) offers the flexibility needed to adapt to learners' unique style without compromising on quality and impact (Mozingo, 2023).

*Note.* Sign language is one of many options to ensure engagement of our audiences of interest.

Culturally sensitive and inclusive user analysis can inform what our audiences need, including identifying any accommodation requests and requirements. Learners have different accessibility needs, access is not only for people who are disabled but includes people who are differently abled, neurodiverse learners, older learners, and people who speak a different language. Some assistive technologies like screen readers and tactile artifacts should be considered in the same way that the needs of distance learners who live in areas with limited access to technology and broadband are considered. Examples include audiences of interest who are economically disadvantaged, who are unable to pay for expensive textbooks and materials, and those who wear hearing aids (Cummings, 2023; Mozingo, 2023; Salehi, 2021; Taylor, 2023). Assistive technologies are critical tools to
provide equitable access to the content and materials. Shelby Taylor, graduate student at Old Dominion University offers a cautionary reminder about the use of closed captioning as it can be poorly conceive, misrepresent content, include profanity and overall undermine the instructional design message (Taylor, 2023). For a more descriptive dialogue related to learners with visual impairments (LWVI) and instructional message design reference Chapter 2 and 4.

Note. The specialized needs of our audiences of interest can also include access to technology.
Video

Instructional Design scholars contend that video can be impactful and increase social presence in online educational environments (Ramlatchan & Watsons, 2018; Ramlatchan & Whitehurst, 2019). Students in asynchronous or synchronous learning environments who can see their instructor and other students may experience an enhanced learning experience. Particularly when they are able to interact with the instructor and other students and engage in collaborative and problem-based learning activities. However, awareness of the inequities that exist across diverse communities can place limitations on technologically underserviced areas and among marginalized populations.

Place

As a professional in the non-profit arena, learning spaces include formal and informal spaces and places. Placed-based learning and placed-based education (PBE), also referred to as pedagogy of place, is rooted in community building, problem-based learning, and community education (Elfer, 2011). In the 1990s Laurie Lane Zucker of the Orion Society and John Elder of Middlebury College, Middlebury, Vermont breathed life into the act of teaching outside of more traditional learning spaces and referred to it as placed-based pedagogy. Placed-based learning is contextual and recognizes the expertise in the lived experience of the learner within their neighborhood. “Place-based pedagogies are needed so that the education of citizens might have some direct bearing on the wellbeing of the social and ecological places people actually inhabit” (Gruenewald, 2008). When embarking on a culturally sensitive and inclusive IMD, place matters and refers to location and creating space. Ideal learning spaces should offer “equitable access” where authentic, yet disparate voices, come together to share and learn without burden or barriers and create Safe and Brave Spaces for themselves (Ali, 2017, pp. 4-5). To understand the fullness of this expression, we must parse them out and return to the genesis of their formation.
Safe Space is a phrase that was drawn from the Women’s Studies and Feminism movement and relates to the case where women created environments free from physical harm, abuse, and harassment where they could speak their truth (2017). Since that time, the term was co-opted and is currently being used to describe creating any comfortable spaces that are free from personal and harmful attacks. Because the phrase’s original meaning and intent are a departure from its intended meaning, Brave Space has been added to reflect the fullness of the expression (Williams, 2022).

When Brave Spaces are created, those are environments where a person is comfortably uncomfortable without fear of being verbally attacked because of disparate opinions. This is a space where social presence is high because the audience is able to speak and share from their authentic, personal contexts, for themselves with or without emotion. They are freely able to speak truth to power and engage in collaborative learning which enhances the overall learning achievement and the learning environment.

**Future Opportunities & Conclusion**

As global citizen learners and educators, what is proposed in this chapter requires us to mentally and practically pivot as we examine and implement strategies where we can do better and be
better. The end result is that as we begin to create, craft and cultivate
design materials, content, interventions, artifacts and learning/
performance environments through a diversity, equity, inclusion,
accessibility, belonging and accountability (DEIA+BA) lens.

As a community of practice committed to engaging as a
community of inquiry (COI) we must work to maximize motivation,
learning achievement, and performance outcomes. We do this by
integrate cultural analytics into our learner/audience analysis,
adopting strategies that increase social presence and work across the
three presences (cognitive, social and teacher presence) to enhance
and promote an culturally sensitive and inclusive IMD, improve
learner experience and the learning outcomes for diverse audiences in
educational, corporate, non-profit and non-traditional learning spaces.

Where we go from here depends on all of us adding to our
instructional message design process. It is not enough to include
diverse images, closed captioning, incorporating culturally appropriate
language into our instructional design messages if they are not
responsive to the learner's strengths and needs and do not lead to
measurable learner satisfaction and higher learning achievement
outcomes. Culturally sensitive and inclusive instructional design
matters. Doing IMD with serious attention to culturally sensitive user
analysis, improved social presence and awareness of multimedia
artifacts must center DEIA+BA in the design process. This approach
to IMD is a critical component that must be prioritized when
undertaking quality and impactful IDT and HPT curriculum and
interventions.

Future research should investigate the impact of culturally
sensitive and inclusive language, iconography and images on social
presence, audience satisfaction, and achievement outcomes. In
addition, building upon this, researchers might examine the
overlapping presences of the COI frame to measure the impact on
audience satisfaction, engagement and learning outcomes and
performance. Applying a Diversity, Equity, Inclusion, Accessibility,
Belonging and Accountability lens is an emerging approach that is not
a trend but a way we should do culturally sensitive and inclusive
design and develop continuous improvement solutions. Like members
of the academy, practitioners are well positioned to do their part by
conducting audits of student and learner performance on test and
assessment instruments to ascertain which groups are
underperforming (Salehi, 2021). In so doing, this may reveal teaching, learning performance gaps, highlight ineffective teaching artifacts and curriculum that may privilege or disadvantage certain groups over others.

With the rise of globalization and move toward cultivating global citizens, scholars and practitioners would be wise to begin to assess evidence-based, culturally sensitive and inclusive methods to address and affect results based change in IMD and those artifacts that help to convey our instructional messages.
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Chapter 5: Message Design: How to Communicate Visual Information to Learners Who are Visually Impaired

Meaghan McLeod
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Citation:
5. Message Design: How to Communicate Visual Information to Learners Who are Visually Impaired

Meaghan McLeod

Key Points:

● Inclusive education is a critical aspect of instructional message design.

● This chapter presents common accommodations and Assistive Technology commonly used by learners with visual impairments.

● This chapter also provides practical strategies to implement educational message design for learners with visual impairments.

Abstract

Message design consists of signs and symbols that play a crucial role in guiding our daily lives. Text, images, videos, graphics, and diagrams are essential tools for communication and education. However, individuals with visual impairments are not able to fully access this visual content that plays such a critical part of our daily lives. Therefore, there is a need to create educational material that can be accessed by all learners including those with visual impairments. This chapter explores practical strategies that instructional designers, teachers, professors, and instructors can use to provide an inclusive learning experience for learners with visual impairments. Including a breakdown of common tools and accommodations such as braille,
screen readers, screen magnification software, and audio description. Along with a guide for crafting accessible message designs for learners with visual impairments in various contexts, including digital and in-person content.

**Introduction**

Signs and symbols are used to communicate messages, ideas, and instructions. These visual representations take the form of graphics, text, and video (Ramlatchan, 2022), known as message design, help to guide us through our daily lives. Visuals are images, photographs, drawings, figures, concept maps, logos (to name a few) which help our brains to retain information. Words are abstract while visuals are concrete, and when used effectively, visuals can improve comprehension, retrieval, retention, and can decrease learning time (Kouyoumdjian, 2012). Furthermore, visual cues are used to identify emotions using facial expressions and body postures (Nelson & Russell, 2011). Let's face it, the modern world is ocular-centric, where sight is the primary conduit to the world (Cavallo, 2105). However, according to a 2018 National Health Interview Survey, significant vision loss has affected approximately 23 million Americans between the ages of 18 and 64 and 9.2 million 65 and older (American Foundation for the Blind, n.d.). **Total blindness** refers to complete loss of vision. **Functional blindness** pertains to the ability to perceive light but an inability to determine its shape or direction. **Low vision** refers to vision loss that hinders daily performance of tasks and cannot be corrected with glasses or contacts (Bailey & Hall, 1989). Low vision and blindness can be congenital or caused by age related conditions such as cataracts, macular degeneration, and glaucoma along with metabolic conditions such as diabetic retinopathy, trauma, and injury (Congdon, Friedman, & Lietman, 2003). **Color blindness** affects how a person distinguishes color. Common types of color blindness include red-green, blue-yellow, and complete color blindness (NIH, n.d.).

Due to the vast amount of impairments that can affect our vision, it is essential to explore how message design can be effectively presented for individuals with visual impairments (V.I.). Creating message design techniques tailored to learners with V.I. enhances the
learning experience, fosters comprehension, and strengthens informational content. Which promotes accessibility, inclusivity, and equal educational opportunities.

This chapter aims to offer guidance to instructional designers, teachers, instructors, and anyone involved in creating visual content on how to create visual content for learners with V.I. This chapter effectively covers 1. Inclusive education, 2. Assistive technologies and accommodations, 3. Strategies to develop accessible online content for learners with V.I. 4. Approaches to creating in-person educational content that is accessible for learners with V.I.

**Inclusive Education**

Inclusion is the fundamental right of every individual, regardless of age, to fully engage and contribute to all areas of life and culture, without limitations, risk of exclusion, or threat of marginalization (Braunsteiner and Mariano-Lapidus, 2014). Inclusive education means offering equal learning opportunities for all children, including those who are typically excluded due to disability or language barrier, by placing them into the same schools and classrooms as their peers (UNICEF, n.d.). Inclusion doesn’t exist without exclusion. In order to truly address inclusion, it is important to first look at who is excluded and why (Cologan, 2013; Holmes, 2018). An example of this is the Individuals with Disabilities Education Act (I.D.E.A.). The focus of the I.D.E.A. was getting the students with disabilities into general education classes but the access to the curriculum was not fully addressed (Edyburn, 2005). The students with disabilities were able to attend free public schools and be present in the classroom, but were not provided with equal learning opportunities. Universal Design for Learning (UDL) was developed as a response to improve I.D.E.A. UDL is a scientific-based framework that optimizes teaching and learning for all types of learners (CAST, 2023). Learners have individualized learning patterns and UDL supports flexibility within curriculums to provide equal access without compromising standards. UDL provides various approaches for multisensory learning (Gronneberg & Johnston, 2015). The CAST.org website provides multiple means to achieve engagement, representation, and action & expression. Figure 1 represents a succinct
overview of the guidelines. UDL provides a framework for inclusive education accommodating learners’ diverse needs and fostering flexibility in the curriculum design. Please visit CAST.org for more in depth information and details regarding the UDL guidelines.

Figure 1.
*Overview of UDL Guidelines*

<table>
<thead>
<tr>
<th>Provide Multiple Means Of:</th>
<th>Provides Options</th>
</tr>
</thead>
</table>
| **Engagement the “WHY” of learning**             | • Recruiting interest  
   • Sustaining effort and persistence  
   • Self regulation                             |
| **Representation the “WHAT” of learning**        | • Perception  
   • Language and symbols  
   • Comprehension                                |
| **Action and Expression the “HOW” of learning**  | • Physical action  
   • Expression and Communication  
   • Executive functions                         |

(CAST, 2023)

Taking a step towards inclusive education and truly incorporating those with disabilities into the classroom provides opportunities for others to become familiar with and even experience accommodations. In turn, these diverse interactions can build knowledge of disabilities and restructure the normal parameters that have been associated with education.

Around 80% of students with a disability attend general education classes. However, the problem remains that teachers are not equipped to meet the education needs of diverse students (Smith & Tyler, 2011). This burden alone should not be carried by teachers. As they say it
takes a village. In addition, this problem needs to be addressed with the policy makers, government funding, school administration, and curriculum developers. Instructional designers can contribute to the solution by thinking about a variety of learners (not just one type of learner) and how best to support the diverse learning styles and needs. Remember, Inclusion is a process (D’Alessio & Watkins, 2009) and should be viewed through the lens of exclusion. Therefore, when developing curriculum content ask yourself who can participate and who cannot? Then ask yourself why they cannot participate and this is where you begin to redevelop, alter, or add additional elements to suit the diverse needs of your learners. To assist with this process, research different disabilities and learning styles. Gain an understanding of how they impact the learning process, and what tools and techniques can be used to provide accommodations. Utilizing UDL guidelines and incorporating flexibility into the curriculum. Instructional designers are just a tiny piece of this larger puzzle. Still, there is an obligation to your learners to create impactful and equitable learning experiences. Since a substantial amount of educational content relies on visuals, it is essential to understand the types of accommodations and assistive devices used by individuals with V.I.

**Accommodations and Assistive Technology**

Accommodations involve modifications that address barriers and ensure equitable access to education. These adjustments don't alter the content, instead change how the student learns (Lee, 2023). Accommodations can be broken up into four categories:

- **Presentation:** Alterations with how the content is presented. Example: providing a digital copy of printed text so a learner with V.I. can use a screen reader.
- **Response:** Changes with how assignments are completed. Example: Allowing students with V.I. to use digital devices in the classroom to complete in class assignments.
- **Setting:** Changing the learning environment. Example: allowing a student to take a test in a separate room where there is less noise and distractions.
- **Timing and Scheduling:** Allowing extra time on a test or assignment. Please consider the extra time and effort it takes for
a student with V.I. to complete an assignment. To assist with this please ensure that all printed material and resources needed to complete the assignment are available in formats that can be used by their assistive devices. (Lee, 2023).

Without vision, learners with V.I. rely on other senses such as haptic (tactile), auditory (hearing), and olfactory (smell). The absence of visual input and social cues puts learners who are V.I. at a disadvantage. Some may struggle to comprehend color, shapes, spatial orientation, size, and dimensions (Lintangsari & Emaliana, 2020). Despite the lack of visual input, individuals who are V.I. possess cognitive abilities the same as their sighted peers (Shain & Yorek, 2009). Therefore the use of assistive technology can offer vital support for the learner who is V.I., and enables them to work at their cognitive level. Assistive Technology is a term used for systems and services that improve individuals' independence (World Health Organization, 2023).

Braille, which is a form of assistive technology, is a series of raised dots and is tactile text for individuals who are blind and those with severe vision loss. Braille is considered a code as dots form symbols within braille cells. Braille cells contain 2 vertical rows of three dots. A single cell can represent letters, numbers, punctuation, capitalization, italics, and whole words (American Foundation for the Blind, n.d.), see Figure 2. Louis Braille created the braille six-dot system in 1829. Originally a relief of normal letters were used. Louis Braille got the idea of a 6-celled system from Charles Barbier’s 12-cell night writing which was intended for communication on the battlefield (Britannica, 2023). When including braille in a curriculum, it is important to understand a few barriers. 1. Not all V.I. Learners know how to read braille. This is where the teachers would ask the learner who is V.I. what their preference is either larger print, braille, or using assistive devices. 2. Due to the 6 cell structure of braille it takes up more space on the page than printed words (Abrahamson et al., 2019). 3. It is essential to understand that Braille readers do not read dot by dot; instead they read by gliding their fingers across in a line. When braille is oversized or improperly spaced, it becomes challenging for the reader to decipher (Kleege, 2006).
Figure 2.
An example of the alphabet, numbers 1 - 9 plus 0, and the following punctuation marks, period, comma, number symbol, and space in Braille.

To produce printed documents that include Braille, a Braille printer (also known as a Braille embosser) or a Braille slate with stylus is required. The braille printer receives text from a computer and prints braille on embossed paper. Small volume printers used for personal use can cost between $1,800 - $5,000, whereas large volume printers can cost between $10,000 and $80,000 (American Foundation for the Blind, n.d.). Braille label makers are also available to create quick labels. This can be used in and around the classroom and to label 3D models. Braille slate and stylus (see Figure 3) is a great way to create braille by hand to personalize a card.
The Braille slate consists of several rows, each with 2 columns of 6 cells, evenly spaced. To create raised Braille insert cardstock or heavy paper, the backside of the paper facing up. Using the stylus to push through the backside of the paper created a raised dot on the front of the paper. To do this you must reverse the cell order. Instead of arranging the cells vertically as column one: cells 123 and column 2: cells 456, you need to reverse so now the cells in column one are 456 and the cells in column two are 123. Figure 4 shows an example of how you would create the letter B using the Slate and stylus. Bump Dots are adhesive stickers that can be used as markers to bring attention to an area.
Figure 4.
The first image depicts the Braille letter B. The gray dots represent the braille dots. The second image illustrates the placement of the Braille dots when using a slate and stylus. The Braille dots are inverted, because when using the slate and stylus, you need to push through the back of the page to create a raised dot on the front of the page.

Screen magnification software is used to magnify the screen, including text, images, icons and the mouse cursor. Furthermore, this software offers features to enhance visuals such as, sharpen edges of images and adjust color contrast and color combinations. Importantly, users can customize preference settings within the software to suit their specific needs (American Foundation for the blind, n.d.).

A Screen Reader is software that audibly reads text displayed on a computer screen. According to the American Foundation for the Blind, screen readers are equipped with artificial intelligence capabilities that help identify relevant information. Additionally, screen readers can also interpret icons and graphics. Plus, it includes mouse navigation (American Foundation for the Blind, n.d.). When creating any text document or online content it is crucial to test your documents using a screen reader software like JAWS or the text to speech feature in your word or PDF software. This step ensures that all your content is accurately identified and can be accurately read by the screen reader software. While testing this chapter, I encountered
issues with certain abbreviations. For example, “VI” was mistakenly interpreted as the number “6” and “IDEA” was interpreted as the word idea. To address this problem, I inserted periods between the letters of these abbreviations, which allowed for correct interpretation. If your table cannot be properly interpreted by the screen reader software, there are options to make the information more accessible. One option is to include a link to a document that presents the table into a more accessible format, such as a list of bullet points, organized subcategories, or a descriptive paragraph.

Audio description is a verbal description of visual content that includes objects, text, signs, artifacts. Audio description is used in museums to describe the artwork and has been used in Theatres to describe the sets, costumes, props, and actions of the characters. Audio description is also available with certain TV shows and movies. Here is an example of audio description during a clip of the animated movie The Lion King Audio Description -The Lion King Clip - You Tube. When creating descriptions it is important to reduce auditory clutter (Chen & Dote-Kwan, 2021). Being concise is key when describing images, diagrams, or graphs. For instance, if there is a decorative border around an image, it can be omitted from the description and focus on describing the content within the image itself (Braille Authority of North America & Canadian Braille Academy, 2011).

