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Instructional Message Design: Theory, Research, and Practice (Volume 2)

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Volume 2

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(Edited by Miguel Ramlatchan & Casey Kohler)

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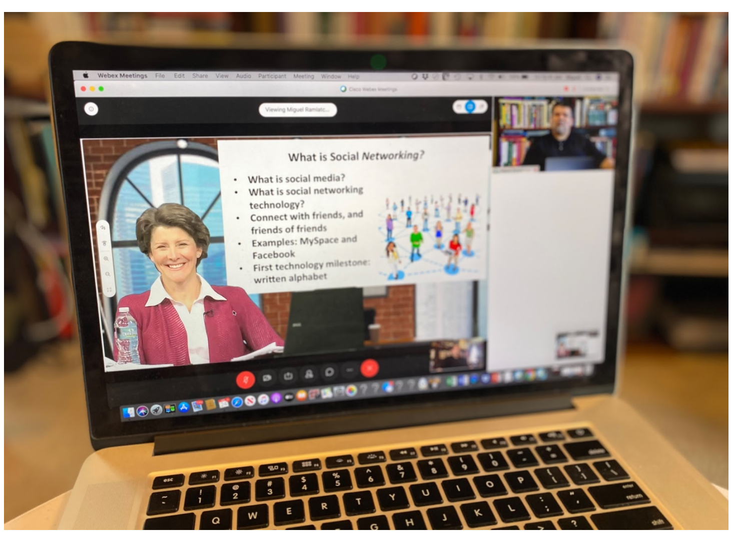
Preface

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 practice. For instance, cognitive load and multimedia learning theories provide best practice, 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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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 1: Message Design for Instructional Designers - An Introduction

Miguel Ramlatchan, PhD
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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 falls 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 practice.

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 are occurring 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 on solving 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 of 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. 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.

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.

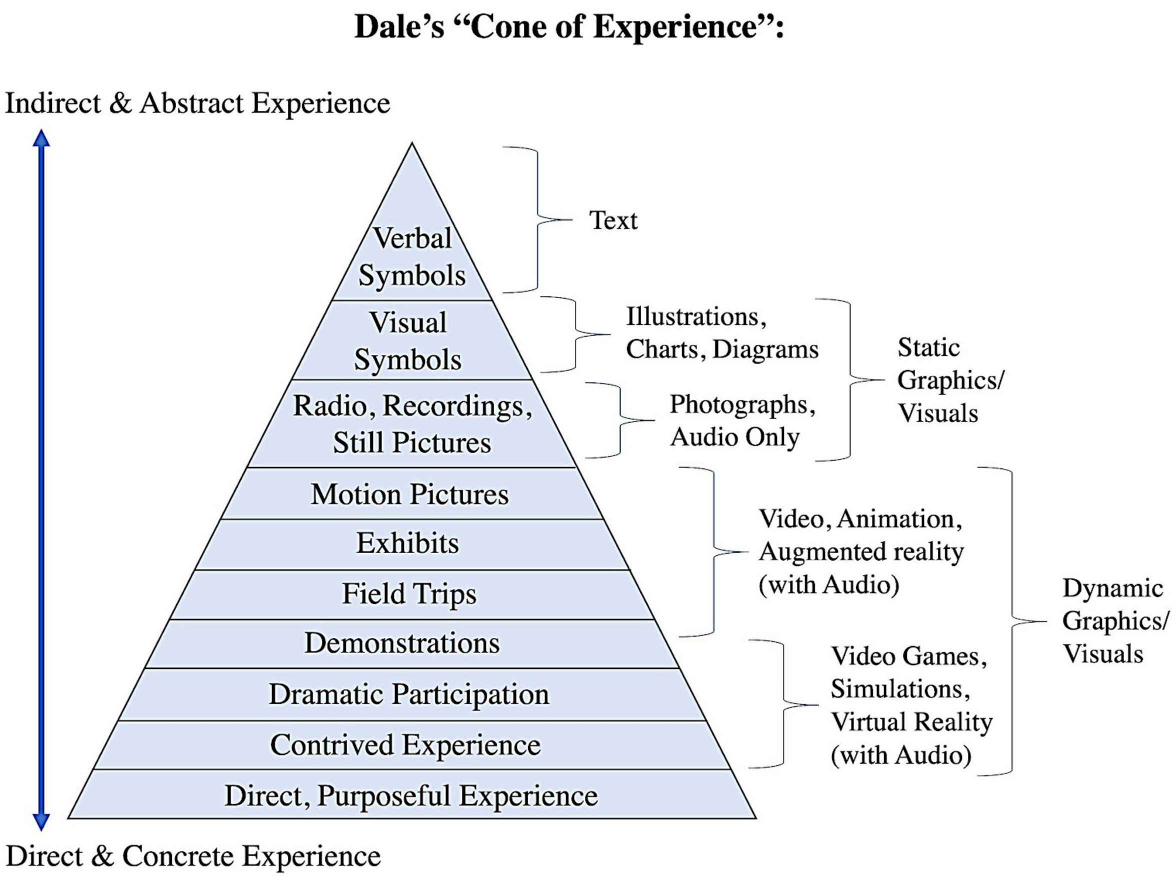
Rather than comparing technologies and tools to each other (as in a media comparison study), it is more important to study the efficient and effective use of each tool in a message design context (Clark, 1983). It is also important to focus on which media or technology has features that differ from other 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).

For instance, 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 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 2).

Figure 2.
The Cone of Experience

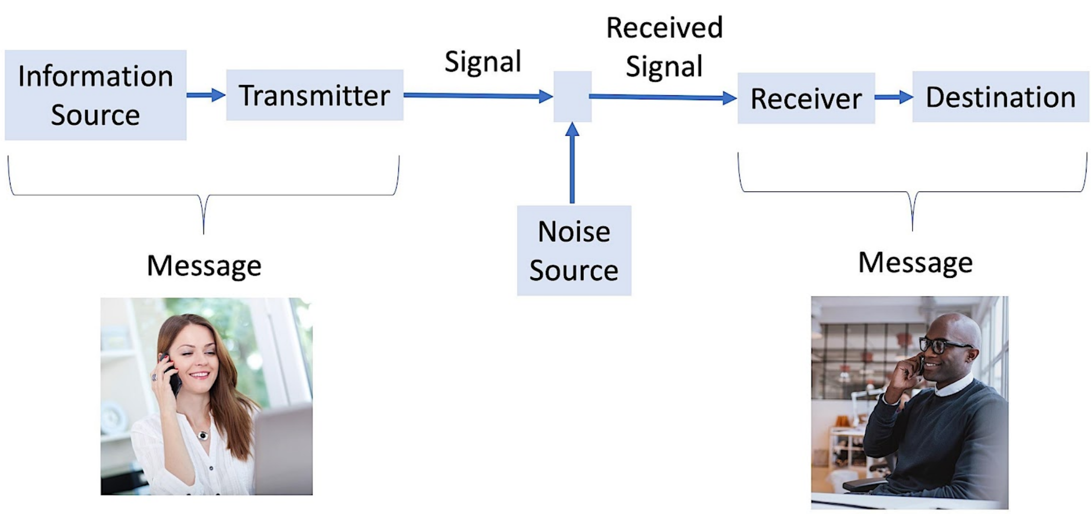


Note. The cone of experience can be used to describe how message design tools and techniques can be used to engage students in terms of indirect and direct experiences (modified from Dale, 1946).

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; for instance 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 3 (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 3.
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.

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.

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, or 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

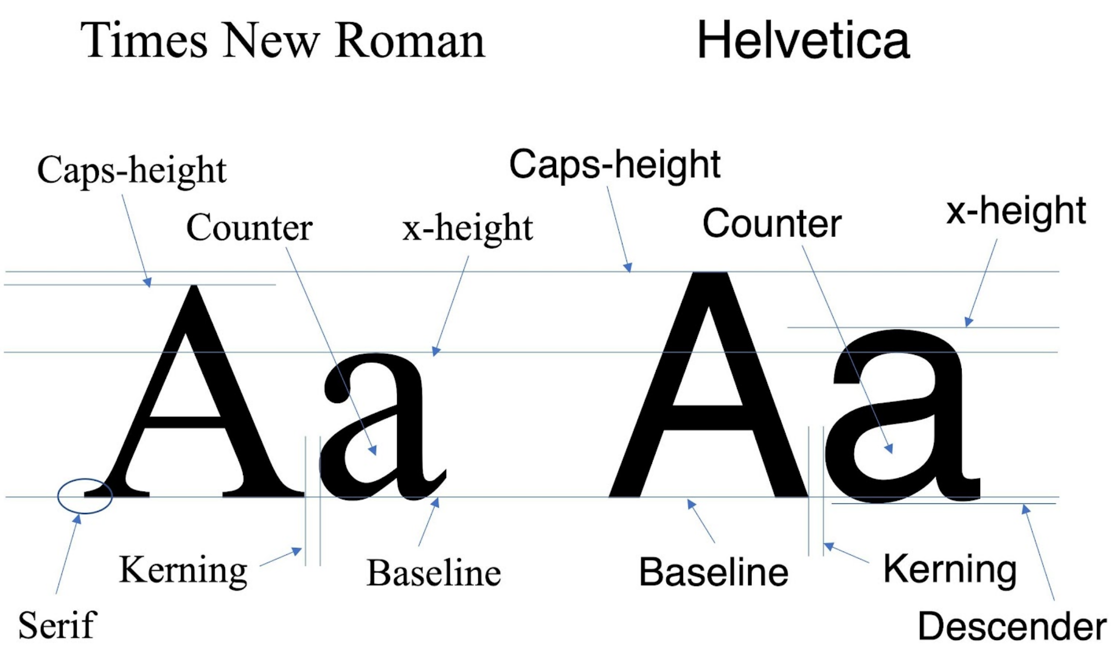
Text and Typology

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 4). Other common variables in terms of writing for instructional designs include font size, line spacing, and the selections 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).

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 4.
Font Design



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

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 5). It should 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 5.
Color and Perceived Meaning

Black	Elegant, Somber
White	Purity, Innocence
Red	Passion, Power
Orange	Happiness, Warmth
Yellow	Brightness, Idealism
Green	Growth, Nature
Blue	Tranquility, Dependability, Sadness
Purple	Royalty, Nobility
Brown	Duty, Reliability

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, funness, 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 as 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 (Tufte, 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 drawing, portrayals, point of views (such as "how-to" videos), and highlighting (such as the use of digital pens, slow motion, and zooming) (Schwarts & Hartman, 2014). 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 stimulus, 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 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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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 2: Cognitive Load Theory and Instructional Message Design

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2. Cognitive Load Theory and Instructional Message Design

Elisa L. Shaffer

Key Points:

- Cognitive processing is required for all learning tasks, and is separated into components of intrinsic, extraneous and germane cognitive load
- Working memory and long-term memory vary greatly in their functions and capacity
- The effects of all types of cognitive load can vary based on learner expertise
- Message design can significantly decrease the level of extraneous cognitive load
- Intrinsic load can be decreased through proper anticipatory actions of the designer or instructor

Abstract

Cognitive Load Theory's (CLT) purpose is to aid in the design of messages, instructional and otherwise, so that learning and message retention are more effective. CLT was introduced in 1998 by John Sweller and his colleagues. They used the constructs of three areas of memory, sensory, working, and long-term memory, to develop a theory to address the limited capacity of working memory. Through these efforts, they created the concepts of intrinsic, extraneous, and germane cognitive load and used these concepts to explain how various loads are placed on working memory. The purpose of this

chapter is to describe the three areas of memory, the three concepts of cognitive load, and address various effects created by intrinsic and extraneous cognitive load while guiding instructional designers on best practices to minimize load and maximize performance.

Introduction

Sweller et al. (1998) published the article *Cognitive Architecture and Instructional Design* and formally introduced Cognitive Load Theory (CLT) and its general principles. Though concepts related to this theory had been introduced in other articles before that time, including the theory itself in a 1998 article, this article went deeper into the effects and issues associated with measuring cognitive load and has become a seminal work within the instructional design field (Sweller et al., 2019). As a result, CLT has distinguished itself as a fixture in design in traditional classrooms and multi-modal learning environments. The following chapter will give you an overview of CLT, common effects from cognitive load both from the 1998 model and current research, approaches to overcome those challenges, and general practices to aid you in developing message design with a focus on cognitive load.

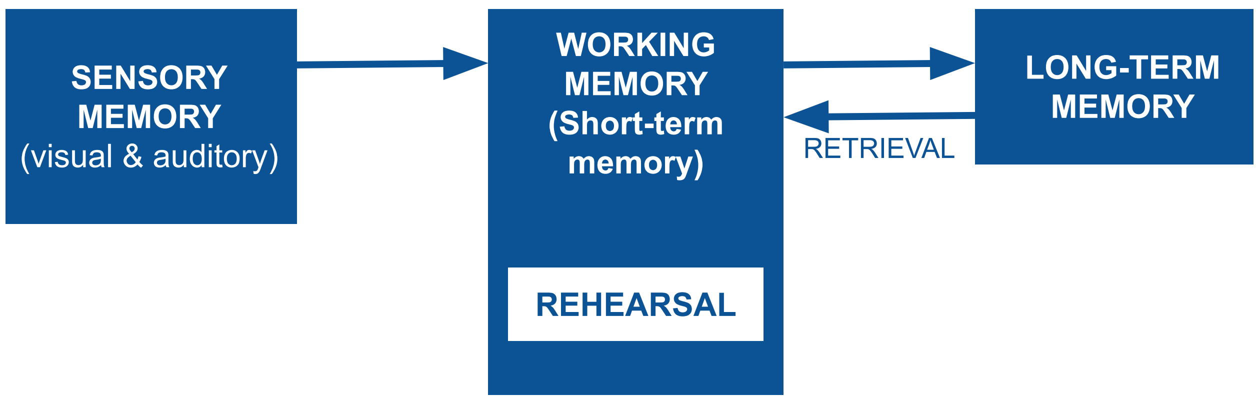
Memory

Before discussing Cognitive Load Theory, it is essential to include a discussion of memory and how it is utilized to process information. Memory is defined as how information is encoded, stored, and retrieved by the brain (Mellanby & Theobald, 2014, Baddeley 2000, 2003). Many believe that cognitive theory was the first to introduce short-term memory, or working memory, and long-term memory concepts. Still, evidence suggests that William James, in the late 1800s, was the first to describe these two different terms regarding memory (Mellanby & Theobald, 2014). Later, Baddeley introduced the concept of sensory memory, completing the three most common memories recognized by researchers in cognitive psychology and neuroscience: working memory, long-term memory, and sensory memory. Information Systems Theory similarly views the memory retention process as a computer processes information

(Richey et al., 2011). Data is first received in the sensory memory for a brief time. Then, if attention is made to the working memory, the information is quickly moved to working memory or rejected. Next, the data is encoded and stored within working memory, which will be further discussed later in this chapter. Finally, if the information is well-rehearsed, it moves to long-term memory via encoding and storage and can be retrieved at will. These three memories are illustrated in Figure 1.

Figure 1.

The Memory System from an Information Systems Theory Viewpoint.



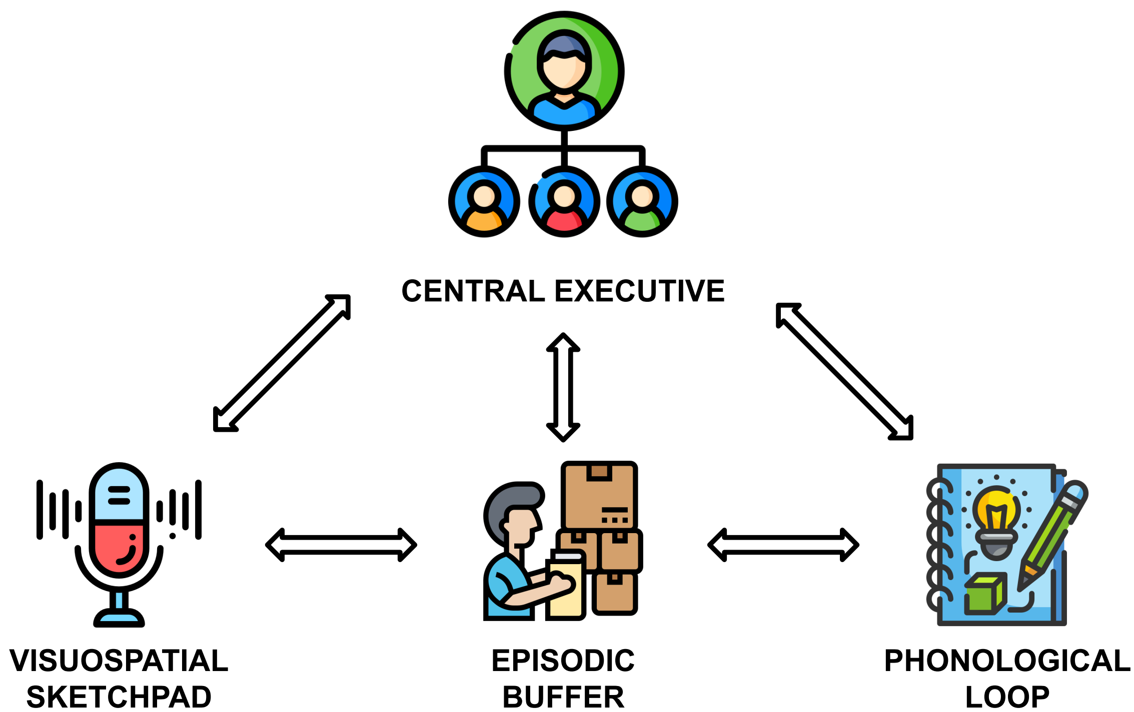
Note. Adapted from *The instructional design knowledge base: Theory, research, and practice,* by R. C. Richey., J. D. Klein, & M. W. Tracey, 2010, Routledge. Copyright 2010 by Routledge.

Working Memory

Working memory, sometimes referred to as short-term memory or the mental workspace, is the central processing center of the brain for the encoding of information in the memory system. This processing center has been widely studied as a center with limited capacity, or load, that simultaneously manipulates and stores information for brief periods (Alloway, 2009; Anmarkrud et al., 2019, Mellanby & Theobald, 2014). Baddeley and Hitch introduced this idea of a limited capacity system in 1974 (Baddeley, 2000, 2001, 2003, 2017). Their multicomponent depiction of working memory has stood as the foundation for decades of research in working memory. Although Baddeley's model has changed some over the years, it consists of four key components: central executive, phonological loop, visuospatial sketchpad, and episodic buffer (Baddeley 2000, 2003). Their relationship to one another is illustrated in Figure 2.

Figure 2.

The Current Model of Working Memory



Note. This figure has been designed using resources from Flaticon.com. Adapted from "Working memory and language: An overview" by A. Baddeley, 2003. *Journal of Communication Disorders, 36*(3) (https://doi.org/10.1016/s0021-9924(03)00019-4)

The central executive component is considered the essential element of working memory. It regulates the flow of information, attention, and coordination of the other three subcomponents in the working memory system. Baddeley (2000) suggests that it is not a storage location for memory but a processing unit. Metaphorically, it acts as a supervisor with three assistants, making the decisions about what deserves specific attention and what can be ignored within its limited capacity (Baddeley, 2017). Additionally, the central executive functions as a link to long-term memory from the three subsystems, as well as codes for time and place (Anmarkrud et al., 2019).

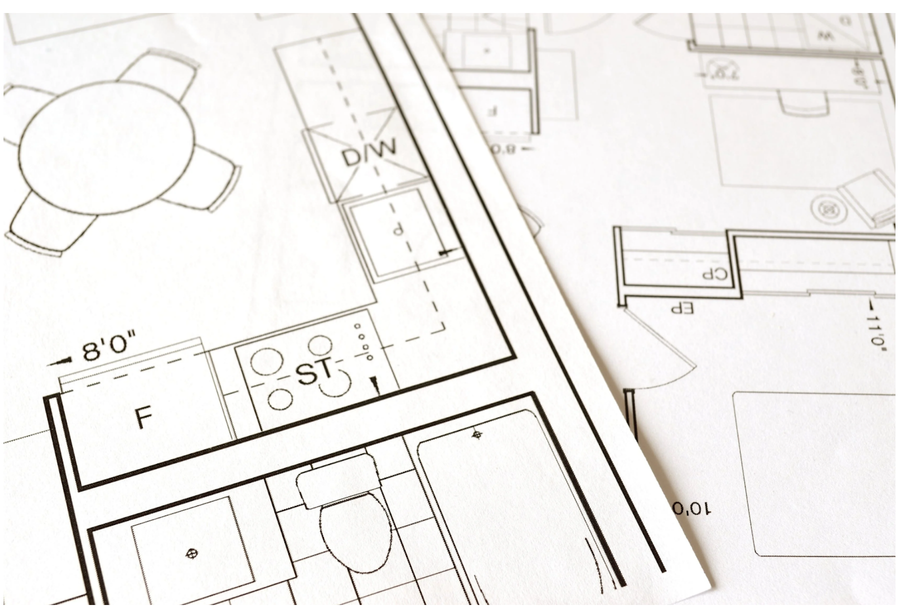
The phonological loop serves as the "assistant" for the part of memory that interacts with the spoken and written material (Anmarkrud et al., 2019, Baddeley 2000, 2003). The phonological loop consists of two parts: the phonological store is where information is stored in a speech-based form, and the articulatory control process allows us to repeat cues verbally in a loop. An example of this is the common phrase "phone, wallet, keys," which helps one remember their essential items before leaving home (see Figure 3). However, in the same respect, one can overload the loop with too much information, for example, watching a recorded interview with background music (Emory, 2019).