Accessibility Requirements

The World Wide Web Consortium (W3C) is an organization dedicated to promoting web accessibility through the development of international standards and support materials for the web. Within W3C is the Web Accessibility Initiative (WAI) which is a collaboration of stakeholders from disability organizations, accessibility research, government, and multiple organizations from around the world with a mission to advance web accessibility. The following are the key activities relating to web accessibility.

- Ensuring that W3C standards support accessibility
- Developing accessibility guidelines for web content and applications, browsers, and authoring tools
Developing resources to improve web accessibility evaluation processes and tools
Supporting education and outreach on web accessibility
Coordinating with research and development that may impact future accessibility of the web
Promoting harmonized international uptake of web accessibility standards

(W3C, 2023, About the Web Accessibility Initiative section). The Web Content Accessibility Guidelines (WCAG) consists of 14 guidelines and 64 checkpoints. These guidelines were developed by the Web Accessibility Initiative (WAI). The accessibility level of a website is determined by the number of checkpoints satisfied, resulting in one of three ratings: A, AA, or AAA. A is the lowest score, and AAA is the highest accessibility score (Moreno et al., 2008). Note that AAA is difficult to achieve and most legal standards accept a rating of AA, see Figure 5.

Figure 5
*The Web Content Accessibility Guidelines (WCAG) Levels*

| Level A          | ● Base level of conformance that provides the basic level of support.  
                  | ● Barriers are present and impact certain users. |
|------------------|------------------------------------------------------------|
| Level AA         | ● Most common level of conformance and is used in many regulations and legal settlements.  
                  | ● Accessible for more users than level A, including those who use assistive technology. |
| Level AAA        | ● Highest level of accessibility criteria including A and AA standards.  
                  | ● This level may not be easily achieved so many organizations choose to only use specific criteria. |

(Level Access, 2023)
Message Design for Online Material

For websites aiming to meet AA and AAA accessibility standards, one important guideline is color contrast. **Color contrast** relates to the foreground (text) and background (the color behind the text). Accessing color contrast can be done so by using an online color contrast checker. These tools utilize the 6-digit hex code, which consists of three pairs of numbers/letters. Each pair represents the various levels of red, green, blue (Code Conquest, 2023). **Color ratio** is a measurement of the contrast in brightness between two colors, specifically the foreground and background. The difference is represented as a ratio ranging from 1:1 (white text on white background) to 21:1 (black text on white background) (Web AIM, 2023). For AA compliance, the minimum contrast ratio is 4.5:1, However, when using large scale text (18 point or 14 point bold) a slightly lower ratio, 3:1, is acceptable. On the other hand, for AAA compliance, a higher contrast ratio of 7:1 is needed (W3C Web Accessibility Initiative, 2023). In Figure 5, the foreground color is coded as FFFFFF (white) while the background is coded as 050A82 (blue). When inputting the color hex code into the contrast checker, the circles at the bottom will be green if the color combination meets accessibility standards and red if it fails. This specific checker provides an option to view the color choices in greyscale (Figure 6).
Figure 5.
WCAG contrast checker, blue and white

![WCAG contrast checker, blue and white](image)

Figure 6.
WCAG contrast checker, grayscale

![WCAG contrast checker, grayscale](image)

Figure 7 represents color combinations that do not pass accessibility requirements. While Figure 8 shows the color wheel that can be used to select a new color. As you choose a new color, the contrast ratio will automatically update to reflect the new color.
Figure 7.
Colors partially compatible.

Figure 8.
Image of color wheel.
Fonts and spacing

The American Council for the Blind provides guidelines for creating large print documents, which are typically used by individuals with low vision. It is important to understand that everyone’s visual needs differ, these guidelines provide a good starting point. Digital word processor applications such as Microsoft Word or Google Docs allow users to adjust the font size of the text within the document. Additionally, computer users can enlarge or decrease on screen content using the zoom in or out functions (American Council for the Blind, 2023). Here is an overview of the guidelines for large print documents as provided by the American Council for the Blind:

- Heading: Arial font, bold, with 22pt font
- Subheadings: Arial font, bold with 20pt font
- One blank space between headings/subheadings and the paragraph
- Paragraph: Arial font, NOT bold, 18pt font
- Spacing: 1.15
- Alignment: Margins flushed left and ragged right
- 1-inch margins
- Underline any emphasized words
- Bullet points should be large, round, and black and no spacing between each line.
- Single column per page
- Notes and citations at the end of the article

For the complete list visit American Council for the Blind- Larger print guidelines Large Print Guidelines | American Council of the Blind (acb.org).

Sonification

Sonification is non-verbal audio used to relay information (Vines, et al., 2019). An example of sonification is Morse code and Geiger counters (Vines et al, 2019). Morse Code, particularly the simplified version known as International Morse Code, is a
A communication system that uses dots, dashes, and spaces to represent the alphabet, numerals, and punctuation. Electrical pulses of varied lengths transmit the code via sound. In addition, Morse Code can also convey information visually using flashing lights (Britannica, 2023). A Geiger counter detects radiation by identifying a process called ionization. Through internal sensors, the Geiger counter calculates the number of paired ions created every 60 seconds. For each pair of ions produced, the Geiger counter emits a distinctive “click” sound (United States Nuclear Regulatory Commission, 2020). In video games, sonification is used to distinguish various actions of characters (such as footsteps, jumping, or landing), interactions with objects (that are falling or being thrown), or to signify events. Furthermore, sonification can be applied to educational materials to create a more engaging experience by combining multiple sensory elements. For instance, sound can add dynamics to a static visual like representing the sound of a heart rate while at rest versus engaged in exercise. This approach not only adds dynamics but also promotes a more inclusive and engaged participation (Walker, 2019).

When incorporating sonification into videos, games, simulations, or modules, it is important to pay attention to several factors: the timing, speed, pitch, volume, and the timbre (which refers to whether the sound resembles a simple tone or a musical instrument like a violin, piano, or organ) of each sound. These elements are used to ensure users can effectively distinguish between various sounds and their associated values (Vines et al., 2019). Furthermore, offering a pre-brief explanation of each sound can be valuable in providing users with a fundamental understanding of the sounds they will encounter. When developing digital content that incorporates sonification, it would be beneficial to create a prototype and seek feedback from a diverse group of individuals who are V.I. This feedback helps to ensure that the understanding and interpretation of the sounds are effective and accessible.
ALT Text

**ALT text** is a written description of non-text content such as images, tables, and graphs. This description is presented as electronic text, making it accessible and can be easily enlarged or read aloud (WCAG, 2023). When creating ALT text, the importance of the image should be considered first. Determine if the non-text content is used for layout, decoration, navigation, supplement, or content. All ALT text should be accurate, brief, and to the point (McEwan & Weerts, 2007).

Mack et al provides a list of suggestions to include in ALT text descriptions

Photographs:
- A description of the subject(s) in detail
- The main action or interaction between subjects
- The setting or the background
- Anything else that is important for users to take away

Non-Photographs:
- The type of image (e.g., bar chart, screenshot of an application)
- The key information in the image (e.g. names, headers)
- The main takeaway from the image you want conveyed
- Anything else that is important for users to take away from this image (Mack et al., 2021, p. 4).

When writing the ALT text description, it is not necessary to include phrases like “this is an image of” because the screen reader will supply that information. However, it is important to indicate the type of image such as illustration, photo, infographic, graph, etc. (University of South Carolina, n.d.). Taylor and Francis Journals offer additional guidance on effectively writing ALT text:

- Do not use information already presented in the caption. If the caption describes the image, then the image can be considered decorative and ALT text is not needed.
- Do not use bullet points within an ALT text description as
screen readers do identify that particular formatting.

- If multiple images are grouped together, then provide each image an individual description.
- Each ALT text should conclude with a full stop /period as it allows the screen reader to pause before continuing. (T&F Journals, n.d.).

**Portable Document Format**

Portable document format (PDF) is an electronic version of a document that can be shared, viewed, printed, and electronically signed. Essentially PDFs are pictures of pages formatted into a single document (Adobe, 2023). Since PDFs are considered images, screen readers tend to have trouble reading the text in image form. However, Adobe provides an extensive online guide on how to make PDF’s accessible and how to check the accessibility level. Here is the link to Create and verify PDF accessibility. The online guide can also be reached by searching the web for “creating accessible PDFs in Adobe Acrobat.” The Adobe accessibility guidelines provide steps on how to create an accessible document. Two features worth mentioning are security settings and the image-only PDF. Security features can be applied to PDFs so the readers cannot alter, copy, print, or comment on the PDF. With the security features in place, screen readers are not able to extract the content and therefore not able to convert the text to speech. To remove the security features the document creator can go to File>Properties>Security>Security method>No security.

Once the security features have been removed, then screen readers can access the document. Those reading the document can alter the reading settings by selecting Tools>Accessibility>Change Reading Options. For PDFs that are considered images only, the document owner can check the status using the accessibility checker. If it is image only then simply select ”Fix” from the accessibility checker options. To manually change the document go to Tools>Scan&OCR>Recognize text>in this file.

The **Reflow option** can temporarily present all of the PDF text into a single column, which makes it easier to read on mobile devices and magnify zoom levels on monitors. The document will not print while in reflow mode. Only readable text will show in reflow; the
following will not conform: page numbers, headers, footers, or digital signature fields.

Adobe also offers a feature called **Text(accessible)** which allows the PDF text to be formatted properly to print using a braille printer (Adobe, 2023). When creating a PDF document, it is good to run an accessibility check to ensure it can be read by your readers.

**Hyperlinks**

The original purpose of the web was to have easy access to obtain, read, and navigate text documents (MDN, 2023) Uniform resource locator (URL) is the digital address to an online document or webpage to another (WebNots, 2023). **Hyperlinks** allows users to create a link that correlates a string of text with a URL. Hyperlinks are distinguished from other text by being underlined and in blue text (MDN, 2023). When creating hyperlinks often users use “click here” or “click the link”, but these prompts are not accessible for those using screen readers. Screen readers allow users to list all of the hyperlinks within a document. When a hyperlink states, “click here” or “use this link” it provides no information to where the link will take the user. It is critical to create a meaningful hyperlink, which provides an explanation of where the link is redirecting the user (George Mason University, 2023) To create a meaningful hyperlink within a document, follow these steps:

- Click “Insert” from the toolbar
- Select “Link”
- You will be prompted to enter the display text, which is where the meaningful text for the hyperlink will go.
- Finally the “Link field” is where you can copy and paste a URL.

Many websites have embedded meaningful hyperlinks into their URL, so when the URL is copy and pasted the meaningful hyperlink appears instead of the URL. For example, here is the website URL that was copied from George Mason University website “creating accessible hyperlinks” [Creating Accessible Hyperlinks – Assistive Technology Initiative (gmu.edu)] Notice how this meaningful
hyperlink provides information on the destination it links to.

**PowerPoint Presentations**

PowerPoint presentations consist of a series of visual slides. Each slide includes images, text, graphs, along with other visual elements. PowerPoint presentations are used widely in business and educational settings (Britannica, 2023). Similar to other visual documents, PowerPoint presentations should be modified to ensure they are accessible to individuals with V.I. Diane Brauner created a detailed list of ways to modify a PowerPoint presentation. Here is a list of excerpts from Brauner’s list.

**Font Size:**
- Heading minimum of 32 pt.
- Subheading minimum of 30 pt.
- Text minimum of 28 pt.

**Font:**
- Arial, Verdana, Tahoma, Antique Olive, APHont
- Avoid Italics instead use underlining, quotations or bold text.
- Use left alignment only.

**Screen Readers:**
- Try to avoid animations and slide transitions. Screen readers have a hard time interpreting them. If animations and transitions are absolutely necessary then convert the Powerpoint Presentation to a PDF or word document. Make sure to use ALT text on any important animations and images.
- Alt text is also needed for all tables and graphs
- The outline view in Powerpoint enables the creator to view the presentations as read by screen readers. However, this mode does not display Alt Text.

**General Accessibility:**
- Videos should be captioned and include audio description
- Images should include Alt Text. Alt Text can be created by right clicking on the image and selecting View Alt Text
- Create meaningful hyperlinks
- Check accessibility using the built in accessibility checker
- Before class, provide the students with V.I. a copy of the PowerPoint presentation so they can upload it to their device. Additionally, have a converted version (PDF or Word document) ready to share with the student if needed. (Brauner, n.d.).

To view the full list please visit the following link Creating Accessible PowerPoint Presentations.docx (live.com) or visit perkins.org and search for “Creating accessible powerpoint presentations.”

**Message design for in-person and in the classroom**

Creating content for in-person settings provides an option for the use of tactile objects. Learners with V.I. can gather information through touch (Karbowski, 2020). Creating three-dimensional renderings from two-dimensional images and using tactile graphs and diagrams can enhance logical development (Linn, 1972) and assist with teaching subjects such as art, geography, math, and science (Radecki et al., 2020). **Tactile graphics** are raised texture and patterns added to a flat surface like embossing paper. While **tactile objects** are three-dimensional renderings (BCC editorial Research, 2018) of artifacts, people, places, and things. Tactile objects can be made out of a variety of mediums including clay, cardboard, papier mâché, wood, and 3D printers. 3D printers have become more user friendly, cost effective, and prevalent in homes, businesses, and classrooms.

Incorporating tactile objects into an educational setting can benefit a variety of learners. Object-based learning is the active engagement of objects in a learning environment. By nature, this form of pedagogy provides learners with a multi-sensory educational experience (Chatterjee et al., 2015). Engaging with objects through touch (haptic engagement) can enhance the learning experience in several ways. It can spark curiosity, encourage critical thinking and analytical inquiry, establish a tangible connection to the subject matter, and improve comprehension (Frigo, 2019).

When designing tactile objects, it is important to consider size and scale. It is ideal to create a smaller model that enables learners
with V.I. to easily run their hands over and explore the entire object with their hands. If the model is too large, it can make it difficult to fully grasp and understand the object.

**Paper handouts**

In traditional in-person classrooms or educational settings, printed handouts are often provided and contain text, images, graphs, or other 2-dimensional information on paper. To make materials accessible, create a digital document that can be easily emailed or shared through a link so the learner with V.I. can access it using their digital device and screen reader. As always, it is important to check the document using the accessibility checker. It is good practice to ask learners with V.I. whether they prefer a large print or digital document. Recognizing that notetaking can be challenging for some learners with V.I. provide a digital copy of the notes. This allows the learner to listen to the presentation and review the notes at a later time.

**Whiteboard/chalkboard**

The blackboard is a significant piece of technology and is essential to the classroom. The blackboard enables teachers to display text and drawings to the entire class. Created during the 19th century, it is still a relevant necessity in classrooms (Molenda, 2007). Since its inception, the blackboard has evolved into the whiteboard, with the same concept except the use of markers instead of chalk. While this technology is revolutionary and widely used, it is not advantageous for learners who are VI.

When planning a lesson that involves using a blackboard or whiteboard, consider making your notes in an accessible electronic document that can easily be read using screen readers. If there is no script, then audio describes any drawings, and state any text out loud.
Need for Creating Inclusive Learning Environment

Instructional designers face the challenge of not always knowing the needs and strengths of each individual learner. Therefore, it is important to create an inclusive educational message design that caters to the unique needs of a variety of learners. Often accommodations and alternative ways to present information are missing from educational content. Let's change the language and thoughts surrounding disability and accommodations. Instead of viewing accommodations as an extra task or a cost increase, think of it as ways to improve the learning for ALL of the learners. Inclusive education is a resource and not a problem (Cologan, 2013). Society as a whole needs to flip the script and start viewing inclusion and accommodations as a means to improve communication, connect in meaningful ways, and enhance creative thinking. We can gain knowledge and skills by interacting with others (Cologan, 2013). Hence, inclusive education can be a valuable resource rather than a problem. It prompts us to question whether educational institutions should prioritize accommodations. Moreover, introducing students to accommodations can provide a foundation and best practices to integrate accommodations into other facets of society like events, museums, and theatrical performances. As we age our vision may diminish or sudden illness or injury can cause visual impairments. Thus, being familiar with accommodations and accessible tools, designed for individuals with V.I. would be advantageous.

Conclusion

Visual content plays a pivotal role in communication and effective message design, particularly in education. Therefore, it is imperative to provide educational content that caters to learners with V.I. As instructional designers, it is crucial to be familiar with the various assistive technologies and accommodations used by V.I. learners. When creating digital content ensure that all the content meets WCAG guidelines and can be interpreted by screen readers. Develop digital copies of handouts and blackboard content so learners with V.I. can have access to the material. Educators, please remember that not all research materials (journal articles and websites) are
accessible and in general learners with V.I. may need extra time completing assignments. Please be patient and communicate with your students about their specific needs.

Ultimately, the significance of educational content that accommodates the unique needs of all learners creates a more equitable and enriching experience. By adhering to these principles of inclusivity, we not only fulfill our ethical obligations but also unlock the potential for greater engagement, understanding, and collaboration among diverse learners.
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Chapter 6. Instructional Message Design for Adult Learners

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Key Points:

- Designers need to consider the potential for adult learners to be distracted by noise in their instructional message designs.

- Examples of media and television commercials can be used to inform instructional message design best practice.

- The messages in our instructional designs can be impacted by technical, physical, physiological, organizational, cultural, psychological, and semantic noise.

Abstract

As stated in Chapter 1, message design is all around us, from the presentations we see in meetings and classes, to the instructions that come with our latest tech gadgets, to multi-million-dollar training simulations. The instructional message design field of study pulls from many applied sciences, including cognitive psychology, industrial design, graphic design, instructional design, information technology, and human performance technology, to name just a few. In this chapter, we will visit several adult learning theories and examples that guide our research into adult learning, look at different real-world instructional message designs for adult learners, and discuss directions for future best practices. Learning about effective instructional message design tools and techniques has been and will continue to be a critical aspect of the overall instructional design process. This chapter will serve as an introduction to instructional message design for adult learners and further awaken the desire for
learners to explore and implement tools when designing messages for adult learners.

**Introduction**

Instructional message design for adult learners can be seen in various messages in this world around us all. Instructional message design for adults will not be effective without learning the foundation of how adults learn. Merriam-webster defines the word andragogy as the art or science of teaching adults (Merriam-webster, 2023). In this chapter, we will explore the history of adult learning. We will examine the principles of some of the great minds on the subject, such as Malcolm S. Knowles (1973), who resurrected the word andragogy in 1968. However, the term andragogy was first coined in 1833 by a German teacher named Alexander Knapp to categorize and describe Plato’s theory of education.

The root word of andragogy refers to methods and principles used in adult education. The word comes from the Greek ἀνδρ-(*andr-)*, meaning "man," and ἀγωγός(*agogos*), meaning "leader of." Therefore, andragogy literally means "leading men." Knowles was one of the first proponents of adult learners’ training techniques. His book, *The adult learner: A neglected species* is still a widely sought-after book in adult learning. We will also explore some of the intended adult education outcomes according to Knowles’s perspective.

Instructional message design is the use of learning theories to effectively communicate information using technology. How does the adult learner learn in this ever-changing environment? How are instructional messages being released to adult learners? How can we use effective message design to foster the self motivation of our students? Techniques must be in place to ensure that instructional message designs are appropriate for the intended adult audience and that it is effective.

Andragogy will continue to play a significant role in instructional message design as the history of adult learning is explored and the questions above are answered. We will explore instructional message design techniques (good and bad). We will also look at Robert W. Pike (1989), an expert in human resources
development and author of the book *Creative training techniques*. Mr. Pike has facilitated thousands of adult training seminars. His principles of adult learning, referred to as “Pike’s Laws of Adult Learning,” are a great asset in adult learning techniques. Finally, we will examine the future of instructional message design in academic and professional development contexts and how the future might look for the adult learner. Now let’s take a look at the history of andragogy.

**Brief History of Andragogy**

The history of andragogy, which consists of learning strategies focused on adults, begins in Greece with Plato's educational theories. Although the term did not originate with Plato, he was indeed teaching adults. Plato was an ancient Greek philosopher born in Athens during the Classical period in Ancient Greece. He founded the Academy, a philosophical school where he taught philosophical doctrines that are widely known today as Platonism (Barrow, 2012; Mason, 2010).

His theories were called Plato’s **theory of forms** (based on the theory of ideas), the **theory of the soul** (immortality of the soul), **epistemology** (man's intuition about what is knowable and what is real), **ethics, politics, rhetoric,** and **poetry**. Plato’s ideas expanded on and were inspired by his teacher Socrates, and the Socratic Method of adult and social learning (Paraskevas & Wickens, 2003). Plato's theories are still debated today. These theories are more centered around philosophical debates, but nonetheless, Plato began the education theories discussions.

Alexander Kapp further strengthened Plato’s educational theories. He was a German educator and editor and in 1833 he originally introduced the term andragogy. Kapp interpreted andragogy as the process of engaging adult learners in the structure of the learning experience. Kapp tapped into the understanding, knowledge, behaviors, skills, values, attitudes, and preferences of the adult learner (Svein, 2017). His contribution was crucial to the foundation of understanding what adult learners bring into a learning environment. Adults bring their knowledge, skills, and experience into any teaching situation in ways that younger students can not.
Moving on into the 1920s, over 100 years after Kapp’s introduction of andragogy, Eugen Rosenstock was responsible for the theory of adult education (Svein, 2013). He was a central force in the work on adult learning in Germany. He was a leading researcher and practitioner in the first theoretical, academic reflections on adult learning and implemented his theories in practical actions. His work influenced key figures of adult learning in the inter-war and post-war periods. His philosophy of learning centered on school being for children, and life being for adult learners (Svein, 2013). However, he is unfortunately not referenced in much adult learning literature.

Fifty years later (in the 1970s), an American educator named Malcolm Knowles popularized andragogy and the theory of adult education (Knowles, 1973). As was stated in the introduction, Malcolm S. Knowles was among the first proponents to create a framework for educators and trainers whose job it is to train adults. Though we must keep in mind he built upon the foundations of adult theory that were present before his time.

In Knowles's book, *The adult learner: A neglected species*, he resurrected the word “andragogy” (Knowles, 1973). Knowles's goal was to create a unified theory of adult theory. They were based on the four brief assumptions below:

1. **As they mature, adults tend to prefer self-direction.**

2. **Adults’ experiences are a rich resource for learning.**

3. **Adults are aware of specific learning needs generated by real-life events.**

4. **Adults are competency-based learners, meaning that they want to learn a skill or acquire knowledge that they can apply pragmatically to their immediate circumstances.**

Almost 20 years (1989) after the popularization of Knowles's adult learning theories, Robert W. Pike entered the adult learning scene (Pike, 1989). He is an expert in human resources development and adult learning. His principles of adult learning,
referred to as “Pike’s Laws”, and his book *Creative training techniques* help revolutionize adult learning worldwide. “Pike’s Laws of Adult Learning, have built upon the original philosophy to provide similar guidance for trainers” (Bishop 2013). Below is a brief description of the four principles of Pike Laws in regard to adult learning (Pike, 1989):

**Law 1: Adults are babies with big bodies.** It is accepted that babies enjoy learning through experience because every exploration is a new experience. While somewhat counterintuitive, adults (as do young children) appreciate the ability or option to explore on their own.

**Law 2: People do not argue with their own data.** Succinctly put, people are more likely to believe something fervently if they arrive at the idea themselves.

**Law 3: Learning is directly proportional to the amount of fun you are having.** Humor is an important tool for coping with stress and anxiety and can be effective in promoting a comfortable learning environment.

**Law 4: Learning has not taken place until behavior has changed.** It is not what you know, but what you do that counts.

As you can see, andragogy has evolved over the centuries and adult learning techniques continue to evolve in the field of instructional message designers for adults. The foundation has been set for instructional message designers in adult learning environments to continue to build on this foundation. Pedagogy for younger learners have different motivations, which can be supported through appealing to their curiosity, making learning entertaining, and praise. However, adult learners have internal (inherent passion, excitement for learning, desire to achieve a goal) and external (need a new job, need a certification to keep a job, need money, need to help and support a family) motivations. Two classic examples from television can be used to illustrate how we can foster or erode this motivation through message design and communication noise.
Two Classic Examples: Effective and Ineffective Instructional Message Design Techniques

What does one think about when they see the words instructional message design? The average person that is not privy to the world of instructional message designers, will immediately focus on the word instructional and equate it with an instructor teaching a specific topic to a specific segment of society. However, instructional message design goes further than that. The various means to get a message out to your target audience are growing more and more as designers push the envelopes to engage their intended audiences.

Some would go so far as to suggest: will there be a need for instructional designers in the future? Well, I would not push the envelope that far, we certainly need humans to create instructional messages for specific intended audiences. Instructional message design explores how various media and delivery systems might be used more effectively to help optimize instructional communications within context-specific instruction (Bishop 2013).

Instructional messages are all around us, and they are strategically designed to relay messages good or bad, to intended audiences. Instructional design can have an affective emotional impact on our learners. Instruction design seeks in part to change the attitudes and actions of learners, and instructional message design is how we communicate that intent. Media and television commercials have similar goals, to influence the attitudes and actions of their audience, and thus there are lessons for instructional designers to learn from them. We can certainly just look at the millions of dollars that are spent every year for a 30-second commercial during a super bowl football game in America. Wow! Who would not want to have that coveted job on a special project as an instructional designer to relay a message for a specific brand during this event? It’s exciting to see what message will be the most talked about commercial, or instructional message, the next day at work or in the office around the water cooler. What instructional message did the instructional designer try to convey to the intended 50 million viewers watching on their televisions and other devices? Did the instructional message designers knock it out of the park, or was the audience confused and left thinking, ‘what was the message behind the message?’
One of the best received commercials during a Superbowl was the 1980 classic with “Mean” Joe Green (an NFL Hall of Fame defensive tackle for the Pittsburgh Steelers football team during the 1970s) and a young kid (see Figure 1). The kid was giving “Mean” Joe Green a pep talk after a bad game, however, not only did he use his words, but he also utilized a message in the form of a classic Coke. The classic Coke was instrumental to the instructional message in that commercial. It instructed the audience, just by the iconic imagery of “Mean” Joe Green guzzle down that Coke, to go and buy a Coca-Cola when they are having a bad day and they too can start smiling again.

The juxtaposition of a huge, hall of fame football legend having a bad day and a small child who idolizes him is still classic instructional message design. Let’s go back to the meaning of an instructional message design and dissect this commercial. Was the instructional message designed in the real-world an application of instructional and learning theories? To design the tools and technologies used to communicate and effectively convey information?
Figure 1
Coke’s Classic Mean Joe Green Superbowl commercial

Coca-Cola - “Have a Coke and a Mean Joe Greene” [Commercial, 1980]

https://www.youtube.com/watch?v=xflOCZYX6F8

Kid - “Mr. Green, Mr. Green?”
Mean Joe - “Yeah..”
Kid - “You need any help? …I just want you to know, I think, I think, you’re the best ever,”
Mean Joe - “Yeah, sure,”
Kid - “Want my Coke? …Its okay you can have it”
Mean Joe - “No,”
Kid - “No, really you can have it,”
Mean Joe - “Okay” (drinks Coke as happy music plays)
Kid - “See you around”
Mean Joe - “Hey kid, catch” (throws jersey at kid with a smile)
Kid - “Wow, thanks Mean Joe!”
I would agree that this commercial did utilize designed tools such as the wording on the Coke bottle, the uplifting and well timed music, the hulking and limping football player whose day is changed by the simple act of a child, and the product bottle and label design itself. Please take a moment and view this commercial and see the various instructional design messages in this classic.

Welcome back, since we just finished viewing this great classic it’s only fitting to watch one of the worst commercials in Superbowl history. Remember we are examining the instructional message design and our audience is adults. The Groupon commercial was aired in 2011 and intended to get folks to order Tibet’s well-known fish curry dish (see Figure 2).

**Figure 2**
*Groupon’s Culturally Insensitive Commercial*

https://www.youtube.com/watch?v=xwgYqIZUtZ0

Groupon Super Bowl Ad ‘Tibet’
“Mountainous Tibet one of the most beautiful places in the world, this is Timothy Hutton, the people of Tibet are in trouble, their very culture is in jeopardy... but they still whip up an amazing fish curry, and since 200 of us bought at Groupon.com we are each are getting $30 dollars worth of Tibetan food for just $15 at a Himalayan restaurant in Chicago, save money, unlock great deals in your town, Groupon.com”

The company logo was in a simple font and easy to read, and the audience knew which company the ad was promoting. Although there was a famous actor named Timothy Hutton in the commercial, the instructional design message was lost. The fish curry dish that he spoke about did not make audiences rush to the Groupon website to purchase discount tickets for the dish or travel to Tibet to enjoy this great fish curry dish in person.

What was the problem, the message? He starts off talking about how beautiful Tibet was, and then goes further to comment on how the people in Tibet are in trouble, and how their culture is in trouble, but come get savings on your fish curry dish with Groupon. It was an instructional design message that had adults furious; asking what in the world were these ad executives thinking with this obviously disturbing example of cultural insensitivity. I certainly would not want to be the instructional designer behind that Groupon message.

The message attacked and minimalized someone’s culture, and that was a horrible instructional design message where adults rallied around to have it removed. In essence, the message in the ad was saying, we don’t care about the trouble that your country is facing, just whip us up a bowl of fish curry, and we will keep coming for the wrong reasons not the right ones, and by the way we don’t care about how bad your country issues are either. But this restaurant in Chicago has great curry chicken.

Below is the exact quote from Groupon after receiving all the negative feedback from this horrible instructional design message: “We hate that we offended people, and we’re very sorry that we did ... we thought we were poking fun at ourselves, but clearly the execution was off, and the joke didn’t come through” (CNN, 2011). Instructional
design messages for adult learners in any medium must be carefully
designed in a way that the learners can process the message without
any communication noise. This design clearly had communication
noise in its message, and it took over the positive message which was
to buy Groupon discount tickets for your local restaurants.
Instructional message practitioners need to consider strategies and
review processes to design a message that will not offend or turn off
adult learners. Such as, are the colors culturally appropriate? Can the
audience envision themselves? Does it bring a sense of belonging? If
there are jokes, do they come off as appropriate or offensive?

Why am I taking the time to praise a 43-year-old Superbowl
commercial at the time of this writing, and pointing out a poorly
designed Superbowl commercial from over 12 years ago? The point is
that after all these years, these instructional message designs still
provide teaching moments. A text on a bottle can represent a world
brand that makes you begin to utilize your cognitive senses, schema,
and start salivating for the item. While the Groupon ad’s message
design still serves as a culturally insensitive and misplaced joke.

Instructional message designs pull from many applied sciences,
including cognitive psychology, industrial design, graphic design,
instructional design, information technology, and human performance
technology. Instructional message designers have to create, evaluate,
and adapt the intended outcome from this blending of best practices
for adults and how adults process information. Take the learning
process seriously because it is serious and important (McLagen,
1978). Adults learn differently and have different motivations that
have to be taken into account during message design.

The various concepts, principles, and key points used by
instructional designers are growing every day. Concepts such as color,
animation, fonts, videos, etc. do matter in the world of instructional
designers, and when you get the details correct, then you will get the
message correct. Regarding the Groupon commercial, their message
was buried with negative noise that had adult learners turning away
from the intended message and moving toward a whole new message
that the creators of the commercial never expected. The adult learners
were now sending messages to the company to cancel the commercial
because of the poorly designed instructional message.

When designing for adult learners, instructional designers must
be willing to learn from past mistakes and embrace lessons learned
from past instructional designers and past targeted audiences. When designing for adult learners’ designers will be motivated to utilize creativity as much as possible. However, instructional message designers must design with balance in their projects and understand learner characteristics. According to McAnany “designers must know and understand learner characteristics in order to create effective instructional messages and materials” (McAnany 2009).

Adults have a reference point for many of these instructional design messages. They can distinguish between what they want to reference or not based on their experiences. New adult learners can be somewhat nervous in any new educational environment. Can it be because there are other adult learners that are also bringing their various experiences as well into the learning environment? Successful Adults learners are motivated to learn; they have invested their time and funds to learn specific subjects. Some adults do not need the motivation to learn they are independent. As independent learners, they can often have a passion for learning, and the learning environment can be fun for them. Though bad instructional message design can tax that motivation.

Communication Noises to Avoid for Adult Learners

I mentioned the fact that the Groupon commercial was overcome with communication noise. In the instructional message design, you want to stay away from conflicting messages while designing for adult learners. In the Communication System Model, the following communication noises can hinder the intended message in instructional design for adults. However, let’s define communication noise. Communication noise is defined as any barrier to the effective communication process (Shannon & Weaver, 1949). The messages in our instructional designs can be impacted by technical, physical, physiological, organizational, cultural, psychological, and semantic noise (Oaks, 2023). Noises are the ineffective communication process between senders and receivers. In other words, did the sender's communication relay the exact message to the receiver with no communication barriers? We can certainly see that Coca-Cola sent the correct message to the receivers and after reviewing the message,
adults were ready to go out and purchase a Coke to brighten up their day.

However, in the case of the Groupon commercial, we certainly saw that the sender did not get the correct message to the receivers, and therefore the response back to the sender was unfavorable. Let’s take a closer look at the 5 top communication noises.

Refer and compare Example 1 below to Example 2 on the page after, there is certainly some sort of communication noise sent to the reader. You cannot make out the 5 top communication noises on the chart below. As an instructional message designer, I failed in ensuring that you can receive the message I intended to relay to you. Sharon Fisher (1989) states that visual learning is one of the top adult preferences regarding learning environments.

**Example 1:**

![Diagram of 5 Types of Noise in Communication]
Example 2:

https://newsmoor.com/tag/psychological-noise/

Clearly the intended audience can see a little better five types of noises in communication and a brief example of each noise on this second figure. When designing instructional messages for adults, designers must remove all noises to ensure that learners can process the information without any interference. For example, if Example 1 was presented to adult learners, they would quickly summarize that the instructional designer did not take the effort to review the picture of the chart or was not concerned about the communication noises that would result from the feedback of not seeing the picture of the chart.
(note, while Example 2 is easier to read, can you still see the visual noise it also contains in its smallest red text?).

What type of noises were represented in the Groupon commercial? If you guessed psychological (personal biases, assumptions, attitudes) and cultural (contexts, expectations, morals, etiquettes) noises, then you are correct. Groupon did not eliminate sensitive issues surrounding the people of Tibet. Also, they failed to recognize the impact of differences in culture, race, and economic status, which clearly resulted in the wrong meaning for the commercial. It was fine to market Tibet and their delicious fish curry dish but, the disconnect and lack of insensitivity of having a Tibetan waiter serve you while stating that the Tibet people are having major problems sent the wrong instructional message design.

**Future Research**

Communication designs can be based on a wide variety of technologies or a combination of technologies. Technology in the form of tools and techniques includes the study and the use of typography, color, illustrations, photographs, modeled graphics, augmented reality, animation, video, video games, simulations, and virtual reality (Ramlatchan, 2019). The future of instructional messages for adults is bright. The ongoing world of technology will enable designers to interact with adult learners at an amazingly fast pace with innovative technology, while factoring in the latest on adult learning.

The sky's the limit as it relates to the future of instructional message design and based on the above current tools, designers will be armed to design meaningful and state of the art messages for customers worldwide. Now with the introduction of Artificial Intelligence (AI), instructional designers are having heated discussions on how far is too far as it relates to AI. The ethical and moral implications of artificial intelligence as it relates to adult learners and instructional message design will have very interesting implications for future research and practice. With the fast and furious pace of new technology, instructional designers will have a great
arsenal to design from and the possibilities of great designs for customers will be endless.

Conclusion

Andragogy continues to evolve, and we owe a great debt to those founding fathers from Plato to Pike. New techniques and theories are being created as innovators and educators introduce new techniques and tools for the adult learner. Instructional message designers will utilize these technologies for adult learners, to connect their experience to new ideas.

Adult learners are motivated by learning that they can directly apply in their real-world contexts. Since adults are independent learners, they often have a passion for learning, and poor message design can negatively impact that motivation. Instructional message designers must continue to study the foundation of andragogy and seek out information on how to design for adults. Of course, design projects will always get feedback from the customer but utilizing some of the founding fathers of adult learning’s techniques will serve as a foundation when designing for adult learners.

As the saying goes, there is a right and wrong way of doing things. Welcome the opinion of other instructional message designers when designing for adults so you can avoid a worldwide apology like Groupon. Continue to draw inspiration from some of the instructional message designs like Coca-Cola and their “Mean” Joe Green commercial. These two examples illustrate some of the many aspects of communication noise that can distract our adult learners from our instructional message designs. Designers need to consider the potential for adult learners to be distracted by noise in their instructional message designs.

Pay attention to the communication noises in your designs that will have adults frustrated and some completely not engaging at all because the communication noises were too loud, and the intended design message was lost. Our instructional message designs can be impacted by technical, physical, physiological, organizational, cultural, psychological, and semantic noise. Poor message design may only result in more cost and time delays. The goal is to eliminate as much noise as possible as my example of the bad illustration in
Example 1 depicted. The end goal is to design with excellence always at the forefront. Finally, as instructional message designers for adults, never lose your passion for designing for adults. Designers should aspire to be the trailblazers that many can glean from, just like the trailblazers Max Miedinger and Eduard Hoffman who co-created the typeface Helvetica. So many of us are utilizing and will utilize some version of Helvetica in our instructional designs. Continue to design with boldness, passion, and creativity, while incorporating some of the techniques in this chapter.
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Chapter 7: What Can Instructional Designers Learn from Graphic Designers?