Figure 3.

A visual representation of the use of the articulatory control process with the phrase "phone, wallet, keys."

The visuospatial sketchpad "assistant" serves as the part of memory that interacts with the visual and spatial information, similar to how the phonological loop interacts with the central executive (Baddeley, 2003, 2017; Sweller, 2008). The visuospatial sketchpad allows for the visual, spatial, and possibly kinesthetic encoding of information, such as the layout of your residence. In the previous example, when your home was mentioned, it was highly likely that a design of your home, either in pictures or diagram, was brought from your long-term memory into your visuospatial sketchpad for use in your working memory (see Figure 4). In the same way that the phonological loop can be overloaded by too much information, so can the visuospatial sketchpad (Baddeley, 2003). Vredeveldt et al. (2011), for instance, found that closing one's eyes reduces load and improves performance on eyewitness memory recall because cognitive resources are no longer needed to focus on observing the current environment. Using this previous example of the layout of your home, if you were to close your eyes at this moment, you would be more able to easily recall an accurate image of your home and items within and around it.

Figure 4.
A visual representation of the use of the visuospatial sketchpad to recall the layout of a home.



The last subcomponent of working memory is the episodic buffer "assistant." This memory component was not initially considered in Baddeley and Hitch's understanding of working memory. The episodic buffer was added later when they described how the subsystems interact with each other (Baddeley, 2000). This component serves as a "buffer" or interface between the subsystems, long-term memory, and others (Baddeley, 2000). Unlike the central executive, the episodic buffer is more concerned with the storage of information than attention control (Baddeley, 2003). Episodic buffer can package all of the information from multiple components, or sources/chunks, when necessary - hence "episodic" (Baddeley, 2000, 2003). This "assistant" is similar to when you order from your favorite online retailer, and a variety of different items (e.g.visual, spatial, phonological information) are packaged and sent to you, (e.g. long-term memory) (see Figure 5).

Figure 5.
A visual representation of the use of the episodic buffer for the packaging of information and knowledge.

Long-Term Memory

Long-term memory serves as storage for all of the central information executive and episodic buffer deemed necessary to store; a.k.a. learner knowledge. Long-term memory is not just a vault of information but also organizes and assists in recalling critical pieces of information during the learning process (Baddeley, 2017; Mellany & Theobald, 2014). Schema is a crucial component to the use of long-term memory in the learning process. A schema refers to how information is organized in long-term memory and aids in comprehending, storing, and retrieving new knowledge (Richey et al., 2011; Van Merriënboer & Sweller, 2005). Paas and Ayers (2014) state that learners with more knowledge or schema, working memory "space" limitations practically disappear compared to those without prior knowledge or schema. As a result of this schema, the working memory can handle more complex materials or problems that exceeded its capacity before the development of the schema (Driscoll, 2018; Paas & Ayers, 2014).

1998 Cognitive Load Theory Model

Developed in the 1980s by John Sweller, Jeroen J. G. van Merrienboer, and Fred Pass, Cognitive Load Theory (CLT) aims to explain how learner's information processing load generated by learning tasks can affect their ability to process new information and develop knowledge within their long-term memory (Skulmowski & Xu, 2021; Sweller et al., 1998). Sweller et al. (1998) describe the load on working memory in three ways - intrinsic cognitive load, extrinsic cognitive load, and germane cognitive load. Additionally, they suggest that load on working memory was a limited resource. If the cognitive load were increased beyond what a learner was capable of, their learning would be significantly impacted. This model assumed that a learning material's complexity was based upon the number of information components and their connections with one another, known as "element interactivity" (Skulmowski & Xu, 2021; Sweller et al., 1998). Though still relevant today, many early studies only focused on traditional classroom learning and concentrated on decreasing the extraneous load of non-digital sources (Skulmowski & Xu, 2021).

Intrinsic Load

Intrinsic load is simply defined as informational complexity, including the number of items, their comprehension difficulty, and their interaction with one another (Anmarkrud et al., 2019; Emory, 2019; Sweller et al., 1998, 2019). Some tasks will have inherent difficulty based on the task, e.g. three-digit multiplication compared to single-digit addition, regardless of how the instruction is presented. Thus, when more items are grouped, a higher cognitive load is placed on the individual completing the task (Anmarkrud et al., 2019; Emory, 2019; Sweller et al., 1998, 2019). Although intrinsic load can be minimized to a degree based on instructional design practices, as the name suggests, it cannot be entirely removed as it is also heavily based on the learner's prior knowledge (Anmarkrud et al., 2019; Skulmowski & Xu, 2021).

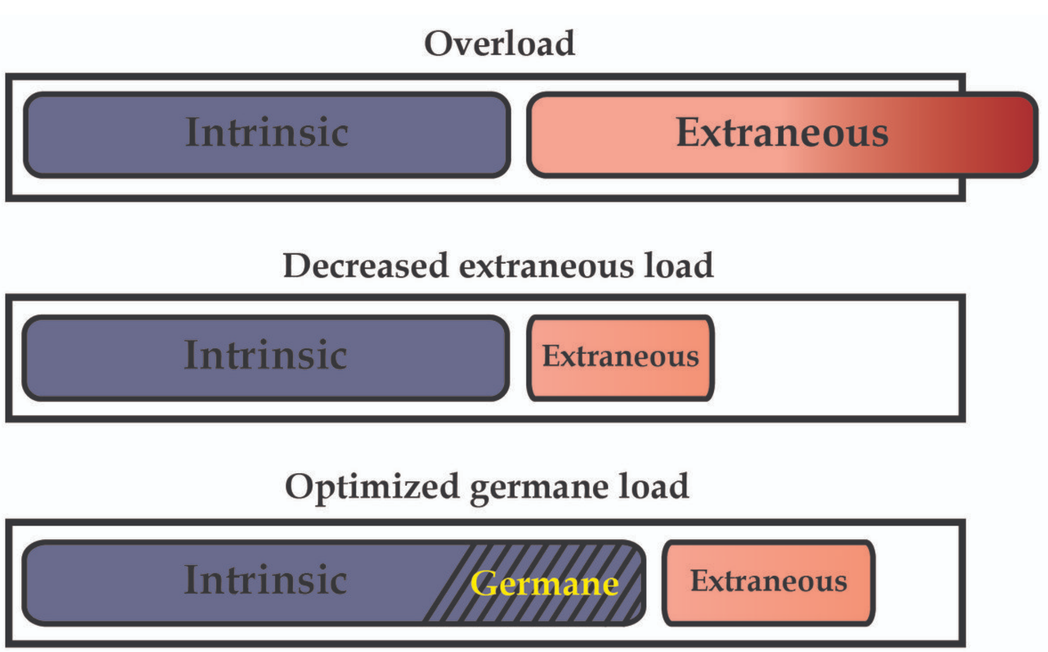
Extraneous Load

Where instructional message design choices cannot influence intrinsic load, extraneous cognitive load can be affected (Anmarkrud et al., 2019; Emory, 2019; Sweller et al., 1998, 2019). Extraneous load is not concerned with the complexity of a task or information provided but in the manner in which it is provided and what types of learning activities accompany it (Anmarkrud et al., 2019; Sweller et al., 2019). Germane load is increased with data that distracts from the intrinsic load. For example, if an instructor were teaching basic English to students learning English as a second language, it would not be helpful to share a complex quote from William Shakespeare with them as it would confuse them more than instruct. Additionally, if that same instructor were teaching English but put the text in a font that was hard to read or in colors that were difficult to see, the load placed on those students would be challenging for those having to sort through the information. Thus, design choices can substantially affect learning by increasing or decreasing extraneous cognitive load (Skulmowski & Xu, 2021).

Germane Load

Germane load is considered the cognitive resources devoted to the processes forced on generating and storing new knowledge into long-term memory (Skulmowski & Xu, 2021, Sweller et al., 2019). This falls more in line with Baddeley's (2000) episodic buffer of working memory and schema development. In the 1998 model shown in Figure 6, the germane load had an additive relationship with the other cognitive load components; for instance, if the other two load components were too high, then no learning would take place due to lack of cognitive resources (Sweller et al. 2019). The most controversial cognitive load, germane load, is described in the following model and has since been changed to germane processing.

Figure 6.
Additive relationship between Intrinsic, Extraneous, and Germane Load



Note. From "Managing Cognitive Load with Authentic Language Materials" by A. Inkster, n.d., *Connecting learning sciences to educational technology: Theory, evidence, and practice.* (https://wiki.its.sfu.ca/permanent/learning/index.php/Managing_Cognitive_Load_with_Authentic_Language_Materials) C.C. BY 4.0

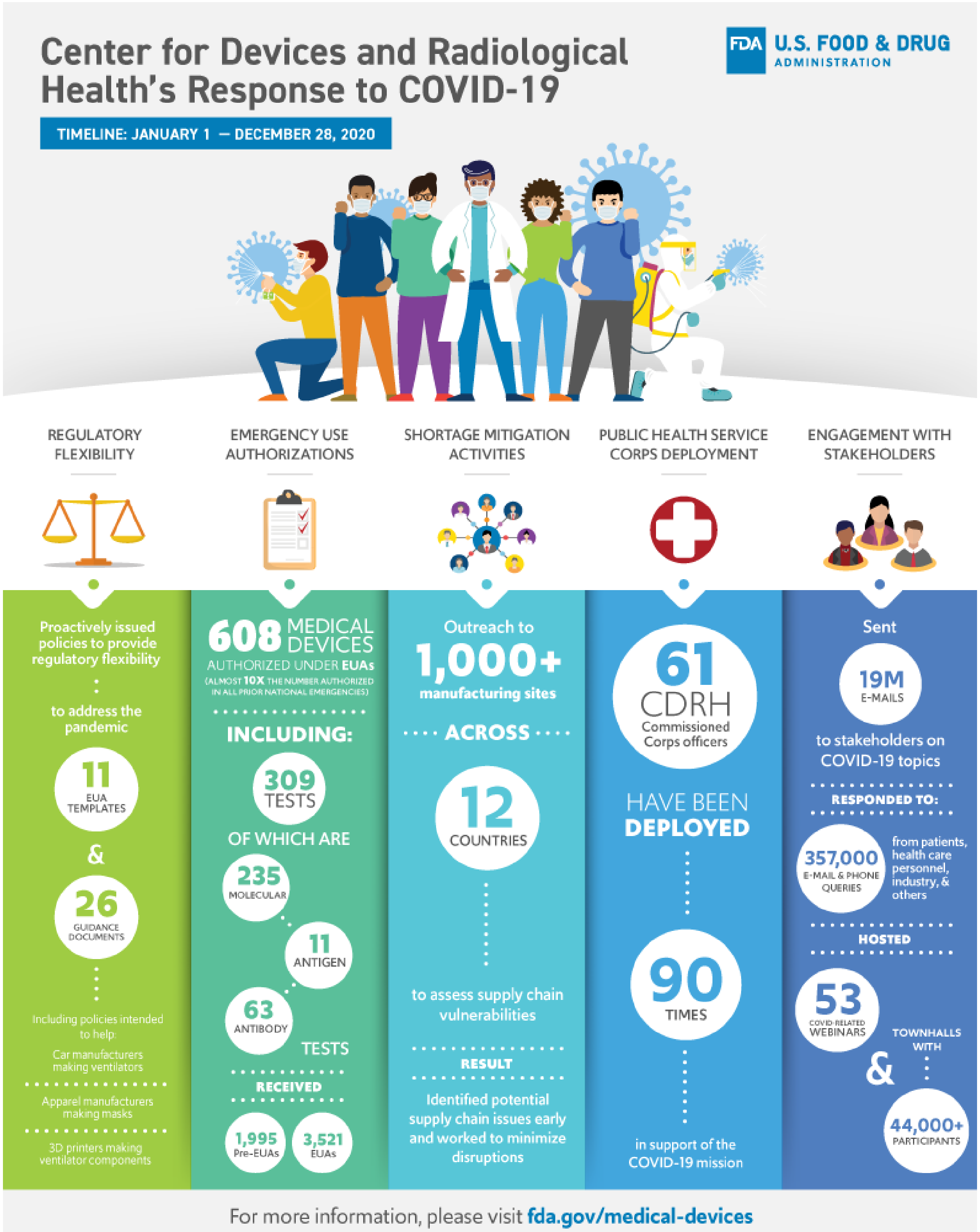
2019 Cognitive Load Model

Some of the characteristics of germane load were abandoned by Sweller et al. (2019) in their revisit of CLT. They no longer asserted that germane load contributed to the total cognitive load but instead "redistributes working memory resources from extraneous activities to actively direct relevant [resources] to learning by dealing with information intrinsic to the learning task" (Sweller et al., 2019). This means an increase in germane load no longer contributes to cognitive overload and can no longer be assumed detrimental to the learning process or performance (Skulmowski & Xu, 2021). An intrinsically complex message design can be very useful as long as the learner can focus their germane resources (see Figure 7).

The primary purpose of CLT is to optimize learning complex information and tasks by efficiently using the relationship between a limited working memory and unlimited long-term memory (Paas & Ayers, 2014; Sweller, 2019). The goal of instructional design and message design is to lower the cognitive load so that learning can occur without cognitive overload. In the following sections, we will explore various effects of cognitive load, their challenges and introduce methodologies that can reduce the cognitive load placed on learners through instructional message design.

Figure 7.

Example of cognitive load in an infographic.



Note. This infographic is a great example of keeping extraneous cognitive load low and relevant content high. The intrinsic load may also be high, but the load is manageable as the learner reads through the graphic from top to bottom. From "Center for Devices and Radiological Health's Response to Coronavirus (COVID-19): Infographic" by U.S. Food and Drug Administration, 2020, https://www.fda.gov/medical-devices/coronavirus-covid-19-and-medical-devices/center-devices-and-radiological-healths-response-coronavirus-covid-19-infographic

Instructional Effects

The following six effects were outlined in the original 1998 paper and have been further studied in the past few decades. These specific effects were summarized as they found a reduction in the cognitive load of instructional content (Sweller et al., 2019). In this section of the chapter, we will address the effect itself and include design methodologies and takeaways to reduce cognitive load. Additionally, these effects will depend upon the learner's expertise level (Kalyuga et al., 2003, Emory, 2019). Later in the chapter, we will discuss the issue of the reversal effect, in which the positive result can be minimized or reversed in some high expertise learners (Kalyuga et al., 2003, Sweller et al., 1998, 2019).

Goal-Free Effect

Referred to as the reduced goal specificity effect or no goal effect, the goal-free effect is when problem-solving questions or situations are posed to the learner without a specific goal outlined by the instructor or designer (Sweller et al., 2019). For example, a learner is posed with a question where two trains are traveling toward one another with specified velocities from a set distance apart. Still, the problem statement is undefined, such as, "Calculate as many variables as you can." As a result, the learner cannot move from a problem state to a goal state as no end goal was defined. In this specific example, this cognitive load could be reduced by stating the following problem statement, “In km, at what distance from Train A’s starting point will the two trains pass each other?” Thus, the end goal is defined, and the learner can move from the problem state to a goal state.

Items for Designers to Consider:

- What is the intent of the message/problem/task?
- Clearly define goals for the message, problems, or activities.
- If multiple goals are required, clearly communicate each goal that the learner must achieve.

Worked Example

Like goal-free problems, worked examples aim to reduce the cognitive load by introducing new concepts to problems through example work (Sweller, 2019; Sweller et al., 2019). In addition, worked examples provide a full problem-solution that learners can study and replicate. This is most commonly used within science, technology, engineering, arts, and mathematics (STEAM) fields and has applications outside of STEAM through examples of citation guides, essay examples, artistic methodologies, etc.

Items for Designers to Consider:

- Worked examples assist in the reduction of cognitive load best for low-level expertise learners.
- Worked examples should not require the learner to integrate different sources of information mentally.
- Worked examples should contain explicit guidance through the problem or task.

Completion Problem Effect

One failure of worked examples is that they do not require the learner to study them. The completion problem effect is one solution to that failure (Sweller et al., 2019). Completion problems build upon goal-free problems and worked examples by beginning the process of completing a problem-solving activity and then requiring the learner to complete the activity with a specific goal for completion. This effect lends itself to the guidance fading effect in which guidance from the instructor is slowly removed from the learner as the learner grows in the expertise (Emory, 2019; Sweller et al., 2019).

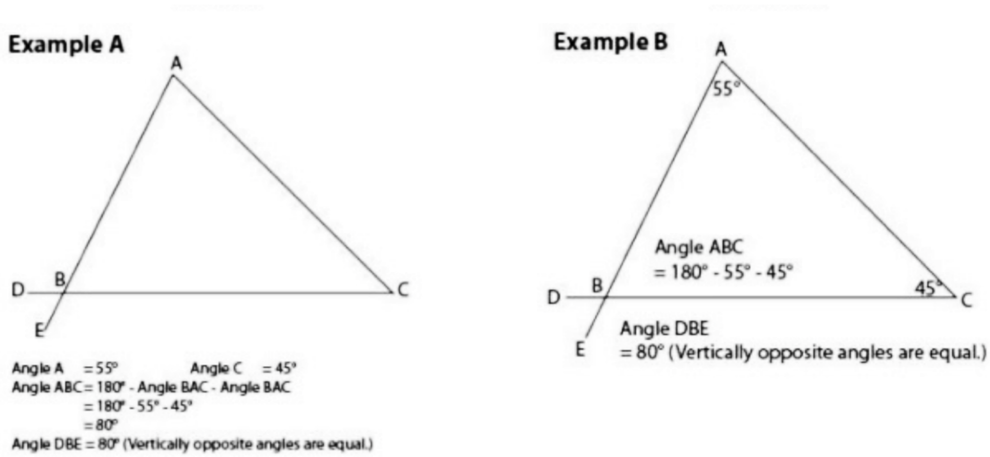
Items for Designers to Consider:

- Vary the level of guidance throughout the problems given in course/message design, starting with heavy guidance and then taper to little to no guidance.
- Provide explicit guidance when addressing new topics.
- Blend between goal-free, completion-problem, and worked examples within your design.

Split-Attention Effect

The split-attention effect stems from when a learner must draw from multiple sources in order to learn a concept (Emory, 2019; Sweller, 2019; Sweller et al., 2019). This effect is easily mitigated by integrating multiple sources into one source. Consider the following example in Figure 8. Combining all the information into the problem, the load placed on working memory is much less for learners.

Figure 8.
Integration of information in Example B eases problem solving as compared to Example A.



Items for Designers to Consider:

- When creating a message, is the message content in multiple locations or one easy-to-read source?
- Will combining the message into one source become cluttered or overwhelming?
- If possible, a singular source of information is superior to multiple sources when information is needed to be considered simultaneously.

Redundancy Effect

The redundancy effect in the 1998 model was highly focused on the traditional in-classroom teaching style. When considering the redundancy effect, the original effect draws a heavier cognitive load in conventional media. Sweller et al. (2019) suggested that incorporating multiple presentations of the same information causes increased cognitive load. Newer studies show that by looking at a cost-benefit analysis of some media, some redundant information is proving helpful in working memory and the development of long-term memory (Kirschner et al., 2011; Skulmowski & Xu, 2021).

Skulmowski & Xu (2021) reported that very subtle forms of redundancy, e.g. keywords or short phrases, can increase learning.

Items for Designers to Consider:

- Am I replicating the same information exactly? Is it necessary?
- More is not better.
- But, a little can go a long way.

Modality Effect

The modality effect is very similar to the split-attention effect in which information is split between multiple sources (Emory, 2019; Sweller, 2019, Sweller et al., 2019). However, modality does not seek to simplify the information, as split-attention does, but improves the working memory's processing by incorporating multiple modalities. For example, if a text and diagram are required to be combined for consideration and the text is short, then the text should be recorded or spoken rather than written (Sweller, 2019). For fixed situations, infographics provide an excellent opportunity to lessen the cognitive load for complex subjects, such as in Figure 8 (Dunlap & Lowenthan, 2016; Emory, 2019, Van Merrienboer & Sweller, 2010).

Items for Designers to Consider:

- Focus on engaging the learning quickly
- Use audio overlay for short text
- Low and mid-levels of interactivity can promote learning

These six effects from the original 1998 model, as well as others that have arisen throughout the past few decades of research, are all aimed at the reduction of cognitive load.

Reduction of Intrinsic Cognitive Load

The following practices, though not specifically outlined by Sweller and his colleagues, do address the reduction of cognitive load by reducing the intrinsic cognitive load to increase the functionality of working memory.

Cueing

Designers can use cues to point the learner toward important parts of the information to be received through color, font, arrows, illustrations, and so forth (Richey et al., 2011). These items along with the proper use of white space can cue learners toward the flow of information and highlight valuable data. This is true of animated media as well with the use of cuts, transitions, highlights, camera angles, etc. Used in an intentional manner, these cues will provide learners with guideposts in the development of their long-term memory and learning.

Chunking

As previously mentioned, working memory is limited, chunking breaks down large amounts of information into groups or chunks of information (Richey et al., 2011). For example, recall your phone number - you most likely used chunking. For many North Americans, phone numbers are in this format XXX-XXX-XXXX, where 10 digit numbers are broken into three smaller chunks. Another example is the often taught scientific method in secondary education, where students learn the steps to proceed through a basic experiment. Instructional designers can use the same techniques when developing messages to break large blocks of information into smaller blocks for lower cognitive load and better processing through a learner's working memory.