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7. What Can Instructional Designers Learn from Graphic Designers?

Mark Richard Parsons

Key Points:

- Graphic or visual design cannot compensate for poor instructional design. Instructional design cannot compensate for poor graphic design. The two complement each other. The collaborative relationship between instructional and graphic design produces a superior learning resource.

- Instructional design is determining the need for an instructional solution, analyzing needs, defining learning objectives, and developing a solution to meet those objectives.

- Graphic design is a form of communication that uses colors, shapes, images, and words to create visual content that surrounds us in many forms.

- Graphic design tips for instructional designers include planning, reducing clutter, designing for learners, working with typefaces and fonts, organizing the graphic space, choosing the right images, working with colors, utilizing a visual hierarchy, being consistent, and using contrast.

- Instructional designers should find inspiration by constructing a graphic design toolbox, getting familiar with editing software, learning the technical terms, start with templates, follow trends, and embrace project limitations.
Abstract

Instructional message design uses learning theories to effectively communicate information using technology. The instructional designer identifies the main objectives and skills to be learned to devise and deliver a strategy for the learner. The graphic designer plays a role by helping guide the learner through the material without distraction. Graphic design plays a vital role with visual learners. Using instructional and graphic design principles is important for effective instructional message design. This chapter looks at the importance of graphic design in the instructional design process. It will explore what skills and strategies instructional designers can utilize from a graphic design viewpoint. The chapter will provide tips for instructional designers who are looking to increase their graphic design skills and knowledge base.

Introduction

I must share my career story to understand the importance of graphic design within instructional design. In my experience, the graphic or visual design aspects of building interactive education media were initially a struggle. In 2002, I landed my first job after graduating from Old Dominion University in Norfolk, Virginia. At Old Dominion, I studied geology and was fascinated by the Earth’s features and how processes constantly changed landforms. I never took any courses in graphic design. The closest course to anything art related was art history, taken only to pass the general education requirements of the degree. My first job was as an Earth Science and Oceanography teacher at a local high school.

At the time, most teachers were using PowerPoint to show visuals and lecturing using slides. I never realized it then, but I was already becoming a graphic designer. I was building slide decks of planets, Earth’s processes, rivers, mountains, rocks, and minerals. Using my skills as a new teacher, I added text to those images. The purpose of the text was so that students could take notes about the vital information that they would need to retain. Early in my career, without recognition, I was already complimenting instructional design
with graphic design. I cannot confidently say I used sound instructional or visual design techniques. I built slide decks to transfer information without using theories, tips, or advice, which will be discussed later in this chapter. Also, it is important to understand that I employed many pedagogies and strategies besides direct lecturing using slide decks as a teacher. I was even recognized as the district’s high-school teacher of the year in 2013-2014. But my journey as a “graphic designer” had to begin somewhere.

I took up a part-time job as a content developer during my teaching career. My primary role was to write the content for the fully-online Oceanography course. As the content developer, I worked with a very talented instructional designer. We would meet weekly and share ideas about how to write the content and then design the content. Once the content was written, the instructional designer would work through creating these extraordinary learning objects. I was allowed to access the staging area and review the work. I was always thrilled to see the final product—one of the learning objects involved learning about the diversity of coral reefs. The instructional designer made the learning object look like you were looking through a snorkeling mask, as seen in Figure 1. It was not exciting material, but the graphic design made it exciting. Different fish swam by as you learned about the reef. And I was excited by this field of instructional design. When the organization designing this educational content had a job opening, I applied and accepted a position.
I quickly learned in my new role that I knew little about instructional design and even less about graphic design. I knew how to make slide decks for lecturing, and I did have extensive educational technology experience and could apply many of the pedagogies and strategies. But, I was far from even a decent graphic designer. The first few learning objects I created were quite hideous. I found myself running out of ideas and searching for inspiration everywhere. Many of the learning objectives I made for my first year as an instructional designer were template driven. It was a crutch I used to feel more confident about the aesthetics. During my infancy as an instructional designer, I learned how vital attractive aesthetics are for instructional design. Graphic design cannot compensate for poor instructional design. Instructional design cannot compensate for poor visual design (Hogle, 2017). Instructional design and graphic design complement one another.
As the years passed, I became a better instructional and graphic designer. I did this using some tips I will suggest later in this chapter. I looked for inspiration everywhere. I kept up-to-date with the latest trends in eLearning. I enrolled in free courseware. I learned graphic design vocabulary and taught myself how to use Adobe Photoshop and Adobe Illustrator. Slowly, I gained the skills in graphic design that I needed to create a better educational product. About three years into my career as an instructional designer, a new instructional designer position opened. The new hire came in with a background in instructional design. This new collaboration accelerated my graphic design skills. Instead of searching for visual design solutions, I would collaborate with my new colleague. I would share my experience and best teaching pedagogy, and in return, I would receive graphic design advice and tutorials. It was a symbiotic relationship that helped us both grow professionally. This brings up an excellent point. Instructional design should not be completed in isolation. Collaboration only strengthens the design and designers. Together, we shared the same goal. We wanted to deliver educational content that was both sound in instructional design and aesthetically appealing. Knowing that if the visual design fails, the experience falls flat. We worked hard to add meaningful graphics and a compelling visual design to supercharge the instruction, training, and presentations. This was not easy to accomplish (Malamed, 2015).

My role within the organization changed after ten years as a self-taught instructional designer. I took on the role of instructional design manager. Shortly after starting the new position, I added three new instructional designers. I shared with them that the most challenging part of our job is learning graphic skills and becoming a self-taught graphic designer. But, I explained the importance of well-designed graphics. Instructional designers can help learners with appropriately designed graphics. Words alone are never enough (Clark & Lyons, 2004). And that is currently what our team is working towards, and we become more proficient every day. Describing my graphic struggle as a new instructional designer was important. Hopefully, this context will help you understand the importance of graphic design so that your designs will not fall flat.
Defining the Roles of Instructional Design, Graphic Design, and Message Design

Using instructional and graphic design principles is essential for effective instructional message design. Before this chapter goes further, let's take a moment and look back at our definitions of instructional design, graphic design, and instructional message design. Understanding how an instructional designer and graphic designer create effective instructional message design is important. This will help you realize that instructional designers should be encouraged to collaborate and learn from graphic designers. Whether through narratives, concept maps, diagrams, audio, video, or interactive and immersive experiences, the mindset of both a graphic designer and an instructional designer is useful and central to the product's success (Spencer, 2013).

In Chapter 1, instructional design was defined as the process of determining the need for an instructional solution, assessing and analyzing the learning needs of a user/client/student group, defining learning objectives, and developing a solution to meet those learning objectives (RamlaGhan, 2023; Reigeluth, 1999; Richey et al., 2011). The instructional designer's role is to create a strategy for learners to build upon their knowledge bases (Spencer, 2013). As also discussed in Chapter 1, the instructional designer utilizes several learning theories (Ramlatchan, 2023). The instructional designer determines how to present information, the appropriate assessment types, and how learners should use that information (Hogle, 2017). Instructional designers can use Gardner's Theory of Multiple Intelligences to know that information must be conveyed in multiple ways. Gardener initially identified six intelligences, and today, there are nine.
<table>
<thead>
<tr>
<th>Intelligence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal-Linguistic</td>
<td>Well-developed verbal skills and sensitivity to the sounds, meanings, and rhythms of words</td>
</tr>
<tr>
<td>Logical-Mathematical</td>
<td>Ability to think conceptually and abstractly, and capacity to discern logical and numerical patterns</td>
</tr>
<tr>
<td>Spatial-Visual</td>
<td>Capacity to think in images and pictures, to visualize accurately and abstractly</td>
</tr>
<tr>
<td>Bodily-Kinesthetic</td>
<td>Ability to control one’s body movements and to handle objects skillfully</td>
</tr>
<tr>
<td>Musical</td>
<td>Ability to create, produce, and appreciate music</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>Capacity to understand others’ emotions and needs</td>
</tr>
<tr>
<td>Intrapersonal</td>
<td>Capacity to understand one’s motivations and emotions</td>
</tr>
<tr>
<td>Naturalist</td>
<td>Ability to classify flora and fauna</td>
</tr>
<tr>
<td>Existential</td>
<td>Capacity to answer questions about human existence</td>
</tr>
</tbody>
</table>
These principles reinforce that information must be conveyed in multiple ways (Northern Illinois University Center for Innovative Teaching and Learning, 2020). This model will help reinforce the mastery of the content (Gardner, 2013). In most larger organizations, the instructional designer is not responsible for the nuts and bolts of how learners interact with the content. The instructional design includes the structure and format of lessons or training. How the learner reacts would often be completed by a programming team led by the instructional designer serving as project manager. Content aesthetics fall under graphic design (Hogle, 2017). However, instructional designers are often required to wear many hats and hold various responsibilities. This is often seen within small organizations (Jordan, 2022). In some roles, the instructional designer will take on more creative responsibilities, including graphic design.

Graphic design helps guide the user through the material without distraction. It enables visual learners to grasp and apply concepts easily (Spencer, 2013). So, you can see that instructional and graphic design definitions are similar. Both aim to help learners interpret and understand a new concept. Graphic designers create everything from websites, brand logos, book covers, and advertisements. They are crucial in designing learning experiences, especially within online learning environments (Hogle, 2017). Graphic designers determine the color palette, the typeface used, the layout and navigation, and the appearance of buttons and interactive elements. Graphic designers choose the images, design banners, draw maps, and create job aids and infographics. When graphic designers assume the role of instructional designers, they possess a solid background in color theory, composition, and visual design. They excel in online learning areas and create a consistent look and feel for learning assets (Chang, 2019). The graphic designer's role is an important one. Learners are motivated when the learning experience is aesthetically pleasing and unmotivated when it is not (Malamed, 2015).

Looking at the definition of instructional message design from Chapter 1, you will see that both instructional and graphic design are needed for effective message design. Message design uses text, graphics, and/or pictures to communicate and specifically address a need or solve a problem (Fleming & Leve, 1993). Instructional message design uses the learning theories found in instructional
design alongside the principles of proper graphic design. The marriage of the two disciplines motivates learners and produces a more impactful learning experience.

**Should Instructional Designers be Expected to Have Graphic Design Skills?**

Since the mindset of both the graphic designer and instructional designer is central to a learner’s success, should the instructional designer be expected to have graphic design skills? Remember, instructional designers often collaborate and deliver strategies through concept maps, diagrams, audio, video, and immersive experiences (Evanick, 2023). And graphic design is a unique discipline with its own set of skills and knowledge. Therefore, it is beneficial for instructional designers to have some graphic design skills, but it should not be expected that they are graphic design experts.

Basic proficiency allows for effective communication since the instructional design process often requires the designer to collaborate with a graphic designer. Effective communication will ensure that educational materials align with the learning goals and objectives. The most critical aspect of instructional design is creating effective and engaging materials aligned with instructional goals and objectives (Evanick, 2023). This engagement is what the instructional design should focus on.

Whether or not the instructional designer should be expected to have graphic design skills also depends on the roles and responsibilities of the instructional designer. Some organizations may have dedicated graphic design teams. Some organizations could work with freelance graphic designers or use pre-designed templates. In other organizations, the instructional designer could be responsible for all the graphic work.

Let’s look into those instructional design specialties a bit closer. Instructional designers work in a variety of industries. While many of the skills are transferable, the roles and responsibilities are different.

- Corporate instructional designers support corporate training by creating interactive training courses. They could collaborate with Human Resource departments or development officers.
(Editorial, 2021). Would they need graphic design skills? Most likely, larger corporations would have graphic design teams. It would be important for the corporate instructional designer to have basic graphic design proficiency for effective communication.

- Government instructional designers create learning objects to train and develop government employees. They often have to meet regional, state, and national requirements. Larger government organizations would likely also have graphic design teams (Editorial, 2021b). It would be important for the government instructional designer to have basic graphic design proficiency for effective communication.

- Non-profit instructional designers create training for employees and volunteers, educational content, and courses for the people the non-profit serves (Editorial, 2021b). The instructional designers in non-profit organizations often wear many hats. It would be important for non-profit instructional designers to be proficient in graphic design as they would often complete all graphic design responsibilities, especially in smaller non-profit organizations.

- Higher education instructional designers transform in-person courses into online courses. The instructional designer could also create new course offerings (Editorial, 2021). It would be important for higher education instructional designers to be proficient in graphic design as they would often complete all graphic design responsibilities. In some higher education organizations, graphic design teams collaborate, or part-time/freelance graphic designers are used to support instructional designers (Roque, 2020).

- Kindergarten through 12th grade (K-12) instructional designers create training for teachers and instructors and convert in-person courses to online formats for students (Editorial, 2021). It would be important for instructional designers in primary and secondary school systems to be proficient in
graphic design as they would often complete all graphic design responsibilities.

Based on the instructional design specialties, it is clear that all instructional designers should possess basic graphic design proficiency. These include basic image editing, knowing how to choose the correct images, the ability to create a detailed visual storyboard, how to properly work with colors and contrast, provide guidance to graphics designers, and knowledge of different typefaces. Running a Google search for skills instructional designers should have produces results that always list graphic design skills as essential. The eLearning Industry contributor Tiffany Oaks listed creativity as the number one skill (2017). Renowned instructional designer Devlin Peck listed visual design skills as ten out of fifteen of the most important skills an instructional designer should have (2023). Ultimately, the organization and instructional designer should create learning experiences that meet the target audience’s needs. Often, the instructional designer is a single individual doing graphic and instructional design (Malamed, 2015). This stresses the importance of instructional designers having at least a basic understanding of graphic design principles.

**Graphic Design Tips for Instructional Designers**

This section will contain graphic design tips and best practices for instructional designers. The section will also cover some essential graphic design advice. These are some excellent tips for more straightforward graphic design. Then, the section will look at planning, reducing clutter, contrast, designing with learners in mind, working beyond text, organizing the graphic space, choosing the right images, and working with colors. Now, you will not leave the section with perfect graphic design skills, but you can revisit this section before your next big design project to refresh. After a while, many of these tips and best practices will become second nature.
Plan

The very first tip, or best practice, is to plan. One mistake instructional designers make takes place when they get excited to work. They will open up the authoring tool, know what they want to accomplish, and begin to design. All instructional designers should be encouraged to slow down and create an outline, wireframe, or storyboard. Storyboards can be graphic, or they can be text-based. Some storyboards are even a mixture of both text and graphics. Generally, a storyboard describes the slide or scene, the narrative/script, and navigational or special features. The wireframe serves as the general outline of the project (Azouz, 2022). Figure 2 shows a wireframe created for a learning object based on food chains. You will see a part of a storyboard in Figure 2. This portion of a visual storyboard displays Slide 9 from the wireframe. The visual storyboard is a great way to communicate with your client or supervisor before spending resources to download the video or stock imagery.

Figure 2
Wireframe and Visual Storyboard Example
Reduce Clutter

The second tip is to reduce clutter. This will reduce the cognitive load of the learner. The learner needs to split their attention between reading and analyzing information. In most cases, less is more. When using images and text, reduce the number of long phrases or highlight important information. Be careful using images with too many colors or using too many fonts. It is best to focus on three colors and two fonts (Editorial, 2021a). By reducing clutter, the main message will be clear. The learner's eyes will be drawn to the most prominent aspect of your design. Make sure the key points jump out and highlight navigation items, buttons, or numbers.

Figure 3
Image Clutter

Note. In this example, is there too much clutter? It is not possible to see the main point of the image. If you look long enough, you might determine it has something to do with Orzo.
Contrast

Your design has to be easy to read. Knowing the contrast ratio between colors and text is essential to ensure your design is accessible to all learners. Contrast is the measure of the difference in perception between two colors. To give you an idea, white text on a white background has a ratio of 1:1. Where white text on a black background has a ratio of 21:1 (WebAIM, 2021). Good graphic and instructional design requires the designers to check the contrast ratio. Here are some basic rules when dealing with contrasts.

- Large Text: Large text over images should have a ratio of 3:1
- Incidental: Decorative images, images that are pure decoration, have no contrast requirement
- Logotypes: Logos, or parts thereof, have no contrast requirement.

Figure 4
Contrast Example

Note. In Figure 4, is the contrast between the text and the image appropriate?
The example in Figure 4 must have more contrast between the text and the image. The white text in the letter N and the background has a contrast ratio of 1.17:1. It blends in too much with the image behind it to be effective. The good news is that there are plenty of free color contrast checkers online for you to check your designs. Also, remember that not all fonts are created equal. Using an illegible font in your designs also makes it inaccessible.

However, visual contrast is essential. You can create noticeable contrasts in your designs through dissimilar characteristics, such as large and minor elements, dark and light colors, or shiny and dull textures (Malamed, 2015). Contrast can create emphasis, visual interest, meaning, comparison, importance, scale, and emotions. In Figure 5, you can see how the contrast of a photograph is used to focus on the bird. The use of contrast in the photograph has removed any background distractions.

Figure 5
Foreground and Background Contrast Example
Design with Learners in Mind

The next tip is to design with your learners in mind. You could be designing a corporate training, or you could be designing a high-school English course. This means you must identify your learners and what they need to know before creating designs. This is more than just image selection or creating a learning object. Knowing your learners before starting a project will help you create a course color palette and could include setting up a color scheme in the learning management system (LMS). Here are some things to consider: What colors will your learners like? Should the design be modern and fresh? Will the design help to achieve the desired outcome? Will the design help your learners be engaged? If you do not know your learners, you could create an irrelevant and uninteresting course (Editorial, 2021a).

Typefaces and Fonts

What is the main difference between typeface and font? You may have heard both of the terms used interchangeably. A typeface refers to a collection of characters, including letters, numbers, punctuation marks, and symbols. Common typefaces include Times New Roman, Helvetica, Cambria, and Arial. A font is a single size or complete character set of a single style. So essentially, a typeface is a family of fonts (Malamed, 2015).

The first thing to realize about typefaces is that type has personality. The typeface should work by reflecting and complimenting the content. For example, if you were designing a training for workplace safety, you would not choose a typeface that looks like it could be used on a children's birthday invitation, as demonstrated in Figure 6. The learners know when the typeface matches and mismatches (Brumberger, 2003). Robert Bringhurst even said, "Typography exists to honor content" (Bringhurst, 2019).
Figure 6
Inappropriate Font Usage

Note. Notice the inconsistency between the font selection and the subject matter?
You explored the differences between serif and sans-serif fonts in the first chapter. You also studied the font's x-height, ascenders, descenders, counter, and kerning. As a recap, you can review Figure 7.

**Figure 7**
*Font Design Example*

Times New Roman  |  Helvetica
---|---
Caps-height  |  Caps-height
Counter  |  Counter
x-height  |  x-height

Note. Several aspects of font design can be seen when comparing Times New Roman and Helvetica, this figure was made with PowerPoint and a 191-point size for both fonts (Ramlatchan, 2023).

You must understand that, as a general rule, serif typefaces are easier to read in print. Sans serif typefaces do not have serifs and are considered easier to read on monitors because of their clean and uniform lines. There are also script typefaces that have strokes similar
to handwriting. These can be either cursive or print. Since script typefaces are difficult to read, they should be avoided for learning and information materials. Decorative typefaces are often used in larger font sizes for headlines or titles. Like script typefaces, decorative typefaces are not meant for learning or information materials. Instead, they are intended to express a feeling that reinforces the content (Cullen, 2012).

How should you select a typeface? There are several things to consider when selecting the typeface for your next project. You should consider this list of questions:

- Does the typeface reinforce your content?
- Is the typeface appropriate?
- How is the typeface being used? Is it for a large title or headline? Is it meant for learning material? Is it being used online or in print?
- Will the typeface be legible on small screens and mobile devices?
- Does the typeface have a variety of styles and contain all the characters that you need for your project?
- How does the typeface look after an authoring tool like Articulate Storyline compresses it?
- Does a font for a typeface change or connect (i.e., connecting or combining of letters or removal of the dot in letters i or j)?

Lastly, when overlaying text on a photo, ensure you do not place the text on a busy image area. Instead, use a solid area of color or a slightly transparent text box. See Figure 8 for an example of how to use a thin rectangle to serve as a text container.
Becoming aware of graphic space is important in graphic design. As an instructional designer, this graphic space will have equal importance. Graphic design is the two-dimensional area used in visual design with properties such as orientation, frame, border, and margin. These properties should sound familiar, so they will not be defined further. Other terms you may be familiar with are foreground and background. The foreground is positive, and the background is negative, commonly called white space. Effective designs are related to white space and non-whitespace (Davis, 2015).
Let's look at an example showing the isolation or loneliness of a teenager. To illustrate this teenage isolation, you could find a stock image of a teenager alone in their bedroom or a classroom. You could also separate the teenager from a background and place the teenager in a dark negative space. Figure 9 was created in Adobe Photoshop using the *Remove Background* or *Select Subject* features in the *Properties* menu. Either feature could be used based on the designer’s preference. Similar features that remove backgrounds and isolate subjects are options in most image editing software. Placing the teenager in this white space, or the area of the image that now lacks content, would amplify the feeling of being alone or isolated. Figure 9 shows an unaltered image (left) and an image with the teenager isolated (right), where the ‘white’ space is black.

**Figure 9**
*Use of White Space to Show Isolation*

For this chapter, all the graphic design techniques for active white space cannot be defined. However, there are a few essential tips to remember as an instructional designer looking to gain a basic knowledge of graphic design.

First, use a grid. Grids can help you achieve a layout that uses white space effectively. A grid was used in the development of Figure 8. Using the grid, compare the portion of white space and non-whitespace (Davis, 2015). You can find balance in symmetry and asymmetry (Malamed, 2015). To apply this rule, you will need to
research more information about the Rule of Thirds. You can view a before and after applying the Rule of Thirds in Figure 10. This rule prevents photographers and designers from ever centering anything and makes for more dynamic designs by holding the viewers' attention for longer.

**Figure 10**  
*Rule of Thirds*

Next, create a visual hierarchy. A visual order provides a focal point and presents a clear message. An effective visual hierarchy shows the learner where to look first, second, third, etc. Of course, an ineffective visual hierarchy makes it difficult for viewers to know where to look first, second, third, etc. Figure 10 shows an appropriate visual hierarchy. You should be first drawn to the large image of the group of people working together, then the large header, and then the descriptive sentence.
Finally, revert back to one of the very first tips, reduce clutter. Do not try to fill every space in the visual. In the same sense, do not allow for too much white space. Find the balance. Remember, not all elements are needed, and some take away from the message.

**Choosing the Right Images**

One dilemma that instructional designers face is choosing the right images. There are so many choices when it comes to images. Designers can choose from photographs, illustrations, 3-D graphics, silhouettes, icons, symbols, and information graphics. But, with all of these choices, what type is most effective for learning? The answer is a complex one. No one graphic is best for all learning tasks (Malamed, 2015). Instead, ask yourself several questions. What is the purpose of the graphic? Will the graphic add meaning or support the learning? Is the graphic cohesive and consistent with the rest of the
design? Does the graphic keep with the tone of the project? Generally, use images that complement the learning process and support the learning goal, see Table 2.

Table 2
Graphic Types for Various Goals

<table>
<thead>
<tr>
<th>Instructional Purpose</th>
<th>Graphic Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depiction of Concrete Objects</td>
<td>Photograph, 3-D Graphic, Illustration</td>
</tr>
<tr>
<td>Tell a Story/Provide a Scenario</td>
<td>Sequential Photographs, Sequential Illustrations</td>
</tr>
<tr>
<td>Procedure/Process</td>
<td>Sequential Photographs, Sequential Illustrations, Screenshots, Icons/Illustrations (showing each part of the process)</td>
</tr>
<tr>
<td>Parts of a System</td>
<td>Labeled Diagram, Photograph, Illustration</td>
</tr>
<tr>
<td>Motion Without Animation</td>
<td>Object/Illustration/Photograph (moving along a motion path)</td>
</tr>
<tr>
<td>Showing a Comparison or Trends</td>
<td>Various Graphs/Tables, Scatterplots</td>
</tr>
</tbody>
</table>

If you spend enough time working with images and graphics, you will eventually begin to create your own. You will do this by editing stock images and creating graphics and illustrations. You may also manipulate vector illustrations. When this time comes, remember that the image must complement the learning goal and fit the style of
the course or project. Whether using photographs or illustrations, consistency matters when creating a cohesive look for your project.

**Colors**

Working with colors is perhaps the most important thing instructional designers can learn from graphic designers. When working on projects, instructional or graphic designers must select a color palette. This should be done with the utmost care. A color palette is a combination of colors used in a design project. There are many approaches to selecting a color palette and many computer-based generators to help in this process. This section will examine the importance of selecting a color palette and some essential tips on working with color.

First, why is working with color so important? The colors selected in instructional message design impact the learner (Shaltout, 2016). With colors, an instructional or graphic designer can draw attention, increase engagement, and increase learning. This is done by reducing extraneous cognitive load. Color is considered a starting point for the instructional designer in crafting an instructional message, which acts as a stimulus and motivating factor for the learner to achieve the necessary level of understanding (Alyahya & Nasser, 2019). Figure 11 demonstrates the use of color to reduce extraneous cognitive load and to draw attention to the four main points of information.
Furthermore, studies have demonstrated that colors affect the level of attention while also increasing the excitement level of the learner (Khamess, 2013). Finally, color alone does not guarantee that visuals will be compelling or accessible by all, but learners do tend to prefer color graphics over black and white. Also, colored visuals will sustain attention longer than black and white (Pett & Wilson, 1996).

You just explored the importance of color, but how can you use color in your next project? Remember, using color alone is not accessible to all learners. However, based on research, it is still important to include color. Let's look at some tips for using color.

- **Consistency.** Keep the use of colors consistent. This can help with the functionality of your design. The learner will know what to expect if certain buttons are always the same color.
- **Visual Hierarchy.** Color can help create a visual hierarchy. Bright-colored elements are noticed first and should be used to draw the learner's attention.
• Number. Learners can only perceive a limited number of colors at one time. When coding information, try not to use over seven colors (Healey, 1996).
• Separation. Color can be used to separate areas of content or isolate navigational features.
• Critical Information. Avoid using color as the only way to convey critical information. Certain color combinations are not accessible to all learners and are listed below:
  - Red-Green
  - Red-Black
  - Yellow-Blue
  - Blue-Orange
  - Green-Magenta
  - Blue-Magenta
  - Yellow-Cyan
  - Orange-Yellow
  - Blue-Green
  - Purple-Yellow

**Fueling Graphic Creativity**

Graphic designers and instructional designers are creative. But it is a different kind of creativity. Instructional designers create effective learning, while graphic designers create effective visual designs. Instructional designers need to spend time daily looking for inspiration. This section will explore ways to fuel your expressive creativity.

If you have not already, you will want to start by analyzing other designs. If you are working with online learning, samples, templates, and infographics are easily found through simple web searches. Spend time each week looking at different designs. Write down what you like about the design and what you dislike. Look at how the designer created the layout. Think about the elements that attracted you to the design. Investigate the use of color and the color palette. How did the colors impact you? Experienced instructional designers begin this analysis when they see an intriguing design.

As you analyze various designs, start to make a collection. This could serve as a graphic design toolbox. Collect the designs you find
appealing. Then, use the design in your next project if it suits the content and learning experience best. Again, inspiration is everywhere. You could find inspiration online from blogs, museums, advertisements, movies, or television. Just remember to take a mental note or use your phone to take a picture. If it is online, grab a screenshot. Then, save these ideas in your design toolbox. Also, stay up-to-date with the latest graphic design trends.

To be graphically creative, you must get familiar with the technical terms and practice using the image editing software. This will take time and patience. How do you describe the dimensions of an image? Do you know the difference between a .png, .jpeg, .gif, .bmp, .psd? Do you know the advantages and disadvantages of using vector illustrators? If you cannot answer these questions, then take some time to research the technical terms a graphic designer already possesses. Then, practice! Open up that image editing software and get familiar with its use. Adobe Photoshop and Illustrator can be overwhelming at first, but as you work with the software, it will become more and more familiar. There are also more simplistic image editing software available for the novice user. If you are overwhelmed by image editing software, using templates is an excellent place to start your graphic design journey. There are plenty of pre-built design templates available for you to manipulate. These can be found for free online, in a paid digital repository, or from a paid source.

Finally, fuel your graphic creativity but know your project limitations. There could be a time when your project does not require advanced graphic work and aesthetics. Before starting your next design, make sure you know the limitations of the project. Also, know your visual design limits. As an instructional designer, some projects will be beyond your graphic expertise. With these projects, it could be best to consult a graphics expert.
Conclusions

This chapter sought to answer the question, what can instructional designers learn from graphic designers? Before the questions could be answered, the roles of both the instructional designer and graphic designer were defined. Instructional designers determine the needs of a solution, assess and analyze the needs of the learner, and develop a solution to meet those needs. A graphic designer guides the learner through the material without distraction. They aim to help learners interpret and understand a new concept visually. Graphic designers who assume the role of instructional designers possess a solid background in color theory, composition, and visual design. Research shows that learners are motivated when the learning experience is aesthetically pleasing (Malamed, 2015). Therefore, instructional designers with basic graphic design knowledge will create more compelling experiences. This basic knowledge includes image editing, choosing the right images, creating visual storyboards, working with colors and contrast, and knowing typefaces.

Since it is beneficial for instructional designers to possess basic graphic design knowledge, the remainder of the chapter served as graphic design tips for instructional designers. The tips included planning, reducing clutter, contrast, designing with learners in mind, working beyond text, organizing the graphic space, choosing the right images, and working with colors. The chapter concluded with some advice to fuel visual creativity.

Reading this chapter did not make you an expert graphic designer. However, this chapter presented some design tips you can revisit before your next big project. Remember to find inspiration everywhere and practice using image editing software. The next chapter will highlight the possibilities and capabilities of three-dimensional instructional message design. Some of the principles suggested in this chapter will apply to three-dimensional graphics.
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Chapter 8: Add Depth to Your Message - The Use of 3D Printing in Instructional Message Design

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Citation:
8. Add Depth to Your Message - The Use of 3D Printing in Instructional Message Design

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Key Points:

- Instructional message design can use 3D printing as a path for learners to construct knowledge.
- 3D printing can increase student engagement and facilitate skill development.
- 3D printing is support by Constructionism, the theory that learning is most effective when students are engaged in making tangible, real-world objects.
- There are four levels of 3D printer integration: recreation, content knowledge support, problem-based learning products, and student choice design products.

Abstract

3D printing is an emerging technology used for the creation of physical objects. While it does not seem like a tool for instructional message design, 3D printing facilitates the development of many skills, such as creativity, critical thinking, and problem solving, as well as the development of content knowledge. It allows students to design and create real objects, or for teachers to show recreations of items from history. Tools, such as math manipulatives, can be designed and printed to help students learn abstract concepts. This chapter aims to provide a conceptual framework for 3D printing.
integration into instructional message design, with considerations to educational setting. The chapter wraps up with a guide for getting started with 3D printing and resources for tutorials, file repositories, and lesson plans.

**Introduction**

For many people, 3D printing may still seem like a concept from science fiction. To go to a computer and request a machine to create something from a digital file definitely reminds me of Star Trek’s Captain Jean Luc Picard saying “tea, Earl Grey, hot” to a food replicator from the classic science fiction television show. But 3D printing technology is not new; the first commercial 3D printers were developed in the 1980s and were used in medical, dental, aerospace, and agricultural industries (Shahrubudin et al., 2019). The cost of a single 3D printer in the 1980s and 90s was close to $300,000 and still upwards of $50,000 in 2010 (Miller, 2016). However, in 2009 the patent for the fused deposition modeling process for 3D printing expired, which has allowed prices to plunge to $5,000, with many models well under $1,000 (Chun, 2021; Miller, 2016; Torrey et al., 2021). This has allowed for 3D printing to be used in more industries and has become commonly used in universities. The drop in cost of 3D printers has allowed for a significant adoption by hobbyists and small businesses. The innovative nature of 3D printing has also caught the attention of K-12 primary and secondary school administrators (Pearson & Dubé, 2022).

You may be asking yourself, what does this have to do with instructional message design? From chapter one, we know that instructional message design involves real-world application of instructional and learning theories to transfer knowledge to learners. However, as instruction has shifted from a behaviorism to a constructivist view, learners are not seen as empty vessels to fill. Knowledge is constructed by learners and the cognitive tools to do so become more important to instructional message design (Bishop, 2013), which is an ideal application of 3D printing in instruction. The use of 3D printing allows learners to construct their own knowledge through the development of physical objects.
Figure 1.  
*Example of 3D printed objects*

Note. The cost and complexity have dropped to the point where adoption by instructional designers is easier than ever, the results can be 3D message designs that are tactical, can be physically lifted, rotated, and have weight.

**What Exactly is 3D Printing?**

A traditional ink based printer only prints in two dimensions, a length and width. However, Three Dimensional (3D) printing prints in three dimensions, adding depth to an object. 3D printing is often referred to by a wide range of terms including rapid prototyping and additive manufacturing. There are seven main types of 3D printing: binder jetting, directed energy deposition, material extrusion, material jetting, powder bed fusion, sheet lamination, and vat photopolymerization. Each type has its own targeted application.
### Table 1
Comparison of the seven types of 3D printing processes

<table>
<thead>
<tr>
<th>Method</th>
<th>Process</th>
<th>Materials</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder jetting</td>
<td>Liquid binding agent selectively deposited to join powder particles</td>
<td>● Metals&lt;br&gt;● Sands&lt;br&gt;● Polymers&lt;br&gt;● Hybrid&lt;br&gt;● Ceramics</td>
<td>● Large-volume products&lt;br&gt;● Simple, fast, and cheap</td>
</tr>
<tr>
<td>Directed energy deposition</td>
<td>Focused energy source melts material deposited by a nozzle</td>
<td>● Ceramics&lt;br&gt;● Polymers&lt;br&gt;● Metals</td>
<td>● Repair or add additional material&lt;br&gt;● High degree of control and quality</td>
</tr>
<tr>
<td>Material extrusion</td>
<td>Filament heated and deposited along the extrusion path</td>
<td>● Thermoplastic polymers</td>
<td>● Multi-material and multi-color&lt;br&gt;● Low cost</td>
</tr>
<tr>
<td>Material jetting</td>
<td>Build material selectively deposited drop-by-drop solidified by ultraviolet light</td>
<td>● Polymers&lt;br&gt;● Ceramics&lt;br&gt;● Composite&lt;br&gt;● Biologicals</td>
<td>● Very smooth surface finish&lt;br&gt;● Multi-material printing</td>
</tr>
<tr>
<td>Powder bed fusion</td>
<td>Electron beam or laser fuses material powder together</td>
<td>● Metals&lt;br&gt;● Ceramics&lt;br&gt;● Polymers&lt;br&gt;● Composites</td>
<td>● Fast and high accuracy</td>
</tr>
<tr>
<td>Sheet lamination</td>
<td>Sheets of material bonded together</td>
<td>● Paper&lt;br&gt;● Polymer&lt;br&gt;● Ceramic&lt;br&gt;● Metal</td>
<td>● Full-color prints&lt;br&gt;● Inexpensive&lt;br&gt;● Easy material handling</td>
</tr>
</tbody>
</table>
Material extrusion, also referred to as fused deposition modeling, is what is most often found in educational settings. These types of 3D printers work much like a hot glue gun. A thermoplastic filament is heated until it is malleable and extruded through a nozzle and deposited layer by layer to create the object (Shahrubudin et al., 2019).

**Figure 2.**
*The layering of the extrusion process*

*Note.* Layers of molten material are placed on top of the solidified layer below it.
How is it Different from 3D Modeling?

3D modeling is the precursor for 3D printing. Even if using a model from an online database, someone developed the model on a computer using software or a 3D scanner. The software used to create a model can range from simple programs suited for elementary students to those with very advanced features used by experts in industry (Chun, 2021). 3D printing on the other hand takes the information from a computer-aided design (CAD) drawing and prints it layer by layer to create the physical object (Shahrubudin et al., 2019). Some popular software applications for 3D modeling include Rhino, SketchUP, Autodesk Tinkercad, Autodesk 123D, OnShape, Autodesk Inventor, SolidWorks, and many more (Chun, 2021). Modeling software knowledge is required for students to develop their own 3D printed objects and allows students to develop their creativity and spatial abilities (Chun, 2021; Pearson & Dubé, 2022). The major advantage of 3D printing, in addition to 3D computer modeling, is that it brings students’ designs into reality, making their experience more meaningful. Without 3D printing, students may not be as motivated by engaging only in digital fabrication and virtual modeling, where they never actually experience their creations (Ng, 2017).
**Figure 3.**
*Example of 3D modeling environments*

*Note.* The learning curve with many available 3D modeling applications are simplified to the point of making 3D prints easier than ever before.