Scaffolding

Scaffolding is similar to chunking in that information is broken down into smaller chunks, but where chunking is one set of information into smaller chunks. Scaffolding builds upon itself (Richey et al., 2011). Think back to when you learned to read or taught someone to read, first you learned the alphabet. Then you learn how those letters sound when speaking them, then small words, followed by larger words, more complex sentence structures, and so on. By introducing concepts, piece by piece, instructional designers can reduce the cognitive load placed on learners.

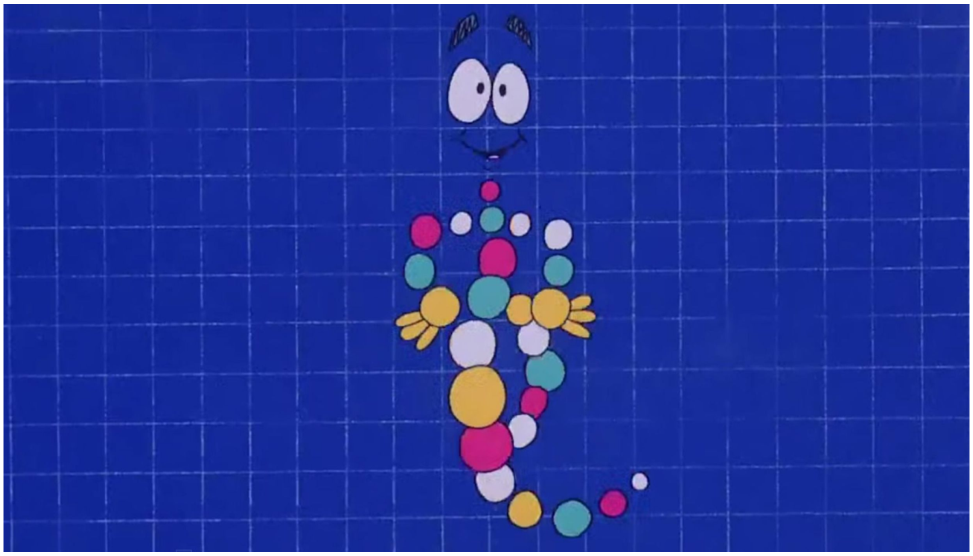
Advanced Organizers

Advanced organizers provide learners with higher levels of information in a more generalized format (Richey et al., 2011). Providing these materials in advance allows the learner to recognize what they currently know, what they will learn, and what they will need to do to get to that level. In a sense, it is preemptive scaffolding. Advanced organizers aim to introduce a topic and illustrate the relationship between learned information and future knowledge. They can be as simple as a minimal graphic to as detailed as a narrative to promote the learner's engagement with the materials.

Emotional Design

A new shift in the cognitive perspective of design is emotional design. This approach introduces positive emotions to the learner and thus increases engagement from the learner (Skulmowski & Xu, 2021). Emotion design includes the addition of enjoyable design elements, anthropomorphizing nonhuman entities, adding warm colors, and so forth. These new studies confirm that the design choices are helping to increase retention, transfer, comprehension, and motivation while also lowering the perceived difficulty of the learning material (Skulmowski & Xu, 2021). For example, in Figure 9, I would posit that "Mr. DNA" from the movie *Jurassic Park* is well-remembered by many, if not all, who have seen the movie and is an example of these new and emerging studies.

Figure 9.
Mr. DNA from "Jurassic Park" as an example of emotional design



Note. From "Chosen one of the day: Mr. DNA from *Jurassic Park*," by C. Enlow, 2018, *SYFY Wire* (https://www.syfy.com/syfywire/chosen-one-of-the-day-mr-dna-from-jurassic-park)

Conclusion

Learning requires both the use of limited working memory and unlimited long-term memory. To make the best use of the limited resource of working memory, one must apply the concepts of cognitive load to all aspects of information communication and message design. Without considering the load placed on the learner, designers and instructors may overload their learners and hinder the long-term development of knowledge. The history of Cognitive Load Theory is long, but it is not over. Discoveries are being made every year, and the understanding of cognitive psychology and neuroscience is ever-changing.

New research calls for a reevaluation of the current Cognitive Load Theory to address the cost-benefit of an increase of extraneous load versus an increase of germane resources (Skulmowski & Xu, 2021). As the world continues to develop further into a more technologically based society, CLT will need to grow and change.

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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 3: Multimedia Learning Theory and Instructional Message Design

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3. 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 and learning.

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 1990’s 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.

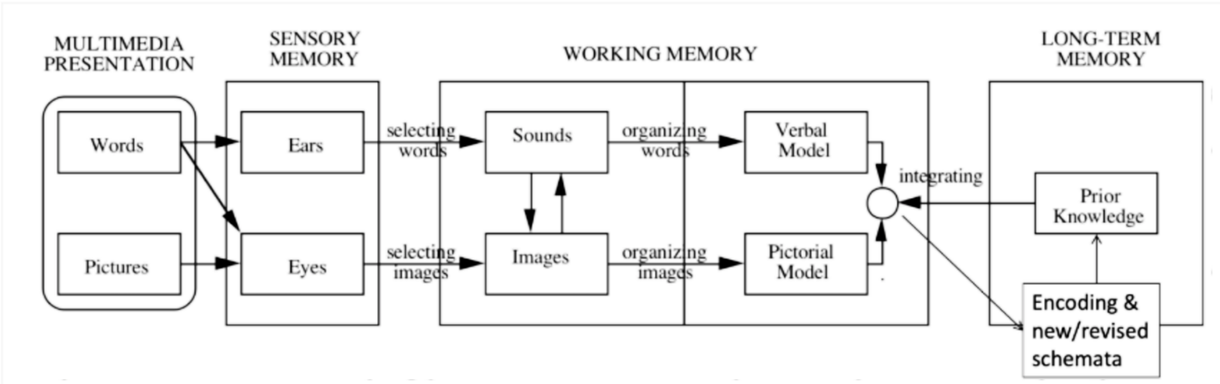
Sweller and his colleagues found similar results when comparing audio integrated with visuals, as compared to the visuals alone or the audio alone (Mousavi et al., 1995). Mayer integrated these findings, along with the implications of split-attention effect into another series of experiments. In a series 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).

Figure 1
Multimedia Learning Theory



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

Foundational Principles: 1. The **Dual Channels principle**, states that our learners have two independent cognitive systems for processing visual and auditory information, 2. The **Limited Capacity principle**, states that our learners have limited working memory resources, and 3. The **Active Processing principle**, which states that to learn students need to focus on relevant information, organize that information for themselves, and relate that information to previous schemata.

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 is 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.

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 realtiy, 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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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 4: Instructional Message Design in MOOCs

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4: Instructional Message Design in MOOCs

Marissa A. Jimenez

Key Points:

- Massive Open Online Courses (MOOCs) have grown in popularity over the last decade as they provide flexible access to content and expertise that wouldn't normally be available to wide, diverse audiences.
- MOOCs, however, have notoriously low completion rates largely due to low student motivation and the lack of student-faculty and student-peer interaction in MOOCs.
- Instructional message design techniques can play a role in enhancing student motivation through the improvement of social presence.

Abstract

Massive Open Online Courses (MOOCs) are appealing to higher education institutions, as they consider MOOCs a way to reach a large, varied group of students. With a completion rate of less than 10%, however, institutions struggle to maintain MOOCs (Major, 2016). While there is little to no cost for students to enroll in them, the cost for the institution to develop and maintain MOOCs can be high from a time and resource perspective. Improving student motivation and interaction in MOOCs may impact completion rates. Designers of MOOCs could leverage instructional message design strategies to improve social presence, and as a result, also improve motivation and interaction.

Introduction

Massive Open Online Courses, or MOOCs, are online courses which offer educational content and materials for free and with open access to all. Many MOOCs are offered in partnership with universities who provide content, expertise, and materials. For example, Coursera offers an English Composition I course that is offered by Duke University. To date, there are 317,285 students enrolled. The course is asynchronous; at their own pace, students follow a syllabus, watch videos, read articles, and complete assessments. At the conclusion of the course, students receive a certificate which can be printed or saved as evidence for a digital resume, like a LinkedIn profile. Most MOOCs do not carry academic credit, however, some institutions may accept courses for professional development credit.

Interest in MOOCs has been growing since the term first appeared in 2008. George Siemens and Stephen Downes coined the term when they taught 25 tuition-paying students and 2,300 non-paying students from the public in an open, online course on connectivism and connective knowledge at the University of Manitoba (Educause, 2011). It wasn't until 2011 that MOOCs reached major visibility when Stanford professor Sebastian Thrun and Peter Norvig offered an introductory course on artificial intelligence. While 160,000 participants were registered, 20,000 completed the course. Since then, MOOCs have grown in popularity, particularly among elite universities and have spurred a number of universities to launch their own (Evans, 2015). While institutions have developed more and more MOOCs, completion rates for them are still low.

The next few sections of this chapter will explore unique challenges of MOOCs and examine how instructional message design strategies that improve social presence can help address those challenges.

MOOC Opportunities and Challenges

MOOCs as Massive

MOOCs are massive in that they have the potential to reach a large number of students. Often offered as free, MOOCs remove the access barrier for students who otherwise could not afford, or have the opportunity to attend, a traditional university (Evans, 2015; Glass, 2016; Howarth, 2016). From a student perspective, however, the experiences gained from a MOOC's reach are a challenge. Most MOOCs offer limited interactivity between student and faculty, and between student and student. While thousands of students may participate in a MOOC, most MOOCs are not designed for students to interact with each other. This can lead to students to feel isolated in the course. Unless faculty extend the learning outside of the MOOC through the use of social media or another public forum, interactivity among members of the MOOC community is limited (Hew, 2016). Students may see that thousands of others are enrolled in a MOOC, but they may lack the visibility to really understand how others are participating alongside them.

From the instructor's perspective, one of the most significant challenges faced in adopting MOOCs is the shift in pedagogy that is necessary for teaching large, online, asynchronous, self-paced courses. In terms of design, instructors must consider that students who have access to MOOCs are coming from various educational, cultural, and motivational backgrounds. Learning activities and assessments embedded in a MOOC may need to be restructured for a larger, more diverse group of students, and that would take a significant amount of time and effort (Evans, 2015; Al-Imarah, 2019). Courses this large can significantly impact access to the instructor, engagement with peers, and overall course assessment (Evans, 2015; Glass, 2016; Ma, 2019; Major, 2016). Students are often left feeling alone and unsupported which impacts their ability to complete a MOOC.

MOOCs as Open

MOOCs are open in that they are 1) available to anyone interested without any enrollment or admission requirements, 2) free without a perceived cost except the cost of access to the internet, 3) expansive without any perceived limitations to content, and 4) flexible in the learning paths students may take throughout the MOOC.

Typically hosted on accessible sites like wikis, blogs, or websites, students can find and participate in a variety of MOOCs across a variety of content areas. “Among consumers of MOOCs are students who participate for a wide range of reasons: informal learning, competency in a particular area, and in some cases, credit toward a formal degree or certification program” (Educause, 2013, p. 2). But when studying student participation and completion rates of MOOCs over the last several years, it’s clear some student populations are participating in MOOCs more so than others. Even among those who enroll in MOOCs, many do not complete them; persistence rates are often low (Major, 2016). “Students are not engaged, motivated, and committed enough, and therefore find it easy to simply not complete the course - often dropping out before even the first assignments are due” (de Freitas, 2015, p. 461). Rieber (2017) explains the discrepancy between enrolling and completion is largely due to a “shopping period” metaphor, wherein students can access the information they need, and then leave the course without officially completing it (p. 1302).

Those who benefit the most from MOOCs are those who are self-directed, have flexible schedules, are digitally literate, English proficient, and intrinsically motivated (Glass, 2016; Reeves, 2017). MOOCs can be challenging for students who cannot navigate a MOOC’s structure (Major, 2016), expect a high level of instructor interaction and feedback (Ma, 2019), and for students from underserved populations (Stitch, 2017). Blacks/African-Americans, Hispanics/Latinos and female students are less represented among students who complete MOOCs (Evans, 2015; Semenova, 2016; Stitch, 2017). From the student’s perspective, the openness of a MOOC is what often drives students to participate in them (Hew, 2016). Students have the flexibility to interact with the content on their own, in the way they want to interact with it. If content is aligned with student learning/career goals and has a perceived usefulness toward reaching those goals, students will participate and complete MOOCs (Haworth, 2016; Ma, 2019). However, many students feel overwhelmed by the sheer amount of content available to them and lack the self-regulation skills to manage it all.

MOOCs as Online

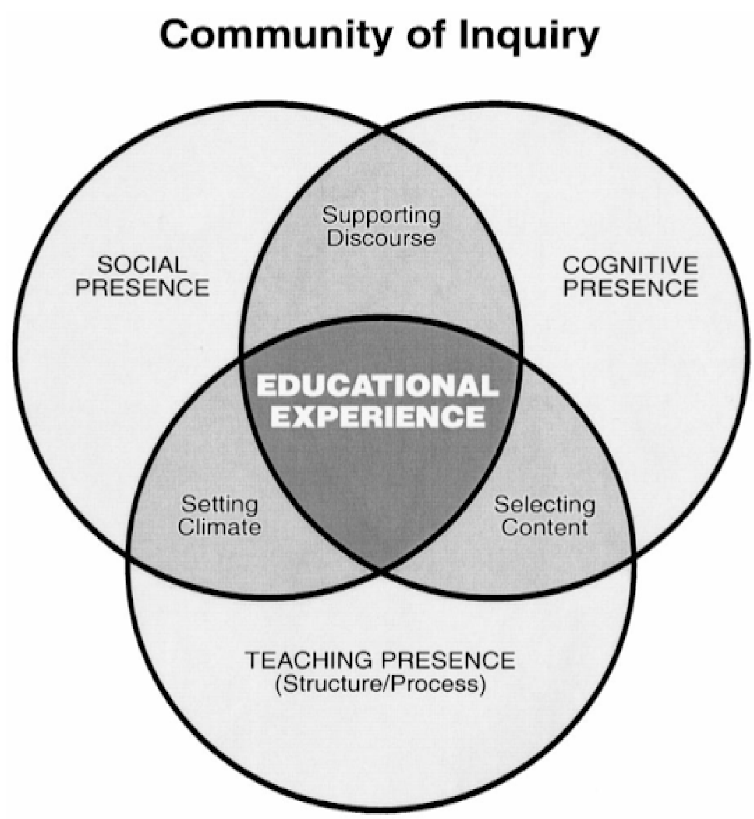
From a faculty perspective, challenges already exist with regular online teaching. One specific challenge for MOOC instructors is ensuring the same level of educational quality in MOOCs that is provided in a typical online course or a face-to-face course (Hew, 2016). Videos are the most widely used resource in MOOCs. Whether the course leverages screencasts, animation, or lecture capture, designing activities for such a large asynchronous class can be challenging. One suggestion for maintaining quality is to increase student engagement in MOOCs via authentic experiences. Authentic experiences are ones in which students can explore or learn about real-life concepts that are most relevant to the learners (Hew, 2016). For example, in a course that teaches about the instructional design process, an authentic learning experience would include one in which a student might design a training module for a client as part of the course. One approach faculty take to accomplish this in a MOOC is through problem-based learning (Corfman, 2016; Hew, 2016). Without authentic experiences, students might engage with course content minimally and become passive instead of active learners.

Addressing MOOC Challenges through Social Presence

One approach to address students feeling isolated, overwhelmed, or disengaged in MOOCs is through improving social presence. MOOC designers can accomplish this goal through instructional message design strategies that enhance motivation and engagement, such as the use of video, multimedia, and other digital tools. Social presence is a component of Garrison's 'Community of Inquiry (COI)' (2000). His seminal research explored the impact computer-mediated communication might have on quality educational experiences. He found that three essential elements are present in a COI: cognitive presence, social presence, and teaching presence (Garrison, 2000).

As illustrated in Figure 1 below, cognitive presence refers to the ability to engage the minds of learners, either through course content or conversation. Social presence refers to the level of interaction and connectedness learners have with each other and their instructors, and teacher presence refers to the planning and facilitation of learning and guiding students through the learning process (Armellini, 2016; Garrison, 2000; Shea, 2009). For the purpose of this chapter, we will be taking a closer look at social presence and its potential to enhance student motivation and engagement.

Figure 1
Community of Inquiry - Elements of an Educational Experience



Note. From "Critical inquiry in text-based environment: computer conferencing in higher education" by Randy Garrison et. al., 2021, *The Internet and Higher Education*, 2(2-3), 87-105.

Social presence is the degree to which a learner is perceived to be "real" in an online setting; it is the ability for learners to project themselves as ‘real people’ (Armellini, 2016). “Social presence is especially important in online learning, because it helps students in the process of translating online activities into interactions that feel real in terms of social interaction” (Pursel, 2016, p. 205). In an online course, social presence is accomplished through opportunities for student-student interaction or student-teacher interaction. Garrison argues that “social presence evolves from open communication (interaction), to purposeful academic exchanges (discourse), and finally, to achieving a feeling of camaraderie.” Students are challenged first to familiarize themselves with the instructor and other learners, understand expectations, and then to feel comfortable in communicating openly. In an online community, it takes time to find a level of comfort and trust, develop personal relationships, and evolve into a state of camaraderie (Garrison, 2007, p. 160).

To combat the challenges learners face in a MOOC, the next few sections will review strategies for strengthening social presence with effective instructional message design. Designers of MOOCs can do this by 1) personalizing learning and the learning environment and 2) creating opportunities for engagement and collaboration.

Personalizing Learning and the Learning Environment

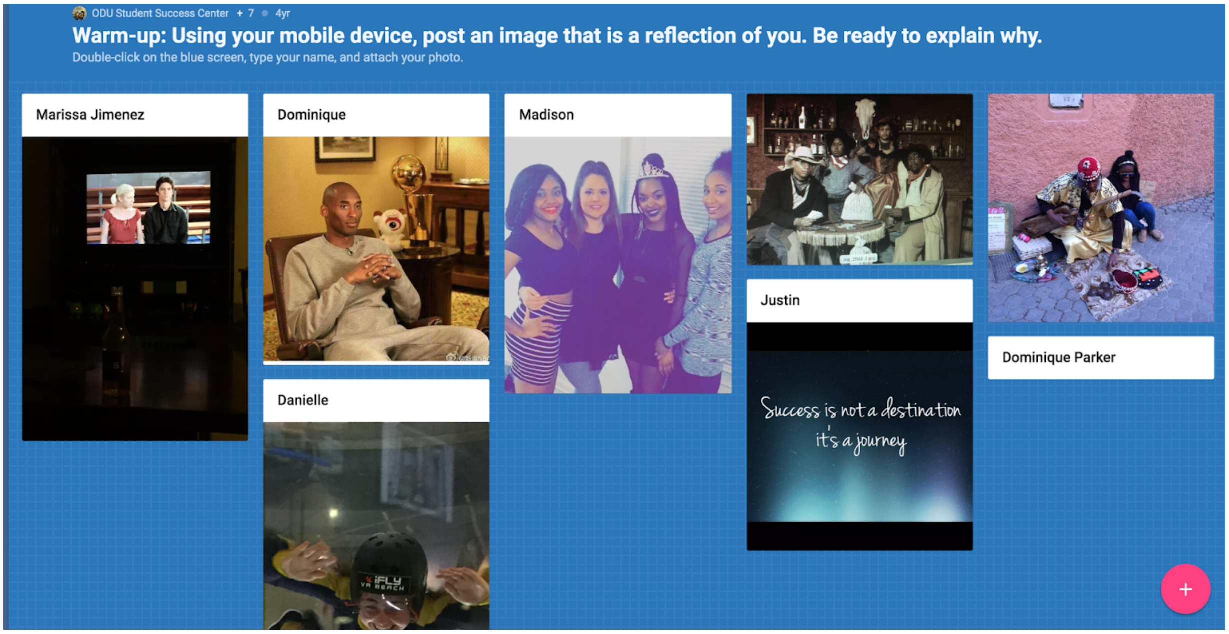
Use of student videos to connect and share experiences

Videos are the primary vehicles for delivering instructional content in a MOOC (Davis, 2018, p. 339), but videos can also help students identify with a group or learn about peers in a group to improve social presence. Giving students the opportunity to record short videos introducing themselves personalizes the learning and the MOOC learning environment. Students have the opportunity to see themselves and each other as part of a larger learning community who may not interact with each other regularly but who may perceive each other as all working towards the same goal. When personal introductions were required, students were more engaged and willing to solve conceptual problems together (Gregori, 2018, p. 161). As Mayer details in his research regarding Multimedia Learning Theory, there are several principles for the design of multimedia instruction, and there are three that are used to foster generative processing; these include the personalization principle, the voice principle, and the embodiment principle (2019, p. 9). The personalization principle suggests that people learn better when multimedia leverages conversation style; the voice principle suggests that people learn better when multimedia leverages appealing, human voices, and the embodiment principle suggests that people learn better when multimedia includes onscreen agents who display humanlike facial expressions, gestures, and movements (Mayer, 2019). Also, using student videos to connect and share experiences can help foster a conversational mood in a MOOC.

The screenshot below, Figure 2, is from a Padlet that was part of an introductory activity during a live, student employee orientation session hosted by Old Dominion University's Learning Center. Padlet works as a virtual pinboard, where instructors can pose a question, and students can respond via a unique URL and post text, videos, images, etc. answering that question. While students were asked to post images for this particular training session, MOOC instructors can utilize the same type of technology for students to record and post brief videos introducing themselves. Access to these videos can help students feel less isolated, and part of a larger community of learners. This page could get daunting, depending on the number of students in a MOOC, but the instructor could develop separate padlets organized by last names, areas of interest, majors, etc. to help manage the numbers.

Figure 2

ODU Learning Center - Padlet Screenshot



Note. From *ODU Student Success Center Padlet* by Jimenez, Marissa, 2014, Old Dominion University Learning Center.

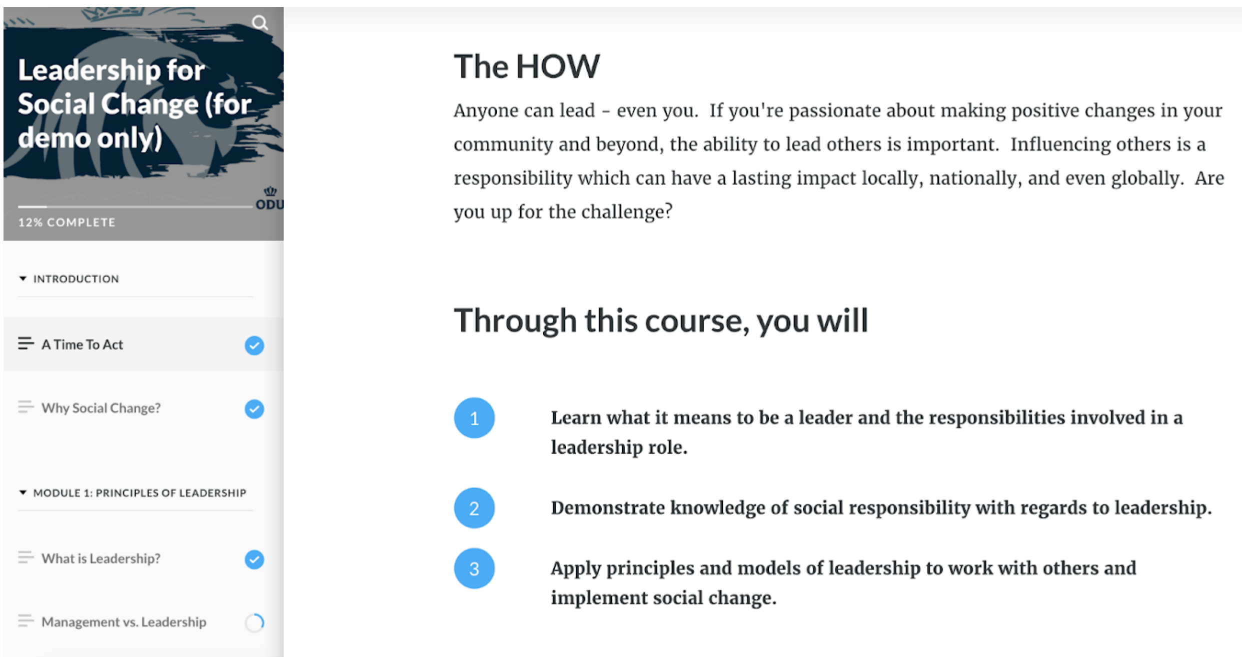
Use of informal language to manage tone

Asynchronous classes, like MOOCs, lack real-time interaction with students, so instructors rely on other course elements to help personalize learning and the learning environment. From an instructional message design perspective, one way to do this is through the use of informal, but expressive language (Weiss, 2000). Some strategies for personalizing learning include the use of emoticons/emojis, humor, or hyperbole (Weiss, 2000). In a study that examined the use of instructional messages with a personalized style, Moreno (2000) found that personalized messages - the familiar, conversational style language used throughout a science lesson - produced better problem-solving transfer and better retention performance. This more personalized language style can help improve social presence in MOOCs by making the content and instructor seem more approachable.

The screenshot below, Figure 3, is taken from the very first module in an asynchronous course titled ‘Leadership for Social Change’ developed by Old Dominion University’s Learning Center. Geared toward juniors and seniors in high school, the language used in the welcome video and in the opening paragraph is casual and informal. Both the video and the opening paragraph serve as an introduction to the course, and the same conversational style is consistent throughout the entire course.

Figure 3

ODU Learning Center - Leadership for Social Change Course



Note. From *Leadership for Social Change* by Jimenez, Marissa, 2020, Old Dominion University Learning Center.

Use of agents or avatars to help learner motivation

The effective use of avatars or motivational agents can improve social influence and learner performance in an online environment, and agent appearance is one of the most important ways in which agents can impact learning (Baylor, 2011). Specifically, if instructional designers use onscreen agents as part of their multimedia lessons, they should work toward creating an agent with a high-level of embodiment, that is, the agent's use of human-like gestures, eye gaze, facial expressions, and movements (Mayer, 2012). The same is true for an agent's voice. Mayer found that, "people learn better from multimedia lessons when words are spoken by a human voice rather than a machine voice" (2012, p. 249). In the same way a live instructor might prompt a student to answer a question, either through the nodding of his/her head or casual hand gestures, an agent that's embedded in an interactive video, for example, could reflect those same movements and elicit a more positive response than with agents with non-human facial expressions/hand gestures/body movements. According to Baylor's research (2011), "gestures can reduce ambiguity by focusing learner attention, and facial expressions can reflect and emphasize agent message, emotion, personality, and other behavioral variables" (p. 295). Tools like Articulate include a variety of human agents that can be embedded in instructional modules, and can be very effective when using scenarios for learning.

The screenshots below, Figures 4 and 5, show agents that have been embedded as part of Old Dominion University's Learning Center's Student Employee Training modules. In a section that reviews specific scenarios, each of the agents chosen have warm, welcoming smiles and use physical gestures that prompt the questions students are to think about. These types of agents can be helpful in improving social presence in large asynchronous classes like MOOCs.

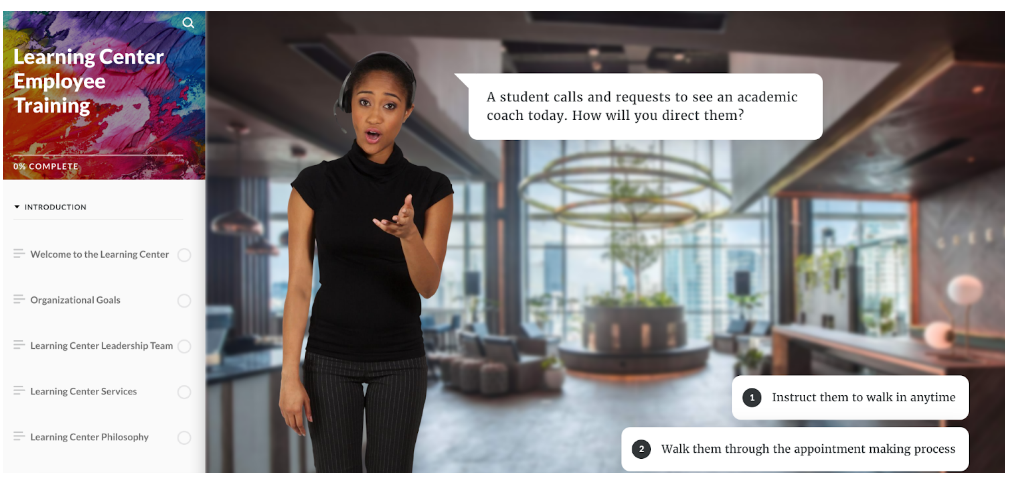
Figure 4

ODU Learning Center - Employee Training Course, part 1.

Note. From *Learning Center Employee Training* by Diana Hernandez, 2019, Old Dominion University Learning Center.

Figure 5

ODU Learning Center - Employee Training Course, part 2.



Note. From *Learning Center Employee Training* by Diana Hernandez, 2019, Old Dominion University Learning Center.

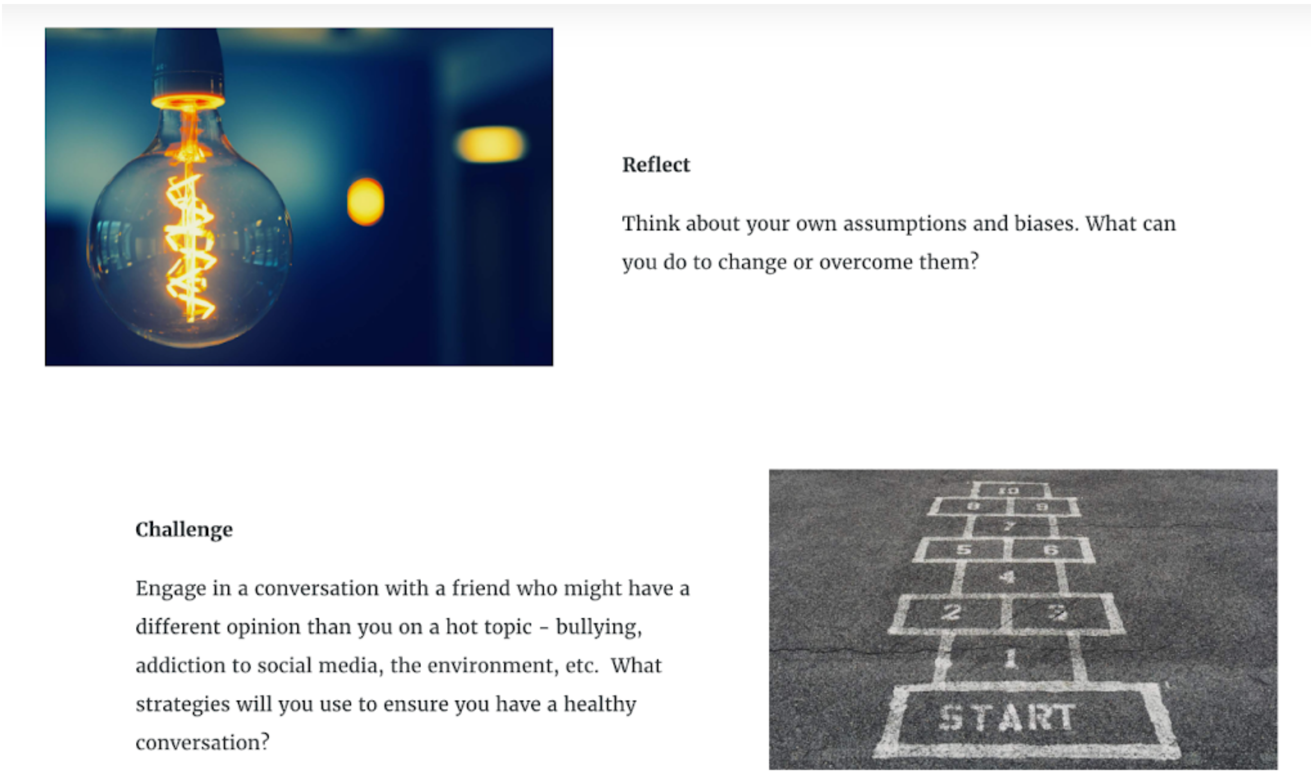
Creating Opportunities for Engagement and Collaboration

Use of discussion boards to facilitate authentic, problem-based learning

Discussion boards, like videos, are a popular method to increase peer-to-peer or faculty-to-peer interaction (Amemado, 2017; Catellanos-Reyes, 2021; Chen, 2019; Corfman, 2019; Liang, 2007; Nandi, 2012). Most instructors leverage discussion boards just for text-based conversations. That is, an instructor poses a question, and the students reply. Instead, the use of what Oyarzun (2017), calls "designed interactions" (p. 158) can be more impactful, for they positively impact online learner achievement and satisfaction. For example, a typical discussion board prompt may ask about one's opinions on the cost of college tuition. Instead, taking a problem-based approach, the discussion board may be used for students to work together to create a visual representation of the rising costs of college tuition or to create a presentation that might persuade institution leaders to address financial literacy challenges. According to Mayer's (2019) 'engagement principle,' asking prompting questions actively involves students in discussion more so than listening to a lecture. Intentionally-designed discussion boards can help facilitate critical thinking and engagement among peers and instructors, and thus improve social presence.

The screenshot below, Figure 6, is taken from one of the modules in the same "Leadership for Social Change" course as mentioned previously titled, 'Inclusive Conversations'. While not a discussion board, the end of every module in the course provides students with a reflective prompt and a 'Challenge' activity in which students are encouraged to participate. Not only are students encouraged to think critically about the content from the module, but they are also encouraged to take action or practice a specific skill. Embedding activities like this in a MOOC can be a good way to increase social presence.

Figure 6
ODU Learning Center - Monarch U ROPES Course



Note. From *ROPES: Monarch U* by Taia Reid, 2019, Old Dominion University Learning Center.

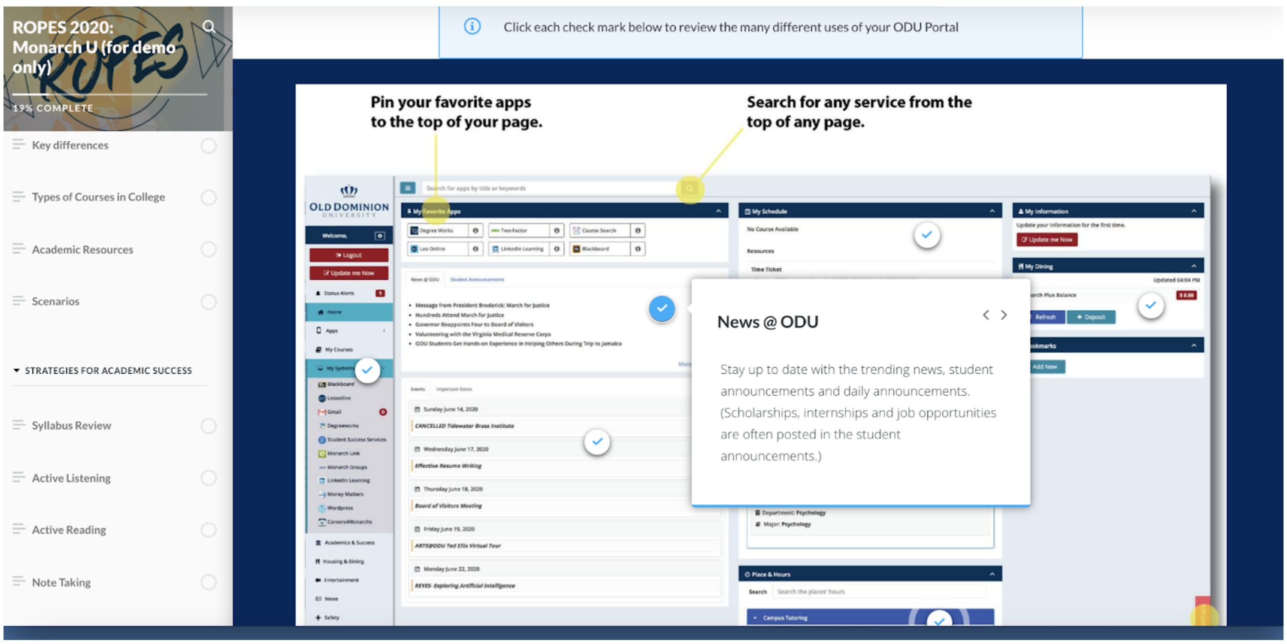
Use of interactive multimedia to improve learner engagement

If one examines a MOOC-type platform like LinkedIn Learning, one will find that every lesson contains video; Khan Academy's entire teaching strategy leverages video. Videos are the main form of content delivery in MOOCs, but they can be enhanced with the addition of interactive multimedia. Interactive multimedia includes, but is not limited to, elements like video overlays, animation, interactive quizzes, digital annotations, data visualizations, etc. (Davis, 2018).

The screenshot below, Figure 7, shows an interactive tutorial developed by ODU's Learning Center that was used as part of an online course for first-year students. Part of the lesson included teaching students about the MyODU Portal - what it is, and the different areas within the portal. Laid on top of the portal screenshot are interactive check marks. When a student clicks on a check mark, additional information about the section is displayed via a pop-up window. While this pop-up shows only text, these pop-ups could also incorporate images and videos for a richer description.

Figure 7

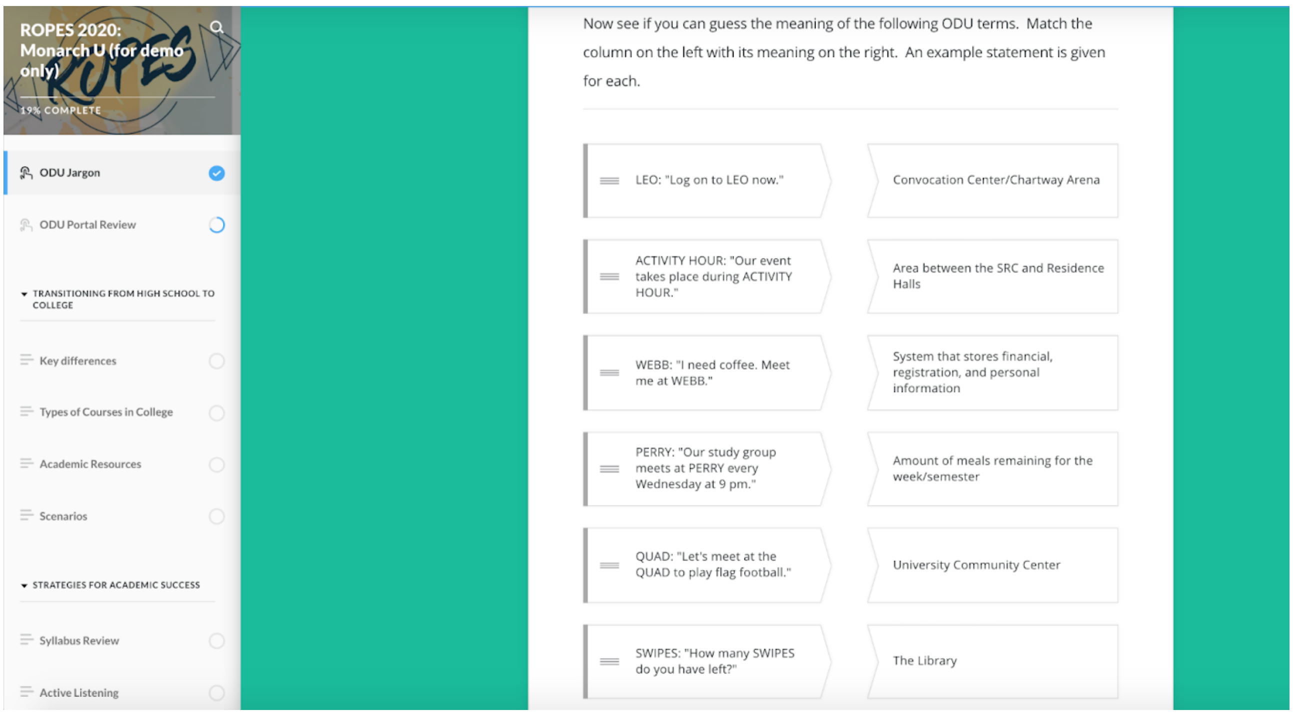
ODU Learning Center - Monarchs ROPES Course



Note. From *ROPES: Monarch U* by Taia Reid, 2019, Old Dominion University Learning Center.

The screenshot below, Figure 8, shows an interactive quiz which was used as part of the same online course for first-year students. After completing a lesson about ODU Jargon & Abbreviations, students were prompted to complete a knowledge check by matching an ODU term to its definition. This sort of assessment can be tracked or can be used for a learner's own self-assessment while completing the course. The types of engagement that is facilitated through interactive multimedia like these can help improve learner engagement and thus social presence in a MOOC.

Figure 8
ODU Learning Center - Monarchs ROPES Course



Note. From *ROPES: Monarch U* by Taia Reid, 2019, Old Dominion University Learning Center.

Use of simulations to improve learner performance

Because MOOCs often provide access to a vast variety of content, it is important for instructors to leverage technologies to better organize or explain content. One way to do this is through simulations. Instructor use of simulations can help improve learner engagement and performance (Lackmann, 2012; Robinson, 2013; Sung, 2012). Robison (2013) explains that "instructional simulations provide learners with the opportunity to interact with a representation of some phenomenon or challenge, and in that interaction grow in skill or knowledge" (p. 42). "Unlike passively listening to lectures, reading a book, or watching a video, an instructional simulation requires learners to construct responses - often in real-time" (Robinson, p.47). Whether the simulation summarizes the process of photosynthesis or explains the parts of the brain, simulations can take seemingly dense content and bring it to life.

The screenshot below, Figure 9, references a simulation program designed by Old Dominion University's School of Nursing and the Center for Learning and Teaching. As a result of COVID-19, many nursing students were unable to participate in their required practicums or clinical experiences. Instead, the School helped develop a simulation of those experiences which normally would have been available face-to-face. Virtual experiences such as these can help improve learning and performance, and in times when face-to-face instruction was unavailable, simulations were absolutely necessary. Embedding simulations like this in a MOOC is not only helpful in learning, but an incredible way to provide students with richer, more visually-engaging learning experiences.