**Related Technologies**

There are many emerging technologies similar to 3D printing, such as virtual reality, augmented reality, and 3D visualization. A popular example of augmented reality is PokemonGo, but it is used in other applications. Augmented reality is a tool that overlays computer-generated graphics over a real-world environment, merging the physical and digital environment. It has been shown to support learner motivation and engagement and build spatial ability and practical skills. It also supports location-based exploration of content and social and collaborative learning. Virtual reality, on the other hand, allows a user to fully interact and manipulate a virtual environment. These environments can be immersive or non-immersive and provide experiential and multisensory experiences.
to practice skills in a low-stakes setting. Similar to augmented reality, virtual reality can increase learner motivation and engagement with self-directed learning (Torrey et al., 2021).

Especially as education shifts from a traditional face-to-face model to more self-directed and technology-enhanced methods, these emerging technologies lend themselves to a variety of instructional design approaches (Birt & Cowling, 2017; Torrey et al., 2021). They can even be combined into mixed reality, which is a continuum between augmented reality, virtual reality, and 3D printing (see Figure 4). The lack of physical, haptic feedback with augmented and virtual reality can be supported with 3D printing to bridge the gap between the virtual and real world (Birt & Cowling, 2017). Visualization in general is a key technique for improving learning, skills, and outcomes, but none of these technologies offer a one-size-fits-all approach. None of these technologies are yet considered mainstream in teaching and learning, and as of 2019, less than 10% of all schools in the United States have adopted emerging technologies such as these.
Figure 4.
The Message Design Continuum between Digital and Physical Products

Note. 3D printing exists on a spectrum of instructional realism between virtual digital objects and various means to create physical objects.
Why Should 3D Printing Be in Instructional Message Design?

The inclusion of 3D printing in instruction provides a range of benefits to students. It facilitates the development of skills such as collaboration, communication, problem-solving, creativity, and critical thinking (Pearson & Dubé, 2022). It can increase student engagement and improve students’ attitudes toward Science, Technology, Engineering, and Math (STEM) courses and STEM careers (Ford & Minshall, 2019). The use of 3D printing challenges the typical teacher-student relationship and requires students to have more control over their own learning (Pearson & Dubé, 2022). The use of 3D printing as educational technology in instructional message design uses these instructional theories to teach applied 3D software modeling and the translation of their virtual designs into physical objects.

Outside of its benefits to instruction, 3D printing is becoming an essential technology and prepares learners for many fields. Educating students on the use and impact of 3D technology will be important for their success in future careers (Chun, 2021; Kwon et al., 2017; Menano et al., 2019; Pearson & Dubé, 2022). Referring to the definition of instructional message design from Chapter 1, message design is the real-world application of instructional and learning theories. The use of 3D printing is, in itself, a real-world application. Integrating 3D printing into instructional message design embeds its importance as an innovative technology.

Conceptual Framework

There are many learning theories that have been linked to 3D printing, such as self-directed learning, experiential learning, and constructionism. According to Pearson & Dubé (2022), 3D printing places value on the creation of an object, indicating that constructionism is well-suited to apply to 3D printing as a learning technology.
Constructionism

Constructionism connects back to John Dewey’s belief of giving learners something to do and Jean Piaget’s constructivism (“Constructivist Theory,” 2015; Gerstein, 2019). Constructivism is the theory that knowledge is constructed by the learner, based on previous experiences. It maintains that the learner has an active role in the learning process. Seymour Papert expanded on Piaget’s theory, developing the idea of constructionism. Constructionism purports that learning is more effective when a learner is actively involved in making physical objects (“Constructivist Theory,” 2015). When using 3D printing in instruction, the 3D printer itself does not construct learning, but acts as a medium for understanding the process of building (Pearson & Dubé, 2022). Designing 3D models is an active process of making and constructing knowledge and enables learners to have a more authentic exploration of objects and concepts (Trust & Maloy, 2017). Constructionism may be referred to as hands-on learning, learning by doing, experiential learning, hands-on/minds-on, or active participation. The fundamental principle is that learning is most effective when students are actively engaged in making tangible, real-world objects (Gerstein, 2019)

Framework of 3D Printing Implementation

Current research on the use of 3D printing in education has looked at the main ways 3D printing is used in education. Table 2 summarizes the implementation methods in three different studies.

Table 2
Comparison of educational uses of 3D printing

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>● Teach students about 3D printing</td>
<td>● Simulation-based learning</td>
<td>● Explanatory ● Replica</td>
</tr>
</tbody>
</table>
• Teach educators about 3D printing
• Support technology
• Produce artifacts to aid learning
• Develop assistive technologies
• Support out-reach activities

• Learning aids to support lecture
• Problem-based learning
• Case-based learning
• Project-based learning

• Prototyping or art-making
• Other teaching tools for engaging students

The most common way 3D printing is used is to support the development of content knowledge through the use of problem-based learning. Educators often are uncertain on how to implement 3D printing as well as how to evaluate student products. Significant time may be needed to teach the fundamentals of 3D modeling and printing for both the teacher and students (Pearson & Dubé, 2021), leaving little time for students to have the freedom to identify their own problem and develop a solution.

Table 3
Levels of 3D printer integration

<table>
<thead>
<tr>
<th>Type of Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreation</td>
<td>The purpose of 3D printing is to teach students about 3D modeling and printing and is used as a replica model, either of basic shapes or of a real object.</td>
</tr>
<tr>
<td>Content knowledge support</td>
<td>The purpose of 3D printing is to support the development of the content knowledge presented, such as a model used to help students make sense of an abstract concept or idea.</td>
</tr>
</tbody>
</table>
Using 3D printing for instructional message design allows for low floors, high ceilings, and wide walls. Low floors refers to the relatively low threshold for getting started implementing 3D printing into message design. High ceilings allow for learners to work on increasingly complex projects as they gain experience. Lastly, wide walls allow for learners to take multiple pathways to solve a problem with 3D printing (Gerstein, 2019; Wendt et al., 2020). This description can be seen with our four levels of 3D printing integration into instructional message design. With recreation, 3D printing may be used only to provide a tangible object or students may design their own replicas of existing objects. The focus is on the final product, not necessarily the creation of the product. Content knowledge support also focuses on the final product with the goal of helping make sense of an abstract concept or idea. It helps to provide context to academic learning (Gerstein, 2019). Problem-based learning and student choice design products switch the focus from just the end product to include the process as part of the message design. These types of 3D printing uses for instructional message design allow learners to have choice and feel like their voice matters (Gerstein, 2019). Specific examples of recreation, content knowledge support, problem-based learning product, and student choice design product can be found in Table 4.

<table>
<thead>
<tr>
<th>Type of Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem-based learning product</td>
<td>The purpose of 3D printing is to engage in the problem-solving process, often with real-world tasks. This model is created under the guidance and specifications of a facilitator, such as a teacher selecting the problem.</td>
</tr>
<tr>
<td>Student choice design product</td>
<td>The purpose of 3D printing is to allow students to have full control over the design process from the selection of the problem to the production of the final tangible design.</td>
</tr>
</tbody>
</table>

3D Instructional Message Design

Using 3D printing for instructional message design allows for low floors, high ceilings, and wide walls. Low floors refers to the relatively low threshold for getting started implementing 3D printing into message design. High ceilings allow for learners to work on increasingly complex projects as they gain experience. Lastly, wide walls allow for learners to take multiple pathways to solve a problem with 3D printing (Gerstein, 2019; Wendt et al., 2020). This description can be seen with our four levels of 3D printing integration into instructional message design. With recreation, 3D printing may be used only to provide a tangible object or students may design their own replicas of existing objects. The focus is on the final product, not necessarily the creation of the product. Content knowledge support also focuses on the final product with the goal of helping make sense of an abstract concept or idea. It helps to provide context to academic learning (Gerstein, 2019). Problem-based learning and student choice design products switch the focus from just the end product to include the process as part of the message design. These types of 3D printing uses for instructional message design allow learners to have choice and feel like their voice matters (Gerstein, 2019). Specific examples of recreation, content knowledge support, problem-based learning product, and student choice design product can be found in Table 4.
All levels of 3D printer integration can offer the low floor, high ceiling, and wide walls. Beginning activities will benefit from scaffolding through direct pedagogical instruction. As students build their skills, they can be allowed to venture into more self-determined directions. However, even when allowing for student choice design projects, scaffolding can be provided, such as a menu of available activities or projects that students could pursue (Gerstein, 2019).

Instructional message design highly depends on your audience. With 3D printing there are many specific considerations relative to the age and setting of integration. This section looks at primary education, secondary education, post-secondary education, libraries, and makerspaces

3D Printer Operation Guidelines

The biggest disadvantage of integrating 3D printing into your instructional message design is knowing where to start with a 3D printer and how to use it. Educators often feel unprepared to use new technology in their classroom and may even avoid technology they think is difficult to learn (Sullivan, 2020). This section serves to offer brief guidelines for 3D printing start up requirements, getting ready to print, printing, and post processing.

Start Up Requirements

3D printing does have a high start up requirement compared to other instructional message design tools. You not only need different types of software, but hardware and materials.

Hardware

The biggest, and probably most expensive piece of hardware you will need is the 3D printer itself. There are many factors to consider when selecting your printer; budget, how many you want to buy, the type of materials you want to use, ease of use, and safety considerations. The most common types of 3D printers found in
classrooms are fused deposition modeling (FxDM), a type of material extrusion, and sterolithography (SLA), a type of vat polymerization (The 10 Best 3D Printers for Schools in 2023, 2023). Some recommended brands of FDM printers are UltiMaker MakerBot, Bambu Lab, Flashforge, Creality, and Prusa. Brands for SLA printers include Elegoo, Creality, and Formlabs.

Software

You will need two pieces of software for effectively using your new 3D printer. The first is 3D modeling software. For 3D printing, 3D modeling software must use solid modeling that generates models that are considered to be water tight with walls of a measurable thickness. Some software uses polygon modeling, which creates walls with zero thickness. This type of software requires much more experience and more steps so it is not recommended to start with. There are many professional grade products, such as Autodesk Fusion 360, Inventor, and SolidWorks that are often found in an educational environment. However, there are many free and online based softwares, such as Tinkercad and OnShape (Software for 3D Printing - 3D Modeling Software/Slicers/3D Printer Hosts, n.d.).

The next type of software is what is called a slicing software. This software takes the CAD model and slices it into layers, converting the model into G-code. This software also allows you to customize 3D printer settings, like print temperature and speed and layer height. Many printers come with proprietary software that does the slicing. This software is often less flexible, but can be easier to use. Other slicing software includes REALvisorPro, Ultimaker Cura, and Simplify3D (Software for 3D Printing - 3D Modeling Software/Slicers/3D Printer Hosts, n.d.).

Materials

The type of materials available to use will depend on the type of printer. FDM printers use a polymer filament that is heated and extruded. The most common material is polylactic acid (PLA). PLA is an ideal starter material and works with almost any type of FDM printer. You will find varieties of PLA, such as PLA+, which is marketed as being stronger, along with Silk PLA, which gives a
“silky” or shiny appearance. PLA can also come as a coextrusion, with two or more colors in one filament. Other materials are acrylonitrile butadiene styrene (ABS), polyethylene terephthalate (PET), and thermoplastic polyurethane (TPU). ABS is not recommended for most educational settings as requires the use of a heated build plate and a fume hood. SLA printers on the other hand use a liquid photopolymer called resin. Resin may be ABS, PLA, PET, nylon, or polycarbonate. SLA printers require more postprocessing and require the use of personal protective gear, such as gloves and protective eyewear.

Conclusion

This chapter aimed to give a brief overview of 3D printing and its application to instructional designers. Instructional message design is the use of tools and techniques to convey and communicate with our learners and 3D printing provides a unique opportunity to bring virtual designs into the physical world for students to touch, lift, spin, and engage with. It is a rapidly growing and evolving technology and this chapter has only touched the surface of its applications. It can seem like an overwhelming task to implement, but hopefully this chapter has provided you with a framework for integration and additional resources to help you get started. 3D printing can change the typical teacher-student relationship, allowing learners to have more control over their learning and construct their own knowledge.
3D Printing Resources

The Maker movement has been a large driving force in the development of 3D printing resources. A fundamental principle of the maker movement is crowdsourcing and participatory culture (Gerstein, 2019). There are many communities and repositories on the internet where people share models and knowledge. Many companies have free educational resources for educators and instructional designers to implement 3D printing into their curriculum. In Table 5 you will find links to tutorials, 3D printing file repositories, and lesson plans.

Table 5
Compiled list of tutorials, file repositories, and lesson plans for 3D printing integration

<table>
<thead>
<tr>
<th>Tutorials</th>
<th>File Repositories</th>
<th>Lesson Plans</th>
</tr>
</thead>
</table>
| ● All3DP  
● SparkFun 
● Clever Creations 
● 3DPrinting.com 
● UltiMaker Community of 3D Printing Experts 
● Ultimaker 3D Printing Academy 
● PrintLab | ● Thingiverse 
● PinShape 
● Cults 3D 
● Printables 
● Smithsonian 3D Digitization 
● CREATE Education Classroom Prints | ● Thingiverse Education 
● Kathy Schrock - 3D Printing in the Classroom 
● Dremel Lesson Plans |
References


Chapter 9: Web Conferencing Best Practices for Online K-12 Teachers

Mitch A. Cumings
Old Dominion University

Acknowledgements:
I could not possibly invest the time and energy toward the work of instructional design and technology without the tremendous support of my family and colleagues. Foremost, thank you to my wife, who is acutely aware of the sacrifices of these two most valuable commodities. Thank you to my children, who are gratefully still too young to understand why dad looks so tired so often. Finally, thank you to my ODU instructors and colleagues, whose constant feedback and support have become the foundations of learning that have fueled the greatest period of personal and intellectual growth of my life.

Citation:

Mitch Cumings

Key Points:

- Use of web conferencing for instructional purposes were widely in place for postsecondary and professional organizations; K-12 schools were forced to embrace them during the COVID pandemic.

- Available data indicates that reliance upon web conferencing as an essential tool in the professional world will continue to increase.

- Best practices principally apply across all instructional settings, with specific modifications.

- Web conferencing, integrated with other valuable technologies, can create a connected and engaging learning experience without the logistical restrictions of time and location. Instructional design is determining the need for an instructional solution, analyzing needs, defining learning objectives, and developing a solution to meet those objectives.
Abstract

Web conferencing - the ability to hold live meetings from a distance through an online platform - has become an integral instructional tool to make learning more accessible and flexible. Although these technologies have been accessible for decades and utilized in both professional and institutional settings with degrees of regularity, they only arrived at a large scale onto the K-12 primary and secondary education scene out of necessity as prompted by the COVID pandemic. K-12 education systems had a crash course in web conferencing through the pandemic, and its value as a meaningful instructional tool persists.
Within the framework of this book, web conferencing aligns with the key elements of instructional message design:

<table>
<thead>
<tr>
<th><strong>Key Points of Instructional Message Design</strong></th>
<th><strong>Connection to Web Conferencing</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional design is determining the need for an instructional solution, analyzing needs, defining learning objectives, and developing a solution to meet those objectives.</td>
<td>Before moving forward with the implementation of a web conferencing tool, it should be determined the NEED for the tool. What is the gap the web conferencing tool will bridge from teachers to learners?</td>
</tr>
<tr>
<td>Instructional message design is the application of theory and techniques to communicate with learners as part of that solution.</td>
<td>Web conferencing is a technology/tool that bridges the gap that can exist when access to a traditional instructional setting is disrupted for any reason. While instructional theories remain true in both a traditional and web-based setting, the techniques can be drastically different across those settings.</td>
</tr>
<tr>
<td>Message design through visual communications can include static art (illustrations, diagrams, photographs) or dynamic art (animation, video, virtual reality, and simulations) with or without accompanying audio.</td>
<td>A reliance on visual aids and a deeper understanding of multimedia design may become significantly more important in a web conferencing setting, although greater mastery of tools will allow teachers to replicate in-person strategies similarly in an online setting (i.e., small group and collaborative work).</td>
</tr>
</tbody>
</table>
Introduction

K-12 primary and secondary education systems experienced their most rapid phases of development during the years of the COVID pandemic. Schools were forced to deploy drastically different instructional practices than they had used before. Educators relied on web conferencing tools to replace traditional, in-person communication with their students. Many educators were inexperienced or wholly unaware of such tools and, let alone prepared to adopt such tools as their primary mode of communication with students. The remote classroom model was designed in a rapid prototype fashion and deployed hastily as a matter of need. It would be unfair to measure the success of that tool under those circumstances, however, one indicator of success is the seeming staying power of web conferencing tools as a continued means of providing instruction for students, teachers, and families.

What this Chapter IS

*Informative:* This chapter will provide a comprehensive understanding of the applications of web conferencing as a general tool for educators in a K-12 setting. It will guide the reader through the key factors related to the tool and its application in all instructional facets of the K-12 system.

*Insightful:* This chapter will explore documented best practices surrounding web conferencing and also discuss the greater potential for the use and expansion of web conferencing to meet a variety of instructional needs that extend beyond the traditional classroom setting. Teachers seeking to effectively utilize web conferencing tools to improve student learning will find value within. Also, school leaders and even business leaders will find applications for these tools to support communication with various stakeholders and incorporate proven instructional strategies into systems that govern their organizations and drive improvement within them.
What this Chapter is NOT

*Tool-specific:* This chapter will not serve as a tool-specific “how-to” training model for a specific web conferencing tool. A number of those resources exist already in print and digital formats. This chapter is a methodological approach to web conferencing, including general strategies and best practices for teachers navigating the online classroom environment. If you have arrived at this chapter, I hope you will be encouraged to explore other available resources once you have achieved a more general understanding of web conferencing tools.

*Marketing-driven:* This chapter will not promote the use of a specific tool nor provide the impression that one tool is better than another. Readers should explore the unique characteristics of their organizations, assess the gaps within their system, and deploy the most appropriate web conferencing tool that meets the needs of their target audience.

*Exhaustive:* Information, applications, and training opportunities exist well beyond the content of this chapter. This chapter will provide a general overview, but readers should pursue deeper mastery of specific skills beyond the content herein. Consider this chapter a launch point for you and your team. Hopefully, one that will provide a viable vessel to help carry you beyond the horizon in your implementation of web conferencing to improve learning within your classroom or organization.

Know Yourself. What can this chapter do for you?

Undoubtedly, each reader has arrived at this chapter with varying degrees of knowledge, skills, and experiences related to this topic. Perhaps you are new to the field, and your only experience with web conferencing is from a student perspective. Perhaps you survived pandemic teaching, and now you are tasked with continued support for online learners. Perhaps you are transitioning to an online teaching position and exchanging a physical classroom environment for an online one. Or, perhaps you are a school leader tasked with developing a system for delivering online instruction to students. Regardless of your circumstances, there is likely something in this
chapter for you. The chart below may help provide a more focused experience for each person seeking to advance their use of web conferencing to impact learning, see Table 1.

Exploring: This category includes all readers who have not had an opportunity to rely on web conferencing as a primary mode of communication with learners. You may have an account, you have likely accessed or participated in web conferencing, but you have not solely or comfortably relied on web conferencing as a planned, primary mode of delivering instruction to learners.

Experienced: This category includes readers who have utilized web conferencing as the primary platform for delivering instruction to learners. You have approached an instructional period with a planned expectation that your mode of delivery would be through a web conferencing tool.

Expert: This category includes readers who have been effectively implementing web conferencing as an instructional tool for a considerable length of time. You demonstrate general comfortability using web conferencing tools across various models, but you also are confident that you have mastered the specific elements of your primary tool of choice. You may also be operating as a teacher-leader or school administrator tasked with aligning systems or practices across a team or organization.
<table>
<thead>
<tr>
<th>Learner Factor</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring</td>
<td>Embrace the opportunity to explore this chapter fully. Most or all of the content included should prove helpful to grow your comfortability and general skill using web conferencing as an effective classroom space.</td>
</tr>
<tr>
<td>Experienced</td>
<td>Some specific elements within the earlier sections of this chapter may seem noticeable given your prior knowledge of the topic. You might find the practical content and strategy suggestions to be the most meaningful parts of this chapter. Reflect on your own personal experiences to identify other powerful points of transfer and share them with your colleagues.</td>
</tr>
<tr>
<td>Expert</td>
<td>You have logged a great deal of time and energy utilizing web conferencing to create meaningful online classroom experiences to students. Several strategies included herein will serve as reminders for you. Navigate this chapter seeking very specific ideas that you can utilize as a leader in your organization to advance the skills and understanding of your colleagues or inform decisions for organizational implementation.</td>
</tr>
</tbody>
</table>

*Note:* All information in this chapter has useful applications. Some information has more relevant application for some than for others.
Web Conferencing

The COVID pandemic signaled a monumental shift in the way teachers relied on technology to provide instruction for students. To many, web conferencing tools seemed as novel as the pandemic was to our global societal infrastructure. However, most postsecondary institutions were already widely utilizing web conferencing to improve student access to learning without the limitations of geographical location. Web conferencing has also been effectively and reliably deployed in the professional world, creating opportunities for organizations to communicate across geographical divides. Web conferencing in the K-12 setting was not widely implemented, where participation in learning in most states is mandatory until age 16, and until graduation or age 18 in others. Within these settings, student attendance is generally tied to in-person “seat time” requirements at a local school building, limiting the necessity for web conferencing tools but also the opportunity to develop successful teacher practices with these tools.

The pandemic caused a number of traumatic effects on K-12 students and K-12 school systems. However, a silver lining emerged from the need for those systems to stretch their use of instructional technologies to reach learners separated by physical distance. While the pandemic endured and disruption to normal routines continued, teachers and school systems continued to adapt ways to connect with learners; web conferencing tools emerged as a most important weapon in that battle. Globally, the number of online learners grew from 0.3 to 1.38 billion online learners in the first month of the pandemic (Adedoyin & Soykan, 2020). That is an increase of 46 times the number of online K-12 students immediately prior to the pandemic; use of web conferencing as an essential instructional technology followed that trend (World Economic Forum, 2020). Figure 1 illustrates the rapid growth of web conferencing.
Figure 1
The diffusion and adoption of web conferencing expanded rapidly out of necessity.

Note: The pandemic forced organizations to rapidly integrate web conferencing as an instructional practice out of necessity. Many organizations established them as essential tools and most continue to utilize these tools (World Economic Forum, 2020).

Forecast

Although most school systems were eager to return to pre-pandemic routines, many students and families continue to demonstrate the need for distance education for a variety of reasons. Web conferencing tools can be leveraged in ways that connect learners with teachers despite geographical separation and allow marginalized students continued access to school programs during any type of event that disrupts their ability to attend in-person. Circumstances where schools could use web conferencing also may include: medical factors such as extended illness/injury or serious procedure, homelessness or family displacement, behavioral circumstances that result in removal
from a traditional in-person setting, loss of access to a school building for any reason, physical location has been deemed unsafe for use, access to subject matter experts, and even choice to continue leveraging a homeschool or distance learning format for their children. This list is not exhaustive, but online learning in primary and secondary settings continues to be a need and desire.

Any disruption to a traditional, in-person school routine that relies on direct instruction can be replaced with synchronous instruction through a web conferencing tool. Continued growth and sustainment of web conferencing indicates the near mainstream status and ubiquitous nature of web conferencing (Li & Lalani, 2020). While a majority of students returned to traditional classroom settings, schools continue to utilize web conferencing for both short term and long term disruptions to learning. Further, 87 percent of United States businesses strongly agree that video conferencing will continue to be essential for their operations (Itelelson, 2021). Web conferencing gives students the career skills that they will eventually need to be successful.

Platforms

There is no shortage of options when it comes to available web conferencing platforms. The verb “zoom” became synonymous with any online virtual meeting platform during the pandemic. While in many cases the term was appropriately attached to the Zoom video conferencing platform. Zoom held a strong percentage of the market during the early months of the pandemic - there were many instances when a request to “zoom” was followed with an invitation to meet in a virtual setting through another platform, such as Google’s Meet or Microsoft’s Teams.

Market shares for the Zoom platform experienced a 383% increase during the pandemic; over the next two years, those shares tumbled 90% from peak levels, see Figure 2. Within that same time period, Zoom’s global market share dwindled from nearly 80% to 55% (Soni & Mehta, 2022); however, Zoom’s linguistic connection to any and all types of virtual meetings has been slower to diminish.
Transferring Traditional Classroom Practice to Online

For the sake of this chapter, and hopefully for your consideration beyond this chapter, let us consider a “classroom” to be any place where students gather to learn. This mindset allows us to move our generic identification of a classroom as a physical space and acknowledge that one type of learning space is not inherently better than another. This type of thinking allows us to value the web conferencing setting on the same plane as a traditional, physical classroom space where successful teaching practices apply, albeit with different considerations.

Attendance: Attendance is an important daily task in every classroom. Foremost in a traditional classroom, as a safety and security matter, teachers need to be aware of and document the students present in their classroom. As a practical activity, teachers need to document participating students for record-keeping and accountability purposes. Web conferencing tools allow for attendance to be collected autonomously by logging the participants who entered
a web conferencing session. Because these procedures are purely autonomous, they collect a range of information, including a roster of participants and a timestamp of their start and end times within the session. Web conferencing apps allow for organizers to select automatic session reports with that information.

## Attendance

<table>
<thead>
<tr>
<th>Traditional Strategy:</th>
<th>Online Adaptation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher manually collects daily attendance information and enters into district-supported data management system.</td>
<td>Utilize auto-generated web conferencing meeting reports, which collects information for all users who participate in the meeting, including log in and log out timestamps.</td>
</tr>
</tbody>
</table>

*Posted Information:* In all physical classrooms, to varying degrees, teachers post important academic reference information. For example, an ELA classroom may post important grammar reminders that are universally accessible to students. A science classroom may post a reference highlighting the steps of the scientific method. Math teachers often post relevant equations and math rules. Social studies teachers incorporate timelines of important events.

A best practice that has become synonymous with sound classroom environments is *posted learning objectives* (Center for Educational Leadership, 2012). This is achieved in different ways per grade level. Early elementary students are learning to read, and posted learning objectives incorporate less complex text and, in many cases, representative graphics.
## Posted Information: Learning Objectives

<table>
<thead>
<tr>
<th>Traditional Strategy:</th>
<th>Online Adaptation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers display learning objectives in accessible locations for all learners to see and reference during lessons.</td>
<td>Create a custom background for your teacher profile that displays the learning objectives for the lesson in the upper corner. This allows your learners to see the learning objectives any time they view the teacher presentation screen and create scenarios for easy reference during instruction.</td>
</tr>
<tr>
<td></td>
<td>Join the web conference with a secondary account. Type or display the learning objectives, or other important information, and display it as the profile image. Participants in the event will be able to see this image similarly to the profile images as other participants</td>
</tr>
</tbody>
</table>

Instructional units are generally scaffolded in nature, with progressive knowledge or skills being built upon prior knowledge and skills. Within the structure of a unit a compilation of **relevant academic resources** emerges. While some content within a lesson is expected to be committed to long-term memory storage, resourcefulness is an essential skill when students are expected to put classroom learning into real-world practice. Learners must be able to utilize resources appropriately. In a traditional classroom setting, teachers often post such resources visibly, or create resource centers for these materials. This is just as important in a web conferencing classroom.
## Posted Information: Academic Resources

<table>
<thead>
<tr>
<th>Traditional Strategy</th>
<th>Online Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical files/folders are accessible for students to manually retrieve items such as: missed homework assignments, guided notes, model work with referenced success criteria.</td>
<td>Create a living resource document and share it with all members of a classroom at the start of each lesson. Avoid using lengthy text segments in this document. Include a title, a link for any shared documents, and (when necessary) a short, descriptive blurb about the resource.</td>
</tr>
<tr>
<td>Reference materials posted on walls or throughout the room for quick reference.</td>
<td>At the start of each class session, post a link to a virtual classroom or shared resource folder using the classroom chat feature. More savvy students will be able to access the shared folder with routine ease, while less savvy students may be less reliable to locate the folder from one class session to another.</td>
</tr>
</tbody>
</table>

**Student Grouping:** Within the structure of a classroom lesson, students will work individually and collaboratively. Web conferencing apps provide comparable opportunities for students to participate in small groups. Oftentimes in a physical classroom setting, the activity and noise generated when multiple collaborative groups work in one physical space becomes distracting to participants and teachers may move groups to other spaces in a building. Whenever a group physically relocates there is a sacrifice of on-task learning time to those transitions. Instructors also sacrifice the opportunity to support those groups and monitor the activities of other small-groups.

Many web conferencing programs allow hosts to easily move throughout breakout rooms, allowing a teacher to interact with groups without disrupting other groups. These applications also allow hosts to
display visual messages to all groups simultaneously or, with some programs, broadcast verbal announcements to groups.

There are moments in a classroom when it becomes essential for a teacher to provide individualized support for students, or focused support for an identified group of students. Generalized instruction and universal support are reasonably effective for 80 percent of classroom students, while the other 20 percent of students may require additional and sometimes intense support to successfully master class content (Dundas, 2022). In a traditional classroom setting, a teacher may be located at a central place in the classroom and students may move to work with them at that location, or teachers may circulate and work individually with a student at their location. An unfortunate circumstance in some settings is that a student may become less comfortable, potentially feeling singled out, targeted, or feel devalued in the eyes of their peers as less proficient. Web conferencing allows for teachers to pull students from another small-group, or the whole-group setting and offer support in a private, personalized setting. Added features allow students to adjust their background settings to either blur their background or replace it with a digital image or background. In most cases the web conferencing app provides these options and also allows the user to create a customized background.

In a traditional space, teachers may use proximity and guided questioning to promote participation. Teacher proximity is shown to have a positive influence on student engagement and learning outcomes (Dong et al., 2021). Increasing occurrences of proximity and positivity of interactions with proximity result in stronger sense of student-teacher connection, greater engagement, and greater learning outcomes. Within a shared physical space, teachers may scan the expanse of a room and physically maneuver to target areas for support. In a digital environment, teachers must modify that same strategy and be routinely present across all breakout groups. Figure 3 provides a comparison of these two settings.
Teachers may need to ask students to turn on their cameras to allow the teacher to be able to scan the virtual body language of their students for confused or bored looks. Teachers can gently and subtly encourage students to blur or use virtual backgrounds if students feel they would be embarrassed by showing their homes or bedrooms.

**Student Grouping**

<table>
<thead>
<tr>
<th>Traditional Strategy:</th>
<th>Online Adaptation:</th>
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</thead>
<tbody>
<tr>
<td>Teacher pulls students individually away from the activity to join at a separate workspace to provide focused support.</td>
<td>Create a private breakout room to quickly pull students away from other groups to have discussions in a private setting.</td>
</tr>
<tr>
<td>Teacher meets with a student before or after class to discuss specific challenges.</td>
<td>Schedule individual sessions with students outside of classroom hours.</td>
</tr>
</tbody>
</table>
Transitions: The more activities a teacher plans within a lesson or unit, the more likely it is for learning time to erode into transition time. This loss of time may seem meaningless in a singular event, but over the duration of a course, an average of just 10 minutes of transition per lesson would equal 15 hours of time over the course of an 18-week school semester. That is valuable lost learning time.

Transitions

<table>
<thead>
<tr>
<th>Traditional Strategy:</th>
<th>Online Adaptation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher posts start and end times on a whiteboard visible to all students.</td>
<td>Develop appropriate interval warnings: Halftime, 5 minutes, 2 minutes. Reminders may be shared to breakout groups.</td>
</tr>
<tr>
<td>Project a common stopwatch/timer app on a classroom monitor for students to see.</td>
<td>In a whole group setting, screen share a common stopwatch app.</td>
</tr>
<tr>
<td>Teacher lists group roles and activity norms within an assignment or visibly posted as common norms for learning.</td>
<td>Define clear group expectations to avoid confusion among groups regarding the purpose and goals of a breakout group. Send short lists to each breakout group at the start of the activity. Included within the expectations should be a clear description of how the group will share their group work with the entire class once returning to the whole group.</td>
</tr>
</tbody>
</table>
Learner Factors

Just as in any academic setting, learners bring a variety of personal skills and knowledge to the classroom; they also carry individual limitations and challenges. In every setting, traditional or alternative, a teacher must make thoughtful instructional decisions to best meet the needs of the collective body of learners. Many of these factors are transferable to all learning settings. However, the online setting does carry some unique considerations that a teacher should be aware of. At the end of this section, Table 1 will provide some specific strategies related to each factor.

Digital Equity: Internet access and capable devices are essential for any online learning experience to be successful. One study estimates that approximately 15 million students lack sufficient internet access, representing approximately 30 percent of students enrolled in public education (Chandra et al., 2020). This factor is the most essential one when considering the implementation of remote learning options, especially programs that necessitate participation in web conferencing classroom sessions.

- Internet access: Lack of access to a quality internet connection can be an immediate disqualifier for participation in online learning. Web conferencing video sharing draws higher amounts of data than a simple device connection.

- Devices: Make sure all students have access to a device capable of operating at the most updated level required by the web conferencing program. In a landscape that relies heavily on Chromebooks, or cloud-based operating systems, be certain that your devices are capable of matching the minimum OS requirements to fully participate in a web conference.

Learner Readiness: A certain degree of digital acumen is required to fully participate as a learner in a web conferencing setting. Similarly to a traditional classroom setting, teachers are responsible for establishing classroom norms for learning as well as guidelines and routines for participation in the classroom space. This is also an essential component for a successful online classroom. Teachers should not assume that all students enter the classroom with the same
set of academic or participatory skills, just like students who enter a traditional classroom setting do not enter at the same levels of academic and participatory skills or motivation.

Student digital literacy improves with practice. Similar to other universal academic skills, practice does lead to proficiency. Consider reading skills, where increased daily reading time is linked to improved comprehension and student achievement (Meyer, 2016). When it comes to digital literacy, student use of technology leads to proficiency and guided student use of technology leads to substantially greater technological literacy. General technology literacy also connects to significantly greater learning outcomes when technology is integrated into the learning process (Bryant et al., 2020).

Student adaptability - the ability to regulate behavioral responses to changing or uncertain circumstances in an online learning environment - is a critical element to engagement and achievement in that setting (Martin et al., 2012). Studies taking place prior to the COVID pandemic identified web conferencing to have a positive impact on learning by creating access to learning for those who did not otherwise have access to formal instruction. However, that success was more greatly impacted by peripheral factors like direct support and student attitudes toward technology (Candarli & Yuksel, 2012). In order for students to fully embrace the benefits of online learning and web conferencing, they need to feel capable of navigating within that setting.

Students participating in an online setting must demonstrate some level of information management skills. The online landscape is inundated with applications that are able to support users. Never before has the moniker “there is an app for that” been more true. Because the pool of available tools is so inundated with options, it is important that students (a) understand the tools they are expected to use in your specific classroom and (b) understand how to manage their information within those tools.

File management skills are generally universal; similar skills will apply to cloud-based file management systems (i.e. Google Drive, Microsoft Onedrive, Box, Dropbox, etc.) or a device-based organization system within the hard drive of a single device. Students participating remotely must establish some basic skills in understanding computer filing systems. Teachers should avoid blanket assumptions and non-specific directions, such as: “I shared it with
“you” or “I put it in Google Classroom.” These types of comments assume (a) that students understand your personal information management structure and (b) that your structure is identical to their other teachers. Unfortunately, neither of these assumptions is universally accurate.

Communication and **collaborative skills** are requisite skills for students participating in any classroom setting. Student engagement is a primary factor that influences learning outcomes and engagement activities typically involve direct communication (Hattie, 2016).

Web conferencing can foster real-world skills by encouraging interactions of students with teachers and with other students. Within a shared physical learning space, students developing collaborative skills may attempt to disengage due to the social characteristics of the space and the challenges of associating in a face-to-face scenario. For some learners, and especially young learners today, the online space can feel more comfortable than a physical classroom space. Teachers should capitalize on those factors that contribute to a more forgiving and less stressful online environment while seeking to adapt and integrate proven traditional methodologies in an alternative setting.
Table 1
*Learner factors and instructional strategies for online class sessions.*

<table>
<thead>
<tr>
<th>Learner Factor</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Digital Equity</strong></td>
<td>Create a class roster that tracks the type of device and Internet access each student will rely on for participating in your class. Work with school administrators to address any specific student needs with mobile wi-fi or district-provided devices.</td>
</tr>
<tr>
<td><strong>Digital Literacy</strong></td>
<td>Incorporate a learner skill assessment early in your class to determine student levels of digital literacy. Incorporate specific language and skills you expect them to leverage during your course. Follow this up by providing clear descriptions and/or training as responses to the outcomes of the assessment.</td>
</tr>
<tr>
<td><strong>Adaptability</strong></td>
<td>Generate a list of notable classroom norms or routines that will be different in the online setting compared to a traditional setting. Include basic factors like attendance and participation as well as more complex factors, like submitting classwork and accessing grades and feedback.</td>
</tr>
</tbody>
</table>
| **Information Management** | Invest time early in a class, building a common information management protocol for your students. Model the process regularly early in the class sessions with gradually decreasing regularity as students demonstrate mastery of the routine.  
Provide a reference tool with a list of essential procedures students are expected to follow. Link helpful tutorials and/or provide orientation for each. |
Establish norms for learning within an online setting. Always recruit student input during this process and post/review the common norms for all classroom lessons and activities. Also ensure students know specific settings that will allow them to comfortably engage with their peers in the online setting, such as background and audio settings.