Figure 9

News @ ODU - Nursing Simulation Program

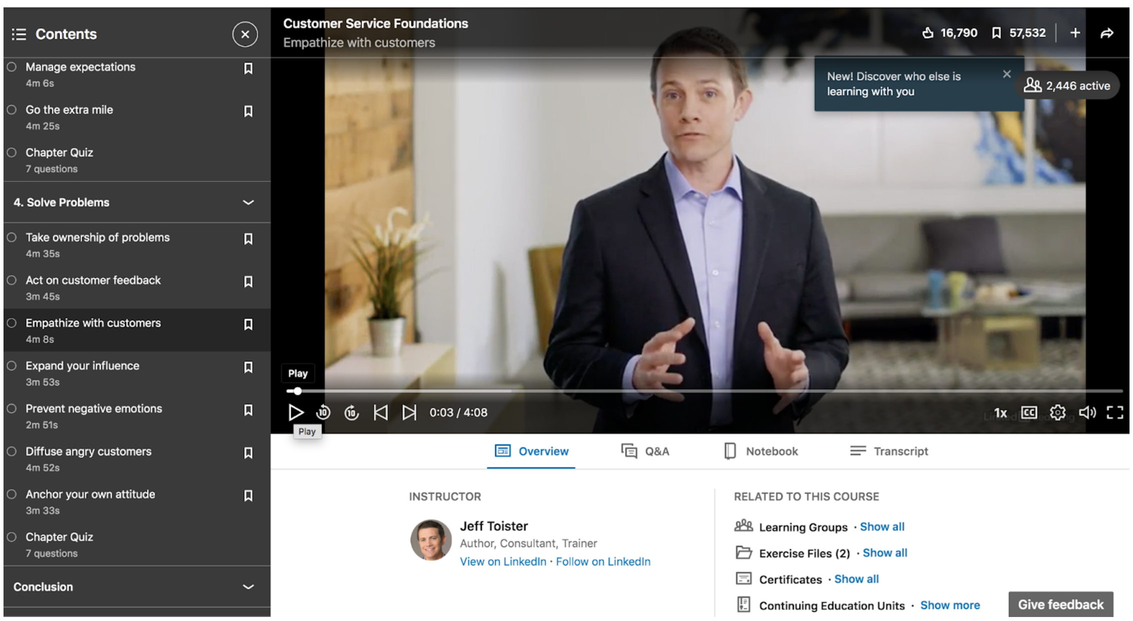
Note. From *Nursing's Medication Administration Safety Simulation Program Makes an International Impact* by News@ODU, 2020, Old Dominion University. https://www.odu.edu/news/2020/7/virtual_clinical_mod#.YzTy4i-B01I

Future Directions

Examples of good MOOC design appear in MOOC platforms like Coursera, EdX, or LinkedIn Learning. These examples appear most in enterprise and higher education. However, more and more asynchronous learning experiences are available for K-12, like Khan Academy, and for continuing education, like Skillshare. Within each of these platforms are robust features able to facilitate the administrative side of MOOCs - tracking enrollment, progress, and completion. From an instructional message design perspective, lessons are well-organized, multimedia is used effectively, activities are diverse, and there are several features that allow students to manage their learning experiences from beginning to end. The screenshots, Figures 10-13 below are from a LinkedIn course on Customer Service; they feature a handful of effective message design examples.

Figure 10

LinkedIn Learning - Customer Service Foundations Course



Note. From *Customer Service Foundations* by LinkedIn Learning, 2021.

As shown in Figure 10, Learners can select which lessons to view under the heading **Contents**. The videos include real people who speak in a casual, friendly tone and use relaxed facial expressions, gestures, and body movements. Learners can access learning groups, exercise files, certificates, and continuing education units under the heading **Related to this Course**, and most impressively, learners can interact with the instructor and other learners within the same asynchronous space.

Figure 11

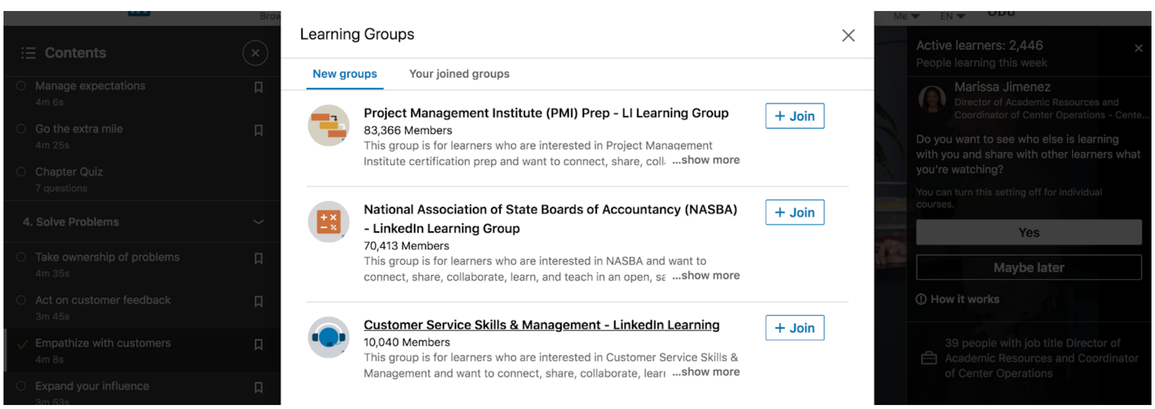
LinkedIn Learning - Customer Service Foundations, Active Learners

Note. From *Customer Service Foundations* by LinkedIn Learning, 2021.

As shown in Figure 11, learners can see other 'active learners' who are taking the same course and are given opportunities for learners to connect with them.

Figure 12

LinkedIn Learning - Customer Service Foundations, Learning Groups

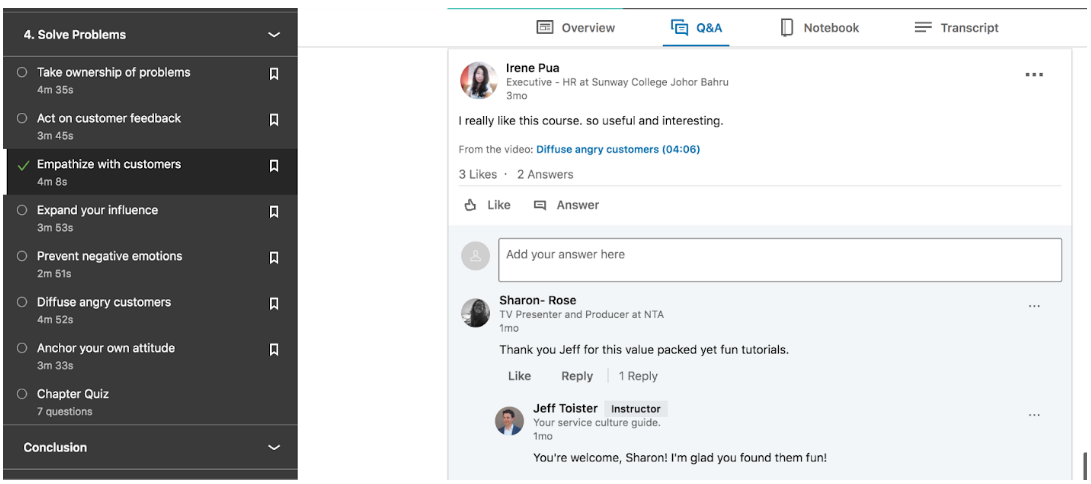


Note. From *Customer Service Foundations* by LinkedIn Learning, 2021.

As shown in Figure 12, learners are given opportunities to join ‘Learning Groups’ relevant to the content of the course, thus extending learning outside of the online course.

Figure 13

LinkedIn Learning - Customer Service Foundations, Q&A



Note. From *Customer Service Foundations* by LinkedIn Learning, 2021.

As shown in Figure 13, learners are able to ask the instructor or other learners questions under the **Q&A** tab, very similar to a discussion forum or social media thread.

Conclusion

While enterprise platforms like LinkedIn Learning are robust examples of MOOCs, institutions and other learning organizations can build similar learning experiences given effective instructional design and instructional message design techniques. Yes, asynchronous learning can make students feel lonely, overwhelmed, or disengaged, but leveraging instructional message design strategies to improve social presence can be the best way to combat those challenges. Personalizing learning and the learning environment and creating opportunities for engagement and collaboration should be priorities for anyone who wants to improve asynchronous learning experiences.

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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 5: A Brief Introduction to Instructional Message Design in Synchronous Online Learning Technologies

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5. A Brief Introduction to Instructional Message Design in Synchronous Online Learning Technologies.

Spyridoula Tsouganatou

Key Points:

- The main benefit of synchronous learning is that it enables students to avoid feelings of isolation.
- A student is able to engage, interact, and actively learn with the instructor and other students in real-time, from any location with a reliable Internet connection.
- Virtual classrooms allow students and instructors to communicate synchronously using features such as audio, video, text chat, interactive whiteboard, and application sharing.

Abstract

This chapter will analyze and discuss concepts related to instructional message design as it relates to synchronous online learning technologies. Synchronous online learning is becoming increasingly popular especially in the pandemic era and it is able to provide students with a lot of opportunities and benefits for their learning processes. This chapter specifically will provide an analysis of the major benefits and challenges of synchronous online learning technologies. It will also discuss learning platforms such as Zoom, that can be used to further provide the reader with concrete examples of an online tool that is able to successfully develop a synchronous and virtual classroom environment. Synchronous, real-time, active

learning is an ever evolving toolset that instructional designers can use to engage and create social presence in online classes.

Key words: synchronous learning, online technologies, Zoom, instructional message design.

Introduction

This chapter will analyze synchronous online learning technologies as they relate to instructional message design best practices. Two modern methods of instruction include synchronous and asynchronous learning environments. Asynchronous learning is described as a learning environment designed to allow learners to learn at different times and spaces convenient to the individual learner. In other words, learners in this environment can set up their own pace in the learning process. Whereas synchronous learning can be described as a learning environment that provides online learners with a platform to learn at the same time and location, virtually or in-person,with their classmates and instructors (Finol, 2020). Synchronous learning can include live in-person classes or live online meetings with the aid of technology with large or smaller groups of students.

Synchronous online technologies and applications play an essential role in modern society, specifically in the education sector. Synchronous learning refers to learning happening at the same time for all learners. From a historical perspective synchronous communication in online learning began even before the widespread use of computers in synchronous instruction. In the very early stages of distance education synchronous forms of communication were created through broadcast radio and television. During the 1980s, technology evolved and students had the opportunity to now communicate and interact with each other through video conferencing platforms and interactive television. Furthermore, the evolution of computer technology and the Internet further assisted the development of synchronous learning environments (Brydges, 2000).

As technology has advanced, so too have technologies and applications which aid in improving instructional methods. Technologies and applications such as Skype, Zoom, Teams, and other web conferencing applications have contributed significantly to education, especially during the time of the COVID-19 pandemic (Stefanile, 2020). They have proven to be an alternative method of instruction for many educators in primary/secondary schools, higher education, and industry (Hacker et al., 2020). There are specific features of synchronous online technologies that make them synchronous technologies and applications valuable and successful. Some of the synchronous tools that educators use and find beneficial are the following (Reimers et al., 2020):

- Microsoft OneNote
- Microsoft Teams
- Ed Dojo
- Zoom
- Screencastify
- SEQTA
- Moodle
- Seesaw
- Google Suite
- ManageBac
- Google Classroom
- Quizlet
- Kahoot
- Nearpod
- FlipGrid

A common feature of these synchronous tools (and many, many more like them) is that they are designed to allow for easy access to information and edits. Additionally, students can easily engage and interact with one another, which develops a sense of community and further aids in their learning. Popular contemporary social media forums speak to the user base and features of several of the most popular web conferencing platforms, see Figure 1 (Morris, 2020).

Figure 1

Example of Video conferencing tools and their features

Video Conferencing for Schools

	Price	Length	Participants	Live stream	Record	Grid view	Breakout rooms	Join without account
zoom	Free basic plan	40 min (No limit with edu account)	100	✗ Pro only	To computer	49 people	✓	✓
Teams	Free basic plan	No limit	250	10k viewers	✗ Paid only	4 people (update to 9 soon)	✗	✓
Meet	Free until Sept 30	No limit	250	100k viewers	Google Drive	4 people (3rd party extensions available to allow more)	✗	✓
Webex	Free basic plan	No limit	100	✗ Paid only	To computer	25 people	✓	✓

theedublogger.com/video-teaching-learning edublogs

Note. Modified from Morris (2020), http://www.kathleenamorris.com/2020/06/01/video-tools-teachers/compare-zoom-teams-meet-webex-edublogs-oct-2020-update/

Collaboration

Through the use of technology, synchronous online learning can facilitate and promote further collaboration among students and educators. Communication tools such as audiovisual resources are available to students and instructors to simultaneously participate in the learning process. In addition, through collaboration in online synchronous web conferencing instruction, the emotional and social expression of the students is further promoted. The latest research on online learning technologies supports the idea that synchronous online learning is superior to asynchronous online learning (Hacker, Brocke, Handali, Otto, & Schneider, 2020), due to its ability to provide real-time feedback and clarity of communication through verbal and non-verbal communication. Discussion forums, for example, a significant component of asynchronous online learning, has been shown to be among the online tools with the lowest capability of conveying feelings and emotions. Feelings and emotions are, however, an integral part of learning. Synchronous learning technologies can successfully overcome barriers like this (National Academies of Sciences, Engineering, and Medicine, 2018).

Social Presence

Research has demonstrated that synchronous online learning technologies and environments have social presence benefits for learners and the instructors (Ramlatchan & Whitehurst, 2019). Furthermore, characteristics of those environments such as real-time engagements and active learning contribute significantly to the sense of social presence, promoting the learning process (Ramlatchan & Whitehurst, 2019a; 2019b).

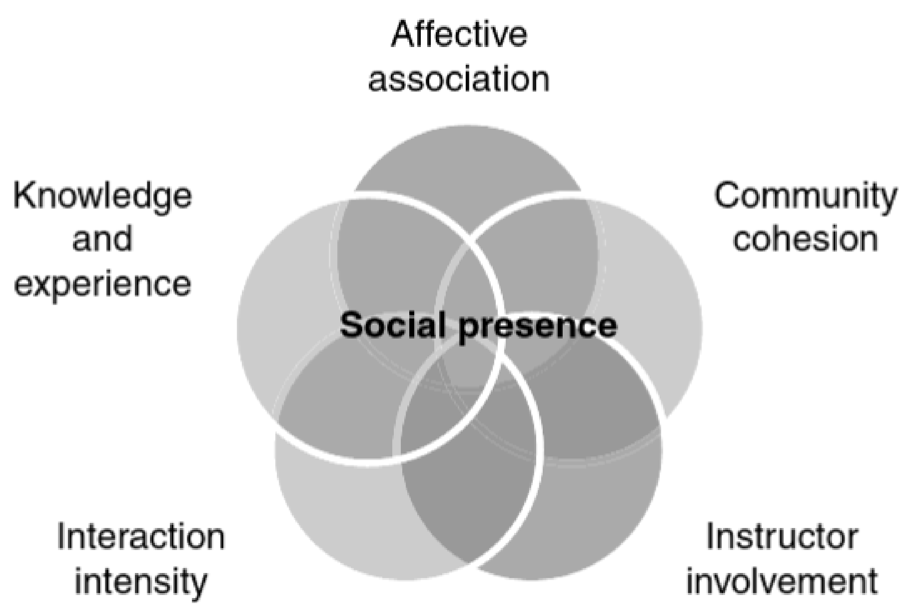
Motivation and learning effectiveness are of crucial importance in synchronous learning environments. For effectiveness and motivation to be supported, educators have to enhance the social presence aspect of the learning environments (Ramlatchan & Whitehurst, 2019). Social presence in learning is the sense students have that they are interacting with an authentic instructor. Synchronous learning activities could increase social presence and thus increase the students' motivation and effectiveness and the learning outcomes. Specifically, students who participated in live interactive telepresence treatments rated their instructor higher concerning immediacy (Ramlatchan & Whitehurst, 2019a).

As virtual classrooms and online learning are becoming more popular, it is essential and critical that instructional systems are re-evaluated for their effectiveness. Ramlatchan and Watson (2019a; 2020), found that to increase instructor immediacy and credibility in synchronous learning environments, educators and instructional designers should consider many aspects. First, the content during the presentation in synchronous settings must be presented to students in order that the instructor's credibility and immediacy are maximized. In addition, instructors and designers should emphasize designing the appropriate content rather than emphasizing which technological device to use.

Lastly, Ramlatchan and Watson (2020), showed that having a blend of human instruction and some form of multimedia instruction (animation, graphics, or other visual content) can create a thriving learning environment that has the quality to engage learners. Online students prefer being able to see video of their instructor along with their instructor's presentation content, at the same time, and most web conferencing platforms allow for this social presence feature.

Whiteside, Dikkers, and Lewis (2017), state that almost 71% of academic instructors and leaders view online synchronous learning as critical in their strategy and the future of their institution. The researchers further developed a social presence model that presents the aspects that lead to the successful development of social presence during online synchronous instruction. Their social presence model describes five significant components of social presence: effective association, community cohesion, instructor involvement, interaction intensity, and knowledge and experience. The image below demonstrates and presents the aforementioned social presence model (see Figure 2).

Figure 2
Whitesides's Social Presence Model



Note. Social presence in our online classes is a blend of several related factors, modified from Whiteside (2015) https://olj.onlinelearningconsortium.org/index.php/olj/article/view/453

In addition, the researchers provide specific strategies that educators and instructional designers can utilize to enhance connectedness in online synchronous learning environments. Those strategies are designing an intuitive, organized environment for learning, cultivating a connection to build a sense of community among students and instructors, connecting content to applied and authentic learning experiences, comprehending in depth a variety of tools and media, harnessing reflection and prior experiences and providing early and continuous feedback to the learner (Whiteside et al., 2017). For example, to design an intuitive organized learning environment instructors and instructional designers can follow various paths. Designing a learning environment that is planned, organized, and intuitive is the first step to integrate and increase a sense of social presence. Students as well as instructors must have the confidence that the online learning space is completely functional and simulates completely the interaction they have in a face-to-face classroom (Whiteside et al., 2017). Instructors should create a well-designed course that is meaningful and interrelated using a systems perspective. Prior to the delivery of the course, instructors must create appropriate materials such as modules, lessons, and folders that will allow for the learning process to take a predictable path until completion (Whiteside et al., 2017).

Frustration and confusion can often be created in students during their learning in synchronous settings if the navigation tools are unclear and do not provide enough guidance to students. Instructional message design research suggests 10 fundamental components for distance education that instructors and instructional designers can utilize to structure an online course. Those components are: course modules, announcements, instructor information, course information, discussions, assessments, submissions, course support, emails, and grades (Whiteside et al., 2017). Additionally, emphasis must be given to designing those courses with formative assessment options and encouraging change for improvements.

Web conferencing applications: Engaging online synchronous learning technology tools

Zoom is an example of an online platform that offers various features that contribute successfully to the development of a synchronous online learning environment. It incorporates a variety of active online structures that are backed by cognitive neuroscience in order to promote learning (Brennan, 2020). Zoom's online structures can offer a successful online synchronous learning process, including polls, chat features, breakout rooms, and whiteboards. Instructors can use polls in various ways such as icebreakers, prediction polls, for reflection, gallery polls, closing polls, and survey polls. Polls offer the opportunity for students and instructors to receive real-time feedback. In addition, polls enhance clarification and reinforcement of concepts that were discussed during the online lecture (Brennan, 2020).

The next feature that Zoom has to offer is live text chat. The chat feature can be used for a variety of purposes. Specifically, it can be used for feedback, for reporting, for quizzes. When students are assigned into pairs or groups then the chat can be used for networking, debate, and group discussions. Whiteside et al., (2017), recommend that educators use the chat feature wisely during instruction time because many times it can distract the students from the lecture. Overall, the Zoom chat feature can engage the learners actively, promoting and advancing successful learning.

Breakout rooms are the next feature that Zoom offers, and it can replicate the small group work of the physical classroom that instructors often want to apply. In addition, breakout rooms can be utilized as icebreakers, for collaboration over exercises, for talk-arounds, for read-arounds, as topic rooms, observer trios, and many other possibilities. Active learning is promoted through breakout rooms by providing the ability for students to actively speak, write, analyze, and create instead of passively listening to the online lecture (Brennan, 2020).

The Main Session Room feature on Zoom can also be utilized during instruction. It is an essential feature on Zoom, and it is the place where most of the time is spent. Instructors can use it for strategic storytelling to introduce a topic and provoke students' interest in a specific discipline and of essential concepts. In addition, the Main Session Room can be used to invite guests during the lecture who will aid further in the comprehension of the concepts and are often individuals who have impacted the field significantly. One-minute papers can also be conducted in the Main Session Room and thus give the students an opportunity for introspection and thoughtful reflection (Brennan, 2020).

Additionally, by preemptively organizing folders and modules, instructors can create Learning Stations to engage students in the learning process. Thus students are introduced to the topics at the start of the lecture. This activity should take them about ten minutes to explore the whole module. Another idea and concept, to utilize in the Main Session Room, are Scoring Clusters. Through this activity, the instructor will hand out a file to the students with an article. After reading the article, the students will have the opportunity to answer questions related to the article and scale their responses on a scale from 1 to 3 (Brennan, 2020).

Lastly, another important social presence feature of Zoom is the ability it provides students and instructors to share their screens. An instructor can allow students, a guest lecturer, or a teaching assistant to share content this way during the lecture. Some of the best practices for screen sharing are verifying that Co-host feature is enabled, verifying screen-sharing button is enabled, assessing the screen-sharing settings during the live meeting, and assigning co-hosts (University of California, 2021).

Zoom Fatigue

The increased participation of students in synchronous online learning environments through Zoom and other online platforms, especially as a direct outcome for the pedagogical needs during the COVID-19 pandemic, means that students spend numerous hours on these video conferencing platforms (Brennan, 2020). This can often lead to the feeling of fatigue in students which can further negatively impact their learning process (Brennan, 2020). Instructors can implement various steps to minimize this effect on students. Fatigue can have various forms such as video fatigue, audio fatigue, physical fatigue, cognitive fatigue, and social-emotional fatigue. For example, some strategies that instructors can implement to minimize the cognitive fatigue of students is to avoid multitasking, practice focusing, and use learning breaks. Cognitive fatigue is directly related to working memory and cognitive processes that overload cognition and negatively affect the learning process (Brennan, 2020).

Future Synchronous Learning Environments

Overall, synchronous and asynchronous online learning technologies have distinct features that make them effective in different learning situations. Educators and instructional designers should be aware of every feature that contributes to a successful learning environment and process for their students. In addition it is crucial that more research is conducted about best practices in synchronous learning technologies for their use during instruction. One particular area that is very interesting, more research should be conducted in classes where students must always turn their camera on during the lecture. More social presence research would give insights and open-minds about the issue. Some features that synchronous collaboration tools offer that asynchronous environments lack are instant messaging, application sharing and whiteboard (Xu & Zhang, 2008). It will be interesting to see how options and features continue to introduce innovation to online learning tools.

Conclusions

To conclude, this chapter provided a brief introduction and analysis of several synchronous online learning tools. These tools exist to provide the opportunity for educators and instructional designers to participate in online learning environments that give them access to many of the features that a traditional classroom offers. Educators and instructional designers should continue their research efforts to improve online synchronous platforms and web conferencing tools. While there are many online tools, instructional message designs that foster social presence will best help meet the needs of our online learners. Instructional message designs and the selection of tools that allow for spontaneous, real-time communications will help enhance and create active learning environments for our online learners.

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Instructional Message Design:
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Chapter 6. Instructional Applications of Augmented and Virtual Reality

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6. Instructional Applications of Augmented and Virtual Reality

Yolanda Montague

Key Points:

- Virtual and augmented reality can be used as another tool for educators to increase engagement and provide students with hands on experience.
- Many options exist for educators when choosing virtual and augmented reality programs, but caution is necessary in order to avoid selecting options that increase extraneous load through over stimulation.
- There are cost barriers associated with including these elements, but there are also options to alleviate those issues.
- The future of virtual and augmented reality is vast, but should still be approached with caution.

Abstract

Virtual and augmented reality are two examples of message design tools in the arsenal of educators that can be employed in order to create relations between content and the real life experiences of students. Virtual reality can take many forms and augmented reality may be an option that provides more relatable hands on experience for learners. As leaders in education are on a continual journey towards more innovative means of teaching, these two choices provide opportunities for educators to be innovative, while maintaining learning as the primary focus. Within the realm of both virtual and augmented reality, there are many options, which allows educators to

amend the tools to best meet the needs of their students. When referring to education, training for military and medical personnel is also included.

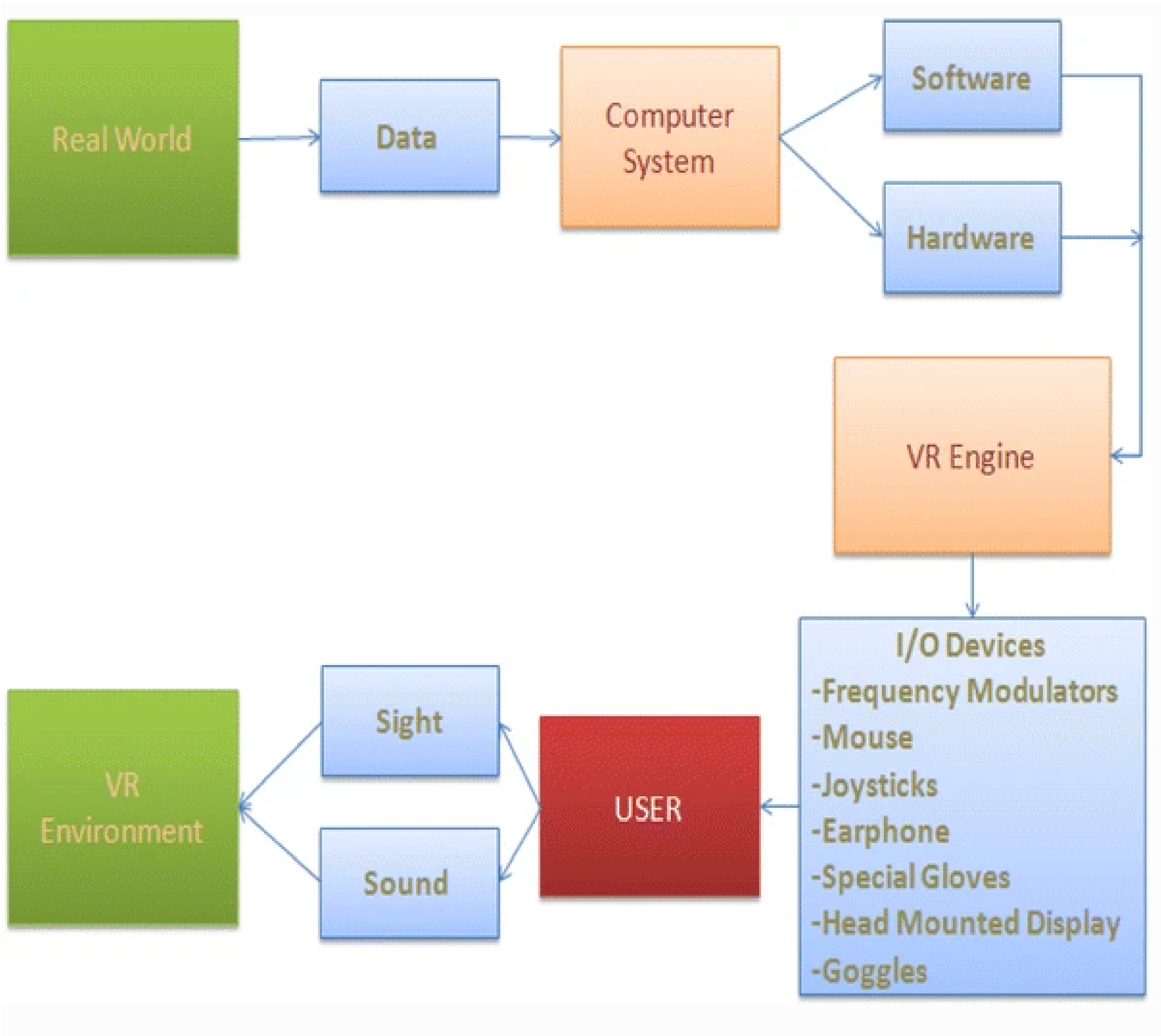
Introduction

In the world of cinema, there are countless examples of a future where individuals have video phones, answer video calls in their vehicles, or even hold a screen up that superimposes an image into the parameters of an existing space. The distant future has arrived and although such examples may have been for entertainment, we now have the option of using such technology for the purpose of providing hands-on educational experiences. Many educators have lamented the fact that it has become more difficult to maintain the attention of their students (Dontre 2020). They seem to be competing against technology that provides constant draws for attention in addictive and entertaining ways. Then, students come to classrooms where they have to focus on one individual who may use a projector screen and an online presentation program. The chasm is vast and difficult to bridge. Also, we are developing a more in depth understanding of the human body and because of this, there are advances in health care which require more precise tools. In order to be able to use those tools, students need opportunities for practice that reduce or eliminate the risk associated with learning on live patients. In comes the chance to engage students in lifelike simulations affording them the ability to physically practice these new skills. Within the military, there is also a great need for opportunities to hone in skills before applying them in high stakes situations. As with any innovation, there is cost associated with its inclusion. Through creative workarounds and enlistment of grants, groups can find a means to employ virtual and augmented reality opportunities for their learners.

Defining Virtual and Augmented Reality

Saposnik & Levin (2011) describe virtual reality as "...a computer-based technology that allows users to interact with a multisensory simulated environment and receive 'real-time' feedback on performance” (p. 1380). Saposnik & Levin (2011) go on to explain that a virtual environment can take on a variety of appearances. Virtual reality is not limited to the game-like experience where users are completely alienated from their physical environment. Figure 1 shows a visual representation of the pieces of virtual reality. According to Ma & Choi (2007) the difference between augmented reality and virtual reality is that, “Augmented Reality never lets a user lose a sense of reality with virtual factors” (p.33). Virtual reality leaves the user completely immersed in a virtual environment, while augmented reality places the virtual elements into the actual reality of the users, both for the purpose of simulating an experience. A more encompassing term for virtual reality and augmented reality is called extended reality and these terms also compensate for the inclusion of mixed realities.

Figure 1
The Elements of Virtual Reality



Note. A visual representation of the elements of virtual reality, data derived from real world systems informs what becomes the virtual environment. From "Virtual reality and its military utility" by Ajey Lele (2013, p.20).

The Use of Virtual and Augmented Reality in Education

Public Schools

Teachers are notoriously strapped for time. It does not take much in the way of searching to find discussions in relation to teachers who have too many demands and not enough time to meet them (Hill 2019). This being the case, is the addition of another set of tools beneficial or the next shiny tool forced on educators by administrators who want their schools to be cutting edge? Too often, educators are given the latest and greatest technology. They are shown how to use it, but there is usually no explanation/examination of how to effectively implement the tool for the purpose of learning (Gilakjani 2013). For example, a teacher is shown how to use the online guided programing site Scratch. They may have a working knowledge of how the program functions, but how does that help them understand the possibilities of implementation in their curriculum? Will they need to then spend more time learning how to include the tool? The answer is, "yes." Once educators are given more learner focused training on the implementation of the tools, they can begin to find ways to effectively include virtual and augmented reality in their classrooms.

The COVID-19 Pandemic of 2020 and 2021 has shown the world that innovation is not an act of futility. Schools across the globe closed their doors and those in education had to instantly convert their in person learning to fit a distance education model. Many felt overwhelmed and that they could not manage this new way of educating their students (Long 2020). In addition to a number of social learning aspects that had to be altered due to the unforeseen switch to virtual learning, one element of elementary education had to be completely revamped: field trips. There was no option to take groups of students together on school buses to visit sites. Here comes virtual field trips. Those school divisions that already had looked into and/or used Google Maps for virtual tours were able to readily make adaptations to something so pivotal as elementary school field trips. Students may benefit on a number of levels from the use of virtual reality field trips. According to Blascovich and Bailenson (2011), the virtual field trips may remain with students for an extended period of time. If this is indeed the case, educators can use that connection to their advantage. They can create activities for after the virtual experience that would continue to draw upon and make connections to their experience. They could, in turn, retain more information which could result in a better understanding of the content that educators are learning.

There are limitations to the effectiveness of implementing virtual and augmented reality tools. The learning is only as effective as the tool (Markowitz et al., 2018). If the simulation is not one that is transferable due to the technology itself or maybe even the learner's experience within the simulated environment, learning may be disrupted. Arcades are a great example of virtual or augmented reality experiences that aren't always for the purpose of learning. Some of the motorcycle simulation rides are entertaining, but don't allow the user the chance to test and practice skills that would be necessary in order to obtain a motorcycle license. Instead, the objective may be to complete a course before the other competitors. This goal would not necessarily assist the participant in learning how to shift gears, braking and maintaining appropriate speed for example, but would supply a somewhat similar experience to riding a motorcycle. In many arcades, there are examples of extended reality but the purpose is enjoyment, not actually learning how to ride a motorcycle. This is the issue that educators must address during implementation. The purpose of the simulation has to remain in the forefront. Another important aspect to consider is the introductory period. If students are new to the concept of using such tools in their learning, they must first get past the initial newness in order to get to the learning goal (Jensen, Koradsen, 2018).

Medical Education

Is it necessary to simulate a surgical procedure before medical personnel perform said task on patients? From an instructional message design perspective, and given the the many simulation options available, it should be. There was a time when, if a patient arrived with a toothache, the tooth was externally examined and, if deemed necessary, removed without the use of anesthesia. As we have learned more about the function of the components that make up the human body, we have a need for more invasive procedures. In an article by Botden & Jakimowicz (2008), virtual and augmented reality have been tools used to offset the possibility of critical issues being caused by surgeons. They discuss how augmented reality simulations are preferred over virtual reality simulations because of the opportunity to include physically handling tools of the trade versus just in an abstract sphere. These experiences also give students an opportunity to receive correction in the moment as they are not removed from the physical environment. Diana & Marescaux (2015) discuss how the use of virtual simulation can reduce the recovery time of patients as medical practitioners are becoming more precise with their ability to perform procedures. Universities are using their augmented reality opportunities as a means of recruitment. Mary Baldwin University has an image and an explanation of how they incorporate experiential learning into their curriculum. This is to show prospective students that they will have the opportunity to have hands-on experience versus just discussions in lecture halls. Figure 2 represents a student working with another student in a lab simulation that includes the use of attachments to monitor the student who is in place of a patient (Mary Baldwin Website, n.d.).

Figure 2

Students using an augmented reality environment to practice skills.

Note. Students benefit from using augmented reality environments to practice skills in low-risk simulations. (https://marybaldwin.edu/health-sciences/about/campus-facilities/).

Military

As mentioned before, military personnel are responsible for performing many high stakes tasks and it would be extremely beneficial if they could perform such tasks in a virtual environment before ever implementing them in practice. For example, Livingston et al. (2002) explains that warfare is shifting. No longer are troops being tasked with open space combat situations. They are finding themselves in urban combat situations. Troops will need to be able to access pertinent information pertaining to the urban structures and layouts without taking their attention away from their surroundings. Also, Lele (2011) describes the employment of virtual reality in order to reduce the possibility of error when constructing military equipment, such as complex aircraft. Military personnel can simulate the building of a piece of equipment and have the opportunity to compensate for any issues without the potential of operator harm. Symposiums have been held in order to discuss and display options for using augmented reality in the rehabilitation process for patients. Figure 3 is an advertisement for an event that was held in order to discuss augmented reality and its use with medically disabled military veterans.

Figure 3
Augmented in Health Care

Note. Example of augmented reality research being included in mainstream health care. (https://acrm.org/meetings/2019-annual-conference/).

Tools of the Trade

Education

As mentioned previously, one resource that may be more approachable is the creation of virtual tools through the use of Google Maps. Either through sharing their screen on the devices of their students or sharing the information on a projected screen, teachers can walk students through environments and locations that they actually would not even be able to explore on a standard field trip. Through the use of Street View and Pegman, an educator can pick a location on a map and walk the students through any city that has been mapped by Google. For example, while learning about Virginia history, a teacher could walk students through Jamestown. The students could be tasked to look for certain markers or find where they are on the virtual field trip in comparison to an older map of the same area. Educators could also use the street view to have students travel along a watershed for a science unit in order to have a visual representation of where their water may originate. Google also has created another avenue for students to have a virtual reality experience called Google Cardboard as shown in Figure 4. According to the Google Cardboard site (n.d.), students explore space, go on tours with actual tour guides, fly and more. The device is simple to put together and they range from $8.95 to $39.95. Another virtual reality experience is available through a free resource called NearPod. Teachers can sign up with their Google accounts and create interactive lessons that would include a virtual reality component. Students will have the choice to see 360 views of Mars, The Great Wall of China, The Great Barrier Reef, and more with or without the use of VR goggles (Nearpod, 2022).

Figure 4

Google Cardboard Goggles

Note. Cost effective mixed reality via Google Cardboard goggles and a smartphone (Flickr).

Medical Education

Diana & Marescaux (2015) go into detail about the many tools that are implemented in the medical field in order to simulate medical procedures and provide more training in general. For example, a 3D simulator that allows medical professionals to examine parts of the human body in more depth in order to gain a better understanding of the specific parts. This allows trainees to have more accurate representations and therefore, reduce the chance of error when operating on when discussing options with patients. One such simulation is in reference to applying a catheter to a patient. This procedure can require many practice attempts before a practitioner is able to perform it on a live patient. Virtual reality simulations allow for such practice in a reduced risk situation (Bodhi Health Education, 2020). These simulators also allow trainees to have a 3D representation of specific organs of patients in order to work through possibilities before actually performing any procedure. There are other augmented reality devices that have been employed in the medical field that assist in active procedure.

One such item is the da Vinci® Surgical Robotic System. This system allows for practitioners to have a 3D representation of the area of operation during the actual procedure. From their location, they are able to manipulate a camera in order to have differing views of the area. There are also benefits in wound securing when employing augmented reality devices. Wounds can be secured more thoroughly, which will result in less healing time and reduced risk of infection. Also, devices that employ augmented reality can reduce the amount of blood loss (Diana & Marescaux, 2015). Touch Surgery Dynamic has developed an iPhone and iPad enabled app called Touch Surgery: Surgical Videos. This app allows medical professionals to watch informative videos, as well as practice surgical procedures using 3D images. The procedures aren’t reserved for one field of study, they pertain to many areas of the medical field.

Military

One important augmented reality tool employed by the US Military is BARS or the Battlefield Augmented Reality System. Livingston et al (2002) explains that this system was developed in response to the shift in wartime situations. Figure 5 shows what these devices look like at their current status of development. As the face of the battlefield has changed, soldiers are more often finding themselves faced with handling combat in areas that are not open spaces. They have to navigate terrain that includes buildings and structures in tight spaces. In such situations, it can prove fatal to remove their eyes from their surroundings. BARS was invented to alleviate the need to look at physical objects in order to become oriented to the physical space. Now, there are heads up displays that can provide building layouts and even track the emotional status of users. For example, if a soldier is being provided with a great deal of information in a situation that requires a great deal of concentration, that extraneous load can prove to be counter productive. It may indeed prove to be a distraction rather than an aid to the user.

Figure 5

Augmented Reality Headsets

Note. This figure displays US Army soldiers wearing augmented reality Microsoft Hololens headsets. Modified from https://www.popularmechanics.com/military/a30898514/mixed-reality-goggles-army/

Funding

Now, after hearing about all of these great options, what happens in situations where there are limited resources? Funding is often limited when working in public k-12 education settings. Educators have to become creative with the materials that they are able to access. One option as a potential work around is creating discourse around the subject of virtual and augmented reality in relation to education. Teachers, specifically, can reach out to their IT departments in order to get a general idea of what resources are being used in their school districts. If they learn of a resource that has already been purchased and in use, that would be a great place to start as far as getting in contact with whomever has the resources at that time. Also, teachers may find that there are resources that have been purchased, but aren't being used. In a blog post written by Auletto (2016), school districts have spent large sums of money on entertainment and food orders, which has prompted investigations into getting more transparency about how tax dollars are spent in public education settings. For those looking to capitalize on already purchased resources, this issue can work in their favor. Leaders in school districts don't want to seem wasteful knowing that spending may be under a metaphorical microscope.

Reaching out to the technology department may also help because Instructional Resource Teachers may be able more directly point teachers in the direction of colleagues who are already using some of the technologies. Educators can also look to their local, state or nationwide education associations in order to apply for grants. For example, in the state of Virginia, there is the Virginia Education Association and this organization provides the opportunity to apply for grants of up to $500 which are awarded annually. The website for the National Education Association also provides a search tool in order to query federal funding options for education (National Education Association, 2022). Grant writing can be intimidating, but one of the great aspects of applying for these grants is that it can be a collaborative effort. Using the connections with colleagues that can be provided through a technology department, teachers can call on each other in order to obtain funds to purchase equipment. As of May 28, 2021, according to Macias (2021) in an article on CNBC, the request for the 2022 Defense Budget was $753 billion. Within that budget,

$715 billion is being requested specifically by the Pentagon. As such, funding for Augmented and Virtual Reality tools is much easier to access. Unlike their counterparts in the public education sector, US Military personnel can look to their departments and their allocation of funding for the equipment that they will use. More extended reality systems for military use are becoming not only more sophisticated but more affordable. Within the medical community, funding takes a consumer based route. Ultimately, consumers are taxed and those taxes go to the medical centers, consumers also pay insurance premiums and pay other expenses that are not covered by insurance providers. Those profits are what should used to pay for the various elements of health care facilities, including the use of new technology in training and in surgical procedures (National Library of Medicine, 2017).

Conclusion

In terms of instructional message design, virtual and augmented reality can be tools that lend themselves to integration in many facets of education and training in our world. The medical field has benefited tremendously from the integration in that the possibility of egregious medical errors has been greatly reduced due to the use of medical simulation using both types of realities as the means of providing practice. Patients can be more confident in their practitioners and practitioners can be more confident in their ability to deliver safe medical care. Within the military, US troops can have up to date training that applies to the ever changing landscape of war situations. They can feel confident knowing that their equipment will provide appropriate aid for urban combat zones. Within education, K-12 educators can now more easily find affordable resources that would allow students to have experiences that would be difficult to duplicate without the use of virtual or augmented reality. There are still some barriers for the inclusion of these two realities, or extended realities. Instructional designers must keep the learning task as the focus and be diligent as to not allow the features that make extended reality beneficial to become a hindrance. As new technologies are developed, the possibility to better prepare learners through the use of these solutions may become even more prevalent.