### Selecting the Right Web Conferencing Tool

When considering using a web conferencing program for remote teaching or conducting online classes, there are several factors they should take into account. By considering these factors, teachers can select a web conferencing program that aligns with their teaching requirements, enhances the online learning experience, and ensures effective communication and collaboration with students. When working to select the right tool for your classroom, ask yourself these questions:

**Is it User-Friendly?** The web conferencing program should have a user-friendly interface and intuitive controls. It should be easy for both the teacher and the students to navigate, access features, and participate in the online sessions without technical difficulties.

**Will it do what I need it to do?** Consider the specific features and functionalities offered by the web conferencing program. Look for features such as video and audio conferencing, screen sharing, chat options, virtual whiteboards, breakout rooms, and recording capabilities. Evaluate whether these features align with the teaching goals and requirements. Also, is the program compatible with the devices and operating systems my students will have access to? Ensure that students can easily access and participate in online sessions using their preferred devices (laptops, tablets, smartphones). Also, consider accessibility features such as closed captioning, screen reader compatibility, and language translation options to support diverse learners.
Is it reliable? The stability and reliability of the web conferencing program are crucial. It should have a strong track record of uptime and minimal connectivity issues. Look for programs that offer reliable audio and video quality, minimal lag, and strong performance, even during high traffic or heavy usage.

Is it secure/safe? Ensure that the web conferencing program prioritizes security and privacy. Look for features such as password protection, waiting room functionality, end-to-end encryption, and data protection measures. Consider the program's privacy policies and data handling practices to ensure student information is safeguarded.

Will it work with other tools I use with my students? Evaluate whether the web conferencing program can integrate with other educational tools and platforms, such as learning management systems (LMS), content sharing platforms, or interactive collaboration tools. Integration capabilities can enhance the teaching experience and streamline workflows.

Can I provide, or provide access to, teacher and student support? Consider the availability and quality of technical support provided by the web conferencing program. Ensure that the program offers resources, tutorials, or training sessions to help teachers and students become familiar with the platform's features and troubleshoot any issues that may arise. These factors will be especially important if there is a lack of institutional technical support for the application, and the teacher has to be the primary support for their students.

Can I afford it? Evaluate the pricing structure of the web conferencing program. Some programs offer free or freemium options with limited features, while others require paid subscriptions. Consider the budget available and the features needed to make an informed decision.

Conclusion

Web conferencing is a tool that can be leveraged to promote connection and collaboration in a synchronous classroom environment when students are unable to gather in the same physical location. Web conferencing can be utilized in place of the traditional classroom setting and most best practices, with some adaptation, may still be deployed in that setting.
Web conferencing is a skill that, like any, develops with practice. Novice users should expect failure and struggles in early implementation and should invest greater amounts of time seeking helpful resources and engaging in mentorship with colleagues who have more experience navigating web conferencing tools. Nothing new is easy and you often don’t know what you don’t know. Stay the course, demonstrate grit, and challenge yourself to be the active and resourceful learner you desire your students to be.

Also, web conferencing should not be viewed independently as the sole modification when moving a traditional classroom to an online setting. It is merely one piece of the puzzle, one tool in the toolbox. Teachers should explore the many other digital tools available to maximize the online learning experience for their students. Emerging technologies provide a range of opportunities and access to create an interactive learning experience for students that can rival the in-person setting and, in many ways, provide a more optimal setting for learning to take place. Programs like Mozilla Hubs can provide a mixed reality, virtually augmented environment that supports real-time interaction between students and teachers in a digital setting. Google Workspace for Education Fundamentals allows real-time collaboration through shared documents. Rapidly advancing generative artificial intelligence tools can provide students on demand feedback that greatly eclipses the human capabilities of teachers. A successful online classroom is the sum total of a teacher’s ability to integrate instructional technologies with opportunities for personal connection, student agency, and a sense of inclusion for all learners.
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Chapter 10: Increasing Accessibility in Educational Simulations

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Citation:
10. Increasing Accessibility in Educational Simulations

Meaghan McLeod

Key Points:

- A key educational benefit of instructional simulations is repetition and feedback.
- Often accommodations and accessibility features are overlooked and not included in the final design.
- Beyond closed caption and transcripts, designers can also include speech to text options, sonification, different input and control peripherals, and multimedia to enhance message design for learners.

Abstract

Simulations are an important aspect of education and training. They provide the learner with situations that mirror real life situations or provide access to unobservable phenomena. The simulations provide the learner with a unique opportunity to master skills through the use of and practice in a safe environment. However, many simulations are not designed with accessibility and accommodations in mind. This chapter provides a general overview of simulations and provides suggestions on how to increase accessibility and enhance the learning experience for all learners.

Keywords: Educational Simulations, Accessibility, Instructional Message Design, Accommodations
Introduction

Education simulations provide an opportunity for learners to practice real-life situations without physically being present (Chernikova et al., 2020). Learners can experience situations and troubleshoot problems without the risk of damaging equipment and hurting themselves or others. The learner also develops confidence and proficiency when using simulations (Hannel & Cuevas, 2018). The simulation's active hands-on approach and participation components spark interest and motivation as it provides an experience that mimics the real world (Lunce, 2006). Educational simulations allow learners to experience a variety of rare situations often not found in an in-classroom educational setting and can be more effective at improving learner performance over traditional classroom strategies (Satre, 2022). An educational benefit of simulations is repetition and time. The learners gain practice and mastery of skills as they repeat learning scenarios. They also can take extra time in scenarios if needed (Kaufman & Ireland, 2016).

Traditional learning materials, including simulations, are often designed for a generalized learner. Someone who can see, hear, and physically and mentally interact with the material as it is. Nevertheless, does that learner exist? Often accommodations and accessibility features are overlooked and not included in the final design. Time, knowledge, and resources impact the amount of accessibility designed into the simulations and learning materials. If the goal of the simulation is to have the learner practice and master the skills needed to perform the task in the real world, or to experience unobservable phenomena, then all actions should be taken so that the learner can be successful – including implementing accommodations and accessibility.

This chapter explores the different types of simulations. Then describes a general overview of the framework associated with simulations. Next, this chapter discusses the current accommodations that are being used in simulations. Finally, strategies on how to implement accommodations to improve the overall quality of learning simulations for all learners are presented.
Simulation Modalities

Simulations are often used to increase diagnostic, motor, and technical skills for healthcare professionals, teachers, management (Chernikova et al., 2020), military personnel, and educational settings. The following is a list of different types of simulations.

Simulated clinical immersion (SCI) is a simulation where students interact with mannequins (Satre, 2022). Mannequins are primarily used in medical training and range in sophistication and size. Some are region-specific (head and neck), while others are full-body. The mannequin simulators can be used for diagnostic and treatment training. Some of the higher-fidelity mannequins exhibit breathing, heartbeat, pulse, and bleeding (Kunkler, 2006).

Role play and the standardized patient is a simulation where the learner interacts with a human acting as a patient (Satre, 2022). This simulation represents a patient problem in a realistic clinical setting (Oh et al., 2015). The patient is coached and trained on how to react to the learner’s intervention strategies.

Situational simulations mimic human behavior and place learners in specific roles. (Lunce, 2006). The goal of the situational simulation is to have the learner experience a real-world situation, whether it be managerial, technical, or other external events. The learner is tasked with specific responsibilities based on their role and is expected to uphold professionalism. Therefore, the simulations should provide accurate information regarding the real-life situation (Rojas & Mukherjee, 2005).

During procedural simulations, the learners master skills by manipulating simulated objects (Lunce, 2006). Procedural simulations play a critical role in healthcare training (Kneebone, 2005) and bridge the gap between skill development outside the operating room and performance inside the operating room (Våpenstad & Buzink, 2012).

Computer-based simulations provide an online platform where large numbers of learners from various geographic locations are able to participate. The platform allows learners to observe, manipulate, practice, and interact with unobservable phenomena. Computer-based simulations usually include interactive videos, multimedia, and verbal material and can include authentic narratives and realistic situations (Dubovi, 2018; 2019). Computer-based simulations can be based on
realistic situations and involve conceptual experiments. This is where the learner uses critical thinking skills and deepens understanding as they manipulate variables, collect data, and draw conclusions (Hannel & Cuevas, 2018). Effectively computer-based simulations, both realistic and conceptual, demonstrate what learners may encounter in real-world scenarios and their future careers (Dubovi, 2018; Hannel & Cuevas, 2018).

Virtual reality (VR) simulations allow the learner to be immersed in a situation. To enter the VR environment, the learner usually wears a VR headset and uses handheld controllers or haptic gloves. Learners experience multiple senses like visual, haptic, and, less often, olfactory. VR simulations demand elaborate graphics and realistic interfaces (Våpenstad & Buzink, 2012). Although VR-simulations are computer-based, the difference is the immersive aspect. The learner perceives they are physically present in a non-physical environment and may feel temporarily disconnected from time and the real world (Radianti et al., 2020).

**Common Simulation Framework**

Each simulation contains one or more scenarios. The scenario happens during the simulation and involves characters and objects. The scenario determines the role of the learner, interactive prompts, and how the simulation will respond (Reigeluth, Schwartz, 1989). Branching is a series of decisions and actionable steps embedded in the learner's scenario. One benefit of branching is that learners receive immediate feedback based on the decisions made (Rababa et al., 2022). Feedback provides the learner with confirmation of correct actions and responses. Natural feedback mirrors real-life consequences. For example, during a flight simulation, the learner may view a shift in altitude and fuel dials based on their decisions (Reigeluth & Schwartz, 1989).

Many simulations contain a pre-brief and a debrief. The pre-brief acts as an orientation session where information is given to the learner before the simulation starts. The information provided usually includes instructions on how to go through the simulation, objectives of the simulated scenario, safety concerns, and learner expectations. The debrief provides an opportunity for reflection and
feedback on the learner's decisions and actions (Verkuyl et al., 2022). The debrief summarizes and reinforces key takeaways to emphasize what the learners have learned and experienced.

**Current Accommodations**

Since simulations provide educational and workforce training, it is important to discuss accommodations, accessibility, and inclusion. According to the U.S. Department of Labor, accommodations are modifications to the job or the work environment. These modifications provide an equal opportunity for individuals with disabilities to get jobs and perform their tasks to the same extent as employees without disabilities (U.S. Department of Labor, nd.). According to digital.gov, an official website of the U.S. government, “Under Section 508 of the Rehabilitation Act of 1973, agencies must give disabled employees and members of the public access to information comparable to the access available to others” (Digital.gov, nd.). Accessibility is defined as eliminating unnecessary barriers preventing someone from engaging in everyday activities (JISC, nd.). Inclusion is defined as a fundamental right for individuals to fully participate and contribute in all areas of life without restrictive barriers and marginalization (Braunsteiner & Mariano-Lapidus, 2014). I define inclusion in education as the opportunity and acceptance of all students to participate and contribute to quality educational materials and tools.

The ultimate goal is to create products and services, in this case, simulations, that do not need accommodations as they are already implemented into the design, and all learners can access them. PhET (Physics Education Technology, https://phet.colorado.edu/) interactive simulations seem to be leading in this area. PhET provides free computer-based physics, biology, chemistry, math, and earth science simulations. Their simulations stand out as being accessible. Design experts were brought in early during the design process to include accommodations (Winters et al., 2020). Due to limited accessible resources, students with disabilities too often miss out on authentic STEM (science, technology, engineering, and mathematics) experiences (PhET, 2023). Using inclusive design approaches, PhET designers are tackling software, assistive devices, and STEM education to provide research-based accessible simulations for all
learners. The simulations created by PhET include the following accessible features: alternative input, interactive description, sound and sonification, voicing, panning features, and zooming options (PhET, 2023).

People with disabilities are often excluded from the conversations surrounding and implementing accommodations, creating a design mismatch (Holmes, 2018). “Product Inclusion is the practice of applying an inclusive lens throughout the entire product design and development process to create better products.” (Jean-Baptiste, 2020, p. 20). PhET seems to be on board with this philosophy along with Winters, Harden, and Moore, who developed a research study based on a design thinking process with visually impaired teens. The goal was to have the participants, visually impaired teens, design and test sonification (or the use of auditory cues) within a simulation. The nonspeech audio, sonification, was a successful motivator. The entire design process promoted empowerment among the participants (Winters et al., 2020).

Carroll, Eaton, & Lusk provided a case study on a deaf nursing student Anna. Anna could lip read and wore a hearing aid which enabled her to hear some sounds. Carroll and Eaton mapped out ways to accommodate Anna during the training simulations. For example, one of the training simulations included a high-fidelity mannequin with audio. The barrier is the delivery of information - audio. The authors suggested the following accommodations: Anna can read from a script, use an automated captioning app, provide a staff member to repeat the audio from the mannequin, or hire a standardized patient (so that Anna could lip read) (Carroll et al., 2021). Without the accommodations, Anna could not access the information and, therefore, could not respond to the simulation. However, by implementing an alternate delivery of information, Anna could understand the prompts and test her skills during the simulated scenario. Carroll, Eaton, and Lusk bring up a critical point regarding Anna’s situation. “The academic program should not assess or measure student competencies based on the essential functions of a nursing job. Rather, they should use ADA-compliant technical standards that pertain only to academic success.” (Carroll et al., 2021 p.100). The Americans with Disabilities Act (ADA) prohibits discrimination against people with disabilities and guarantees that they have equal employment and government services, including
public education opportunities (ADA, n.d.). According to the Department of Education, section 504 of the Rehabilitation Act requires that students with disabilities receive services to meet their individual needs to the same extent as students without disabilities (U.S. Department of Education, 2023), which means that services are allowed to provide an equal opportunity to learn.

In Anna’s case with the high fidelity mannequin, by adding a script or a staff member to speak, Anna is still receiving the same information as the other students, just in a delivery method that meets her needs. Since Anna is in a training program, the goal is academic success. Unfortunately, ADA standards tend to fall through the cracks and are not always a priority when designing simulations. Therefore, simulation designers should be familiar with ADA laws and various accommodations. Training simulations bridge applied academic knowledge to real-life situations. However, simulations could be a valuable tool to provide an opportunity to test the best way to incorporate accommodations in work situations. An example would be a simulation where an employer and employee can sample various accommodations within a work environment.

**Strategies to Include Accommodations**

Designers typically design for non-disabled users and do not consider the needs of users with different capabilities or do not understand how to include accommodations in the product (Keates et al., 2000). Many websites provide valuable information and resources regarding accommodations.

- **Information Management System Global Learning Consortium** (IMS GLC) provide guidelines for accessible learning applications (1EDTECH, nd.).


- **Digital.gov** provides information about accessibility, types of disability, and provides posters of design do’s and don'ts for invisible disabilities like anxiety and dyslexia (Digital.gov, nd.).
Web Aim is a contrast checker website that allows the user to input both foreground and background colors to ensure they meet AA and AAA web accessibility standards (Webaim, 2023).

CAST is a nonprofit that created the Universal Design for Learning (UDL) which is a framework designed to optimize both teaching and learning (CAST, 2023).

It is hard as a designer to understand the specifics of the learners using your simulations and what kind of learning needs they require. However, learners who do not have specific learning needs may also benefit from the added accommodations.

The simulations that require human-to-human or mannequin collaborations can include scripts of the interactions and branching. The added text can help those who experience hearing, audio processing, and anxiety. Include text and visuals in the pre-brief and debrief. The combination of graphics and words trigger mental receptors and provides the organizational structure for the content (Martin & Betrus, 2019). Using standardized patients instead of mannequins is an acceptable alternative in a clinical scenario (Carroll & Eaton, 2019).

Computer-based simulations, including VR, can incorporate the following in the design to enhance the learning experience for the learners. Beyond closed captions and transcripts, designers can also include an option for combining audio and text, especially for directions and branching options. Text-to-speech features can increase the ease of read-aloud (Scalise et al., 2018). Applying audio can assist learners with visual impairments along with cognitive issues. Combining text (written or audio) with graphics creates a more profound learning experience (Martin & Betrus, 2019). The designers can include alternative inputs like keystrokes, joysticks, touch screens, or eye tracking.

Extraneous designs can distract and confuse the learner and cause them to experience cognitive overload (Ramlatchan, 2022). Cognitive load is the amount of new information being processed into a learner’s long-term memory. Knowledge development would be significantly impacted if the information was increased beyond the
learner’s limits (Shaffer, 2022). Therefore, offering accessible options to be turned off and on by the learners would ease cognitive overload and empower them to choose the features that suit their learning needs. Providing short breaks during the simulations can allow the learner to rest their eyes if on a screen too long, and can act as a mental break.

Message design is used to facilitate an appealing design optimal for learning. Message design combines images, text, and video to communicate a message, address a need, and direct learners’ attention (Ramlatchan, 2022). Message design can be strategically used to provide accessibility features like contrast, alt text which describes images, limit the amount of text on the screen at one time, and use multimedia instead of a single format.

Audio descriptions of the scenario and environment can be included for learners with visual impairments. An instructor can provide the audio description, a Word or PDF document that is text-to-speech compatible can be another alternative, or an audio description can be embedded into a computer-based simulation.

Accommodations should be seen as a means to optimize learning and give learners the resources they need to be successful. “The process of how someone achieves a skill is less important than the successful outcome of the skill achievement” (Carroll & Eaton, 2019, p. 620). There is no such thing as a standardized learner. Each learner has their own learning style, whether it be visual, auditory, or kinesthetic (Willingham et al., 2014). To expand, each learner has specific needs and optimal learning environments. As a designer, it is hard to anticipate specific needs. Therefore, familiarizing themselves with various accommodations and means of presenting information would greatly benefit the learner. Simulations should be designed so all learners can have an equal opportunity to master the skills.

**Conclusion**

Research strongly suggests learners assimilate information more effectively when actively involved and engaged in learning experiences. Simulations provide an active approach to learning and allow learners to put their current knowledge into practice (Hannel & Cuevas, 2018). Furthermore, simulations play an essential role in job
training and education; therefore, all learners should have the opportunity to equally participate in simulations. This chapter provided a few examples of increasing accessibility and learning within simulations. Further research and testing needs to be done regarding the implementation and assistive devices that can be used. A standard guide should be created to assist learning simulation designers on how to optimize learning for all learner types.
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