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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 7. Message Design for Healthcare Simulation

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7. Message Design for Healthcare Simulation

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Key Points:

- Educational simulations use experiential learning to place learners in an environment that mimics reality while minimizing risks to students and patients.
- Well-designed simulations promote learning by structuring each learning experience to include specific learning points, coaching, and feedback.
- Learners gain cognitive, psychomotor, and affective skills through participation in simulation.

Abstract

Simulation is a teaching method that motivates and engages learners (Ifenthaler et al. 2020; Martin & Betrus, 2019), can provide better student performance outcomes compared to traditional classroom education (Chernikova et al. 2020; D'Angleo et al., 2014; Di Natale et al., 2020; Gralnick & Levy, 2011; Pellas et al., 2019), and can even replace some real-world learning experiences (Alexander et al., 2015). Instructional designers who develop healthcare simulations should use relevant learning theory and instructional message design to ensure that the simulation is learner-centered and based in evidence-based practice to maximize the potential for the learning experience.

Introduction

Simulations are used as an educational tool in many different industries. Pilots learn to fly on flight simulators. Students learn chemistry phenomena in digital laboratories. Health care providers learn patient care skills on mannequins and models. If you think about it for a few minutes, you can probably name a few times where you learned something new through a simulation. For instance, have you ever asked “Annie are you OK?” in a cardiopulmonary resuscitation (CPR) class while preparing to start chest compressions?

Simulation has many benefits as an education strategy. This interactive method is linked with increased learner motivation (Ifenthaler et al. 2020; Martin & Betrus, 2019) and improved performance over other classroom strategies (Chernikova et al. 2020; D'Angelo et al., 2014; Di Natale et al., 2020; Gralnick & Levy, 2011; Pellas et al., 2019). Simulation offers an opportunity for students to participate in experiences that might be rare to students in the real world, such as a cardiopulmonary arrest, a stock market crash, or a NATO summit. It also provides an opportunity for students to learn without exposing them to the risks of a real-world situation. The student pilot can crash the simulated plane without getting injured or the expense of plane repair/replacement. Simulation also allows an opportunity for students to deliberately reflect on situations to enhance learning that might be missed in a real-world experience (Chernivokva et al., 2020). The reduction of risks is evident in the Marine Corps’ aviation policy that requires achievement of acceptable performance in simulation prior to attempting the skill in a live flight (United States Marine Corps, 2011).

Simulation also allows educators a chance to demonstrate abstract concepts and to speed up time consuming tasks into a single class period. Not only is simulation a more effective strategy for improving student performance compared to traditional classroom based methods, but it can also be an effective replacement for real-world experiences. A landmark study by the National Council of State Boards of Nursing (Alexander et al., 2015) found that up to 50% of clinical experiences could be substituted with simulation. These findings were without any statistically significant differences in pass rates on the National Certification Licensing Exam (NCLEX) or job performance after graduation as compared to students who completed all clinical experiences in a health care setting.

Not all simulations are created equal. A simulation that fails to give feedback to the learner misses an opportunity to maximize germane cognitive load and promote learning. A simulation that includes confusing messages or includes information that is not related to the intended outcome increases extraneous cognitive load and takes away from learning. A simulation that intends to promote behavior change but only allows students an opportunity to practice a physical skill could fail to meet the learning objectives. Simulation experiences without proper planning or a basis in learning theory result in learner confusion and decreased performance (Lateef, 2010).

To maximize the effectiveness of simulation-based learning, the instructional designer should use message design theory to apply instructional and learning theories to design the simulation. The goal of the simulation is to accomplish the learning objectives, meet the learner needs, utilize available technology effectively, and facilitate feedback to both student and educator (Kern, et at., 2016). To assist with the design process of healthcare simulations, this chapter will introduce simulation-based education, review the history of simulation-based education, evaluate research outcomes of simulation-based education, and discuss relevant learning theories. This chapter will also give a general overview of the development of simulations, especially those that are learner-centered in meeting the intended objectives and based on research findings.

What is Simulation-Based Education?

Simulations are a form of experiential learning where learning is accomplished by doing. Simulation consists of an "artificial representation of a real-world process to achieve education goals via experiential learning" (Abdulmohsen, 2010, p. 35). The objects in the learning experience might be real representations of objects, real objects, or virtual objects. In some experiences, real equipment may be altered for learner safety, such as disabling a defibrillator to allow learner interaction while protecting the learner from an accidental shock. Regardless of digital or real-world format, the learner actions and decisions during the simulation alter outcomes in the experience providing feedback to the learner through experiential learning (Heitzmann et al., 2019; Martin & Betrus, 2019).

Simulations exist on a continuum between visualizations and complex games (D'Angelo et al, 2014). Simulations may have elements of visualization with game-like elements. Visualizations are a representation of a phenomenon or a task, such as an ecosystem or a step to perform a task, without learner interaction. Games, on the other hand, are interactive and the outcomes are related to achieving a reward such as points or progressing to a new level. D'Angelo et al. defined a simulation as separate from a visualization because simulation requires learner engagement. They also defined simulation as different from a game because it focuses on behaviors or processes to achieve a learning outcome instead of gaining a point or currency reward.

For example, let's look at the popular game "Angry Birds". In this game, players hurl digital birds with a sling shot to knock down structures and get rid of a few little, green pigs. The process involves physics and principles of projectile motion to aim and shoot the birds. However, users of the game do not leave the experience with an ability to discuss vectors, momentum, or acceleration. While the players may be primed to learn about rules related to these concepts in the future, knowledge of physics principles is not required to score points and move to new levels in the game.

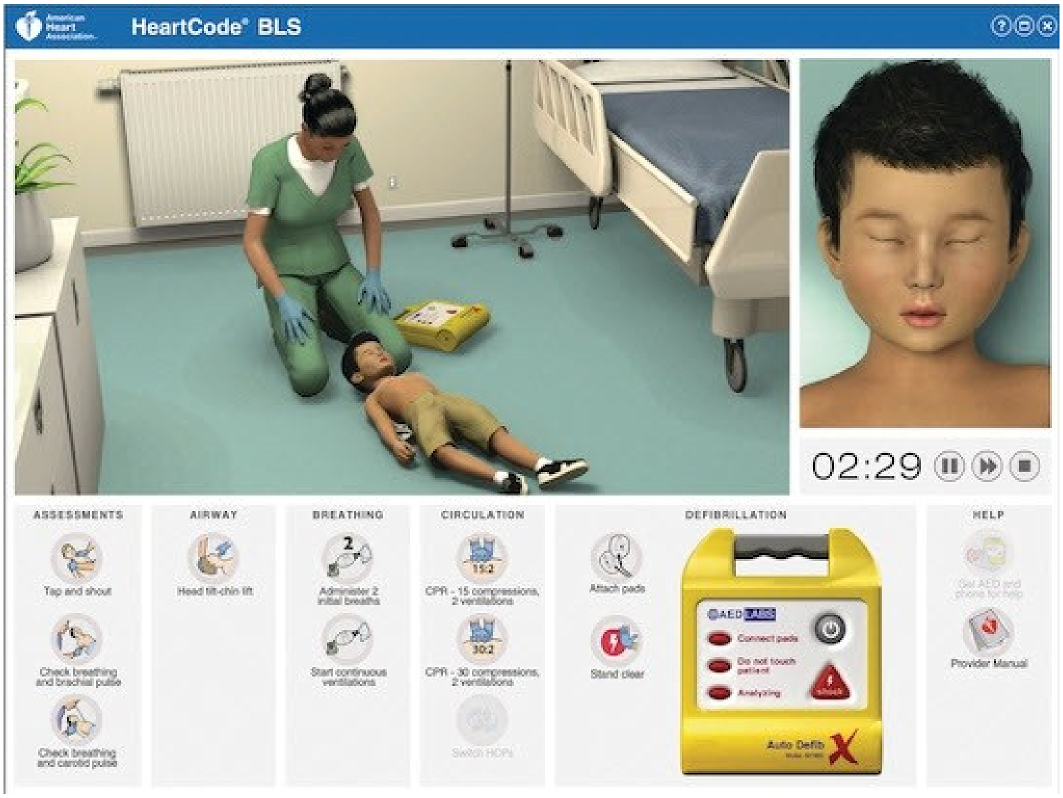
Types of Simulation

Simulation allows learners to learn by doing. The process of "doing" can be accomplished through many different types of simulation activities. The simulation scenario can be live or computer generated. Furthermore, the range of simulation activities progress from simple role play activities to high-tech devices that mimic real environments or equipment.

In a role play or group simulation, learners are required to take on the role and participate in a situation based on how they imagine their assigned role might behave in the described situation (Elmore, n.d.). Learners are often given some background information or an assignment to look up information on the scenario and/or the roles to help guide them through the scenario. In a kindergarten through 12th grade setting, this might include having learners participate in a mock trial or a model United Nations summit. Health care simulations often use a type of role play with a simulated patient. The patient in the role play is not a learner, but an individual who is trained to portray a set of symptoms or health care problems when interacting with the learner (Chiniara at al. 2013; Wilson & Price, 2015). Live role-play simulations can take place in any setting (Chinara et al. 2013). These simulated clinical immersions could be in a classroom or in a setting that replicates a real-world environment. “In situ simulations” take place in an actual clinical environment and the participants are on-duty providers who are at work.

Simulations can also be digital. These types of simulations take place on a computer screen, as a projection into the real environment, or with the use of a virtual reality headset that immerses students into a virtual environment. Digital simulations can be used to teach the learner how to perform psychomotor tasks and immerse students in real-world situations or virtual worlds for psychomotor, cognitive, and affective learning such as anti-bias training, patient care, economics research, and chemistry experiments (Chernikova et al., 2020; D’Angelo et al., 2014; Guralnick & Levy, 2010). Advancements in technology have made this type of simulation readily available to many consumers. Computer based simulations take place on a computer screen. The American Red Cross includes computer based simulations in the online portion of their Basic Life Support (BLS) course (Figure 1).

Figure 1
American Red Cross BLS Simulation



Note. modified from
https://www.youtube.com/watch?v=7S7fjRYSsN8

In this simulation, students receive a report on the patient in the scenario and then click on tasks to perform CPR during the scenario. At the end of the simulation, students receive feedback on the correct steps taken and areas to improve. If necessary, students must repeat the simulation to earn a passing score before moving to the next portion of the course. Augmented reality (AR) can be used to project images or sounds into the real world. Human Anatomy Atlas is an example of AR used in healthcare education. This app has an AR mode that allows students to project virtual organs or human models onto a flat surface to view or virtually dissect. Virtual reality (VR) uses a headset to immerse the user into a virtual world. Students can use VR to interact with virtual patients, orient themselves to the sights and sounds of a healthcare environment, and/or perform virtual procedures on virtual patients (see Figure 2).

Figure 2
Virtual reality headset

Note. While typical headsets tend to be a bit bulky and heavy, continuous improvements will enhance the wearability of these systems (open source photo from Unsplash Photos for Everyone, photo credit to Bermix Studio).

Hardware and software can be combined to create physical simulators that mimic objects or pieces of equipment (see Figure 3). This type of simulation ranges in levels of fidelity with higher levels of fidelity often associated with increased costs. Simulations that fall on the low end of fidelity often involve task trainers or simple models that students can perform tasks to learn psychomotor skills. In low fidelity simulations, the healthcare student could practice changing a dressing or putting in a catheter. The model does not talk or have vital signs that change in response to student action. Simulations at the high end of fidelity include simulators that give real time feedback to the learner by responding to the learner's actions such as a patient whose oxygen heart rate speeds up after administration of albuterol or whose oxygen saturations increase after the head of the bed is raised. High fidelity simulators, called manikins, can be used in simulations designed to assist with psychomotor, cognitive, and affective domains of learning (Errichetti, 2015). Physical simulators can also be combined with simulated patients for hybrid simulation.

Figure 3
Low resolution and High resolution healthcare simulations

Note. Low fidelity task trainer for wound care and high fidelity manikin in simulation lab (photo credit Maria Satre).

History of Simulation-Based Education

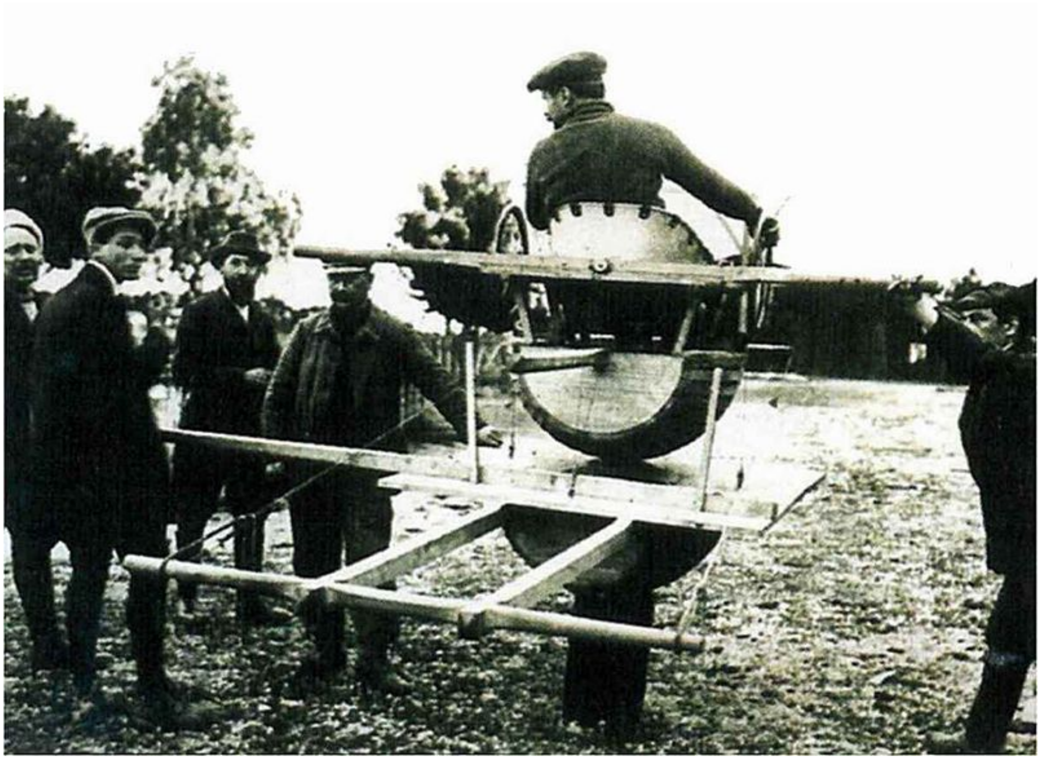
Simulation has a long history in education and training. Military war games that can be traced back more than 1,500 years and were used to simulate bloodless battles and train soldiers in strategic thinking (Errichetti, 2015). In the mid to late 1800s, healthcare students used models of human anatomy for education, and in 1911 the first human mannequin, Mrs. Chase, was developed to allow skill practice on a human-sized model (Singleton, 2020, see Figure 4).

Figure 4
Mrs. Chase human mannequin

Note. The Mrs. Chase human mannequin was a life size doll that allowed for training and practice (Photo credit Hamilton Archives at Hartford Hospital).

Around the same time that Mrs. Chase was developed, several companies started to produce flight simulators to train pilots in flight control and reduce costly crashes (Errichetti, see Figure 5). All of these simulators share common goals to save valuable resources and enhance learner safety.

Figure 5
Early flight simulator for Antoinette aircraft circa 1909



Note. Early in flight training, instructors found it helpful to simulate the experience before taking students on an actual flight (Photo credit https://commons.wikimedia.org/wiki/File:Antoinette_sim_2.jpg).

Development of simulation-based education designed on learning theory became popular in the 1980s with the development of the Institute for Learning Sciences (ILS) at Northwestern University (Guranlick and Levy, 2011). This center brought experts from education, psychology, and computer science together to design educational scenarios. At the time, schools were not equipped with enough computer technology to adopt the programs. The first learning by doing training programs put out by the ILS used coaching and feedback in corporations to train cashiers at a food chain, operators in directory assistance, and guest services at a retail company. Simulation as an education strategy in corporations and in education did not gain significant momentum until the early 2000s. Further advances in online access and e-learning have helped to foster the development and accessibility of computer simulations. Simulation now has a role in diverse disciplines such as corporate training, computer science, physics, engineering, nursing, medicine, political science, languages, and social sciences (Chulkov & Wang, 2020).

While classroom and computer-based simulation developed to give users a hands-on approach to learning, healthcare simulation continued to develop with an urgency to improve patient safety. In the 1950s, Peter Safar and Asmund Laerdal developed one of the most common healthcare simulation mannequins, Rescue Annie, to train individuals to perform mouth-to-mouth resuscitation (Singleton, 2020, see Figure 6).

Figure 6
Vintage Laerdal Rescue Annie

Note. The first simulation system to train and practice cardiopulmonary resuscitation life saving procedures (and was the inspiration for Michael Jackson) (modified from https://www.wcbe.org/arts-life/2021-09-21/the-most-kissed-girl-in-the-world).

In 1966, the first computer controlled patient simulator, Sim One, was developed at the University of Southern California to assist with training anesthesiologists. The patient simulator was placed in a simulated hospital environment with real tools and staff members participated in interdisciplinary communication during simulations (Wang, 2011). Health care simulation gained momentum after the Institute of Medicine published a landmark paper in 2000 documenting the prevalence of medical errors and proposing the use of simulation whenever possible to assist with communication, team work, and critical thinking (Kohn et al., 2020). They provided the incentive for companies to develop commercially available high fidelity patient simulators and for schools and hospitals to implement simulation training programs. Today, high fidelity manikins are widely available in a variety of ages and genders to allow training in a variety of health care settings.

Learning Theories and Learning Domains for Simulation-Based Education

The tenet of simulation as an education tool is that it creates an interactive learning experience. Knowledge of how learners create knowledge in experiential learning can be used to develop simulations that maximize the student learning experience. Previous chapters of this book review several important learning theories, instructional technologies, and communication methods that are essential knowledge for instructional message design. This chapter adds onto that knowledge with a focus on experiential learning theories and learning domains to assist with the development of simulation-based education experiences to assist the participant to assimilate the knowledge presented in the simulation.

Behaviorism

Behaviorism is often described as a stimulus-response theory and is attributed to behaviorists such as Watson, Skinner, Pavlov, and Bandure (Clark, 2018). In this theory, the learner is exposed to a cue or stimulus. The learner's response to the stimulus can be rewarded or punished to reinforce or change the learner response. The goal is for the response to become automatic. Behavioral theories have received criticism due to their inability to describe the learner's motivation for learning and their emphasis on learning in the hands of the instructor instead of the learner. However, the concepts of reinforcements and punishments can be built into a simulation to reinforce intended learning concepts (Whittmann-Price & Price, 2015). Positive reinforcements reward the learner for their behavior such as successful resolution of a problem in the simulation. Negative reinforcement removes an unpleasant stimulus when the learner makes the correct action. In a simulation, this might be a patient monitor alarm that goes silent when the student correctly applies oxygen to the patient. Positive punishment applies an unpleasant stimulus to stop the behavior such as a buzzer that alarms when a student takes a particular action. Negative punishments remove rewards to stop the behavior. This could be incorporated in a simulation such as a lower score for a particular behavior.

Bandura's Social Learning Theory (1997) utilizes reinforcement and social modeling of observed behavior to modify learner behavior. One concept of this theory that is utilized in simulation is self-efficacy, or the participant's perspective that they have the skills required to accomplish the task. Those with low self-efficacy are less likely to replicate the behavior. To promote self-efficacy, the instructional designer should provide opportunities for the learner to be successful as a history of success enhances self-efficacy. Thus, the simulation should have clear instructions and be designed to the level of the learner. Additionally, providing a chance to observe a peer model the behavior can also increase self-efficacy. This can be accomplished through engaging with other media such as a demonstration, web-based learning, or video prior to performing the skills in simulation.

Constructivism

Constructivism is a common theoretical paradigm in education that encompasses many different theories that view learning as an active, learner-centered process where learners build new knowledge by connecting it to what is already known (Whittmann-Price & Price, 2015). Kolb's Experiential Learning Theory (1984) is one such constructivism theory that is often used in simulation

(Whittmann-Price & Price). In this theory, knowledge is created through experience, it requires a resolution of conflicts, and it involves transactions between the learner and the environment. The four main concepts in Kolb's theory are concrete experiences, abstract conceptualization, reflective observations, and active experimentation. The concepts can be included in the simulation design. Concrete experiences can be provided through design of simulations that are built on real-world experiences. Abstract conceptualizations and reflective observations are fostered when the designer builds in opportunities for the participant to think about the actions taken in the experience and reflect on the meaning of the experience to process the knowledge gained. Active experimentation can be included by creating a safe environment for the participant to actively participate and control aspects of the simulation.

Problem Based Learning

Problem based learning is a type of experiential learning that has roots in medical education in the 1960s. This type of education moved into other areas of education such as business, social work, economics, accounting, and architecture (Schmidt et al., 2007). In this learning method, students are given a problem made up of observable phenomena and are then required to activate prior knowledge and develop solutions to the problem presented. The case must be structured in a way that is tailored to the level of student knowledge and provide appropriate scaffolding to assist with problem solving and student independence. The situation should be structured from simple to complex to allow development of schema to reduce cognitive load when students encounter more complex scenarios. The teacher acts as a facilitator to assist when the tasks become too complex and fade to the background when students do not need assistance. Simulation-based education is built around scenarios and follows the design of problem based learning. The instructional designer should consider concepts of scaffolding and the ability for learners to access a guide or tutor when situations are too complex for their current knowledge level to deepen learning and allow the learner to navigate from novice to expert (Benner, 1982).

Clinical Simulation Conceptual Framework

Extensive research exists on simulation in healthcare domains. Kneebone (2005) developed a conceptual framework out of concern for a simulation trend that was task-based and disconnected from the complexities of real-world clinical practice. The four key areas in Kneebone's framework are: gaining technical proficiency, making sure an expert is available for assistance with task-based learning, learning within the context of the profession, and including affective components of learning (see Table 1). Kneebone's framework is intended to be a lens to evaluate the usefulness of a simulation as a learning activity. The connection of the key areas in the framework to learning theory and educational design can be used by instructional designers in health care and other fields to enhance simulation through inclusion of components such as scaffolding, feedback, realism/accuracy, and positive learning environments to enhance simulation in other fields.

Table 1
Kneebone Clinical Simulation Conceptual Framework

Key Area	Elements to enhance education
Gaining technical proficiency	● Break skills down into smaller units ● Include opportunities to overlearn what is required for initial proficiency ● Include reinforcements to assist with learner desire to improve
Making sure an expert is available for assistance with task-based learning	● Tutor should provide specific feedback to help improve skills ● Tutoring should only be provided when needed ● Tutoring should move from assistance to supervision

Learning within the context of the profession	● Simulations should reflect contextual realities of professional practice ● Learning should be from active participation instead of observation
Including affective components of learning	● Learning experiences should be structures as positive experiences ● Learning environments should be supportive for learners

Learning domains

Learning is often discussed in three recognized domains: cognitive, psychomotor, and affective (Whittman-Price & Price, 2015). Cognitive learning relates to acquisition of knowledge or problem solving skills. Psychomotor learning relates to the ability to perform procedures for skills. Affective learning relates judgment, values, and attitude. Instructional designers can develop simulation-based education that can be structured in a way to enhance each of the three learning domains if they align with the objectives of the simulation (Kardon-Edgen et al., 2010). To incorporate the cognitive domain, the learner can be given an opportunity in the simulation to show an understanding of the subject matter and apply a concept to make decisions during the simulation. Application of psychomotor domain can be included in the simulation by giving the participant an opportunity to perform the skill in a live situation on a task trainer or procedure trainer or in a virtual environment. Affective domain skills are included when the participant has an opportunity to interact with other team members, shows willingness to listen to others, demonstrate professionalism, or treats a group members/simulated individuals with respect (Whittmann-Price & Price, 2015).

Instructional Design and Simulation

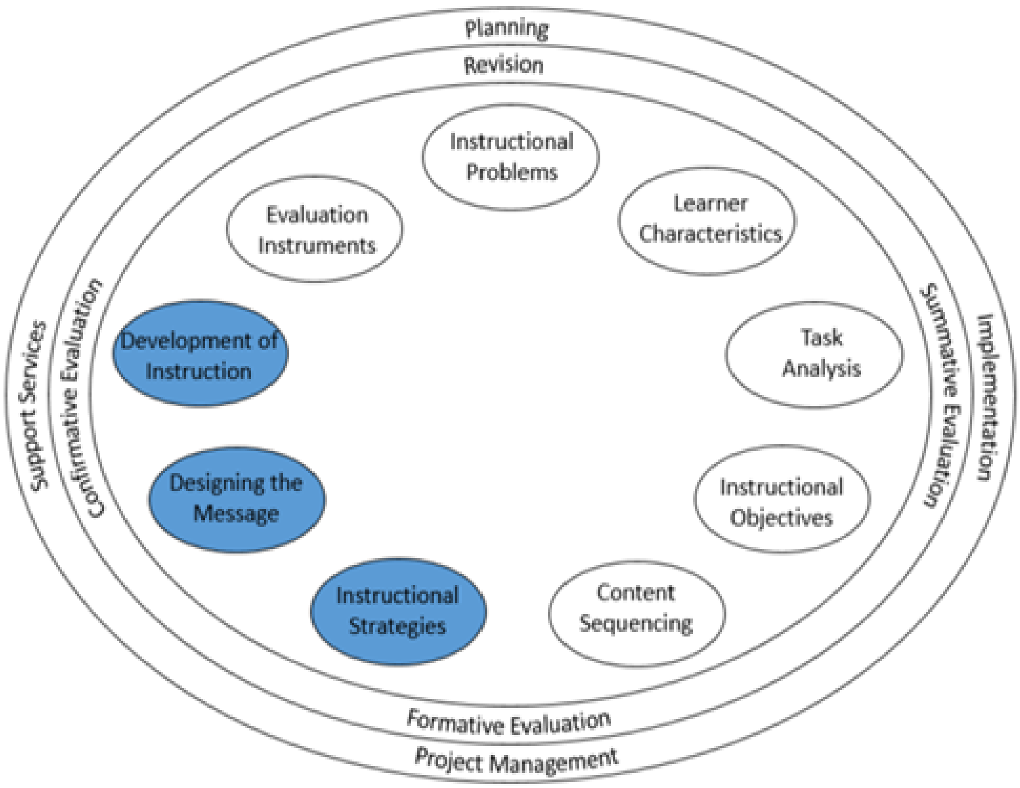
Instructional design is a process that involves identifying a problem that needs to be solved, determining if education can solve the problem, and then designing instruction based on the skills needed to solve the problem (Morrison et al., 2019). Readers of this chapter should have a background in instructional design and understanding of models of design such as the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) model and Gagne's nine events of instruction. The International Nursing Association for Clinical Simulation and Learning (INACSL) Standards Committee has also developed and consolidated best practice guidelines for the development of healthcare simulation:

INASCL Simulation Standards: Simulation Design (2016)

1. Needs assessment
2. Measurable Objectives
3. Structure experience on purpose, theory, and modality for simulation
4. Design scenario to provide context for simulation
5. Use various types of fidelity to create desired realism
6. Develop facilitation that is student centered, objective driven, learner knowledge/experience, and expected outcomes
7. Begin with a prebriefing
8. Include evaluation of participants, facilitator, sim experience, facility, and support team
9. Provide preparation materials and resources to promote learner ability to meet objectives
10. Pilot test simulation before full implementation

However, for this chapter the process of simulation development will follow the Components of Instructional Design Plan from Morrison et al. (Figure 7). In addressing issues of message design in simulation, the focus will be on instructional strategies, message design, and development of instruction. For more information on identifying the instructional problem, determining learner characteristics, analyzing the tasks included in instruction, creating objectives, sequencing content, and developing evaluation instruments, see Morrison et al.'s *Designing Effective Instruction*.

Figure 7
Components of the Instructional Design Plan



Note. The Morrison, Ross, and Kemp instructional design model is a comprehensive approach to the design of instructional systems (Modified from Morrison et al. 2019).

Instructional Strategies

This is the creative step in instructional design. An instructional designer must be innovative in determining ways to present the information or tasks to the learners so that they can connect new knowledge to known knowledge (Morrison et al., 2019). This will assist with scaffolding and help decrease the extraneous cognitive load of the message to improve the amount of available germane load/resources to aid in learning.

Simulation is a tool that instructional designers can use. Alas, it is only a tool, and the message is more important than the tool used to send it. There are many types of simulations available, and the instructional designer must evaluate if simulation is an effective strategy for the learners and learning objective as well as which type of simulation to use.

Determining the Type of Simulation

There are many types of simulations available. For instance, simulations without technology, such as role play, have similar outcomes on student performance as screen based simulations (Chernikova et al., 2020). The largest effect on student performance is found with higher levels of realism, or fidelity, such as live patient simulations or virtual reality (Chernikova et al., 2020. Di Natale et al., 2020). However, high levels of realism, or fidelity, are often associated with increased resource utilization and cost. Simulated human patients in a health care simulation must be trained and scheduled. Physical simulator systems are expensive and require faculty training to run the device. In selecting the type of simulation, the instructional designer should consider available resources, learner characteristics, and learning objectives to determine which type of simulation strategy to use.

Learner Characteristics. The use of simulation as an instructional message should be linked with learner needs and preferences. While several studies show the effectiveness with primary and secondary education, this method of learning is also well linked with the principles of adult learning or andragogy (D' Angelo et al., 2014, Di Natate et al., 2020, Schmidt et al., 2007). Adult learners are drawn to problem based learning, with the hands-on application of theory, that is applicable to real life situations (Swanson, 2011).

Learning Domains and Outcome Competency Goals. Chiniara et al. (2013) evaluated outcomes of health care simulation studies and developed an instructional design map that linked simulation modalities with competency domains (see Table 2).

Table 2
Media and Simulation Modality Selection for Healthcare Simulation Based on Desired Learning Competency Domain

Competency domain	Qualifier	Modality
Rote knowledge	Clinical knowledge	**computer-based simulation*** or Simulated Patient
	Non clinical knowledge	**Non simulation media*** such as models, lecture, reading, videos
Techniques and procedures	Requires psychomotor skill practice	**Virtual Reality*** with self-instruction **Procedural simulator*** with task trainer or high fidelity mannequin with instructor led education
	Does not require motor skill practice	Computer-based simulation, **Non simulation media*** such as videos, e-learning, interactive media
Clinical Reasoning	Self-instruction	Computer-based simulation with **virtual patient***

	Instructor-led	**Simulated Patient***, Simulated clinical immersion in simulation lab, Computer-based simulation
Patient counseling or history	Self-instruction	Computer-based simulation with **virtual patient***, Simulated Patient with feedback from actor, non-simulation media such as readings, videos, and e-learning
	Instructor-led	**Simulated Patient***, Simulated clinical immersion in simulation lab Computer-based simulation
Patient safety	Self-Instruction	Computer-based simulation **virtual world***, non-simulation media

	Instructor-led	**Simulated clinical immersion in simulation lab***
Beliefs, attitudes, and ethics		**Simulated clinical immersion in simulation lab*,** **Simulated Patient***, Computer-based simulation, other media
Situation is dynamic and dependent upon environment		**Simulated clinical immersion in simulation lab*,** **Simulated Patient***, Computer-based simulation, other media

Note. Items in bold with an asterisk designate preferred modality. SP: Simulated Patient; VR: Virtual Reality; SCI: Simulated clinical immersion in simulation lab; CBS: computer-based simulation (Modified from chart in Chiniara et al, 2013).

These researchers divided simulation modalities into the following categories: simulated patient, virtual reality, computer-based simulation, and simulated clinical immersions. A simulated patient (SP) is where an actor was used to role-play a live patient to act out symptoms in interactions with students. Virtual reality (VR) is where students are immersed into a virtual world that recreates health care settings. Computer-based simulation (CBS) is where students use a computer to interact in two dimensional health care scenarios.

Simulated clinical immersions (SCI) are when students interact with mannequins in a laboratory set up with equipment to recreate health care settings. These simulations were not the preferred method of learning when cognitive goals that were not related to clinical or when they needed to learn a new technique that did not require psychomotor skills. Psychomotor skills were best learned in simulations where students could physically perform the skills in the real world or in a three dimensional virtual world. Affective goals were best achieved when students had to interact with an SP or when students needed to complete learning on their own. Chiniara et al. recommended self-contained learning modules such as virtual patients in a computer-based simulation. Affective domain goals and cognitive domain goals require problem solving. Goals that require complex/dynamic situations, are simulations that could be more free flowing and adjusted based on student actions. In these scenarios a simulated patient SP or a simulated clinical immersion SCI were preferred. Overall, Chiniara et al. recommended utilizing the scarce resources of simulation for situations when students are not likely to have an opportunity to experience the scenario in clinical training.

Simulations are also recommended when the clinical problem has a great potential to negatively impact patients or when the real-world skill practice could endanger patients or students. Common scenarios that students are likely to see in school based clinical experiences could be taught using less expensive media. While Chiniara's study was on health care simulation, the link between types of simulation and competency domains provides insight into the potential for simulation with other subjects.

In K-12 learning environments, Di Natale et al. (2006) found that VR offers opportunities for students to learn spatial knowledge, explore scenarios that could be impossible in the real world, improved engagement in the learning process, and improved real-world performance. In a recent literature review of mixed learning environments combining virtual and real-world elements in K-12 education, Pellas et al. (2020) found similar outcomes and reported implementation over a variety of subjects such as art, social science, and physical science. Like Di Natale, they also found that the higher level of fidelity possible in augmented reality increased learning over two dimensional computer simulations and more traditional teaching methods. However, they also found that a high level of visual detail in

VR in biology educational programs lead to decreased learning due to the large amount of extraneous load. This suggests that in selecting this method for instruction, the designer should consider schema development and appropriateness of this simulation method with novice learners.

Designing the Message

Designing the message is a process of combining images and words to clarify the message and to draw the learner's attention to appropriate parts of the simulation to enhance learning (Morrison et al., 2019). This step of the instructional design process can be complex in simulations. There are several aspects of the simulation that should be determined prior to starting the design process.

Multimedia Learning and Cognitive Load

Multimedia learning theory was discussed in previous chapters. This theory states that combining pictures and graphics in the same learning session increases learning. This theory holds true with simulations. Combining simulation with another form of instruction increases learning (D'Angelo at al., 2014). This can be accomplished by adding multimedia such as dynamic representations and scaffolding into the simulation. However, any unnecessary graphics or anecdotes should not be included as they will add to the extraneous load and distract the learner from the intended message (Lunetta & Hofstein, 1981). Additionally, in simulations with a high level of visual content, such as VR, students remember more of the visual content than the auditory content (Pellas et al., 2020)

Multiple types of scaffolding should be built into the simulation design (Chernikova et al., 2020). Scaffolding can include learner prompts with visual or task based guidance, reflection, and expert examples. Chernikocva et al.'s meta-analysis of simulation in higher education found that scaffolding with a single type of scaffold was less effective than a combination of methods. Furthermore, learners with little theoretical knowledge require more instructional guidance during simulations (Schmidt et al, 2007). Scaffolding with prompts and examples is more effective with novice learners (Chernikova et al., 2020). Schmidt et al. (2007) also recommend structuring the simulations from simple tasks to complex tasks when possible to allow for schema development.

Fidelity

The simulation should represent the real situation and be interactive. Outcomes in the simulation should change based on the actions that the student takes or does not take in the experience. The amount of realism in the simulation increases the complexity of the design of the simulation but it also increases real-world performance after students complete the simulation (Diekman at al, 2007; Di Natale et al., 2020; Martin & Betrus, 2019). In simulation, realism is referred to as fidelity. Fidelity may be high or low with high fidelity scenarios having greater detail and complexity than low fidelity scenarios. The scenario can have physical, psychological, equipment, environmental, and temporal fidelity (Diekman et al., 2007; Chiniara et al., 2013). Physical fidelity refers to entities that can be measured. In healthcare simulation, this includes how the patient reacts to actions taken in the simulation (Chiniara et al., 2013). For instance, if the simulated patient stops breathing, then the simulated patient's oxygen level should decrease until the students initiate rescue breathing with a bag and mask.

Psychological fidelity refers to the mental preparation of the learners. Do they have the knowledge required to participate in the simulation? Have they been orientated in what to expect in the simulation? This can be built in with an orientation to the simulation. The designer can have students complete a mock simulation to experience how a computer simulation or physical simulation works. Designers can also incorporate training modules or a preparation assignment to have students review relevant information before completing the simulation.

Equipment fidelity refers to the functionality of the equipment. The equipment should be as close to the equipment in the real-world as possible (Martin & Betrus, 2019). If the equipment must be altered for learner safety, such as disabling a defibrillator, the learner should be oriented to the difference in functionality before the simulation starts (Diekman et al., 2007).

Environmental fidelity refers to how real the surroundings look compared to the real-world setting. Simulation labs can be built to recreate real world settings or the surroundings can be developed in screen based scenarios. Chiniara et al. include interdisciplinary personnel in this category as well.

Lastly, temporal fidelity refers to the flow of time during the simulation. It may flow unimpeded and discuss student performance at the end or take pauses to update the student throughout the simulation (Chiniara et al., 2013). The type of fidelity should be matched to the scenario.

The fidelity should be matched with the characteristics needed for the educational experience (Chinara et al., 2013). For instance, if a learner needs to learn how to use a cash register without making errors, then equipment fidelity should be a priority. If the learner needs to learn how to improve communication skills, then physical fidelity should be a priority. The designer should also consider the complexity of the skills in the simulation and how dynamic the scenario should be to accomplish the task. Affective learning goals and dynamic scenarios require a higher fidelity experience such as simulated patients, virtual reality, and simulated clinical experiences. Chernikova et al. found that the authenticity in the simulation had a greater impact on student learning outcomes than the technology used. It was also found that fidelity had less impact on novice learners as compared to learners who had already developed schema around the knowledge and skills included in the simulation. Diekman et al. (2007) found that incorporating a reality contract (an understanding that the simulation is meant to be a serious scenario) into the simulation also helped students treat the simulation experience as if it were real. The reality of the message design is reviewed at the beginning of the simulation and also includes the boundaries of when the simulation starts as well as any equipment modifications from the real world.

Feedback

The simulation design should include a plan for feedback to the learner since this is an essential characteristic of simulations (Chiniara et al.). Feedback can be provided through task based guidance, visual guidance, text-based feedback, realistic consequences during the simunition, and/or in a summary at the end of the scenario. Immediate feedback is preferred for simple skills and deferred feedback is more effective with more complex skills/dynamic simulations (Guralnick & Levy, 2011). Feedback that is specific to the learner's actions is better at improving student performance than vague feedback (Chiniara et al., 2013; Guralnick & Levy, 2010). Feedback can be included through tutoring immersed and embedded in the simulation design and can be in the form of outcome feedback. Process feedback is more likely to improve performance with complex tasks and a combination of both types of feedback has an additive effect.

The timing of the feedback can also affect learning. Providing feedback during the simulation is effective for procedural tasks but may interrupt learning in dynamic scenarios. Feedback should be reviewed immediately after the conclusion of the scenario to assist the learner in integrating the knowledge gained. Delayed feedback with a time gap after the simulation is associated with less effective learning (Chiniara et al., 2013).

Once a plan is made on the type of simulation, media, fidelity, feedback, and scaffolding, the instructional designer can start to sketch out the plans for the simulation. This starts with a scenario overview and general plan. If using a screen based simulation, the designer should make wireframe sketches with a conceptualization of the screens in the simulation. The learner should be at the forefront of the design with an appropriate color scheme for the audience and the customer. If the simulation is for a corporate client, then company branding for color schemes, logos, or fonts may need to be incorporated (Martin & Betrus, 2019).

Development of the Instruction

The final step in message design of the simulation is the development of the instruction. This is the step of the process where all of the pieces are put together. Steps may include development of written material, recording videos, developing web pages, preparing participant scripts, and recording audio (Morrison et al., 2019). The plan in the past step and should be reviewed to ensure that all necessary tasks are included and any unnecessary tasks are eliminated. Graphics for computer based simulation should be placed in storyboards to get pilot test audience feedback on appearance prior to development and testing of functionality (Martin & Betrus, 2019).

In this step of the design, the instructional designer must write the script for the simulation (Alinier, 2011; Marin & Betrus, 2019). When designing the scripts for a live scenario, the instructional designer should include scripts for non-student participants that include responses to all anticipated student actions and scenario lifesavers. Lifesavers are backup plans to use if students do not understand the scenario, perform an unexpected action, or lack the learning competence required for the simulation (Diekmann et al., 2010; Waseem, 2021). Options include providing a hint to the learners, making the situation in the scenario more obvious by changing the cues to make them more obvious, or altering the scenario to add in aspects related to the participant actions (Diekmann et al., 2010).

In the design phase of the simulation, an instructional designer may create all new materials or expand upon existing simulation materials to help with the cost of simulation. There are simulations that are available for purchase and simulations that are free. Nearpod offers commercial, turn-key simulations that allow students to participate in science and math simulations that are designed for K-12 learners. Zapitalism is a free online program that can be used to teach students about finances. Nobelprize.org has several screen based simulations such as the blood typing game. When using a readily available resource, the instructional designer should assess if the simulation meets the learning goals. The designer may need to develop materials to prepare students for the simulation such as an orientation activity to the simulation and a learning activity to ensure that students have the knowledge and skills required to complete the simulation. The designer may need to develop a feedback activity as well to help learners reflect on what they learned during the simulation.

Chilkov and Wang (2020) provide a good example of utilizing a pre-designed product to create a simulation-based learning activity for students in a higher education finance class. For their course, they utilized a stock market simulation program called StockTrak. The faculty members created learning goals and developed a set of tasks for students to accomplish in trading over a 14 week period. During the simulation, students were able to make trades with allotments for day training, short selling, and trading on margins. They provided learner orientation to the program in class and through the course learning management system. Over the semester, students completed bi-weekly portfolio reports. They also incorporated regular class assignments for students to summarize current events that could influence financial markets. At the end, students reflected on the experience and presented their portfolio performance. Chulkov and Wang's design included scaffolding, regular reflection, regular student feedback, and a strong connection to the learning goals of the course. They found that students who participated in the course section with simulation performed statistically better on course exams. Students also indicated that they felt that participation in the experience positively added to their understanding of course concepts.

After designing the simulation or creating a learning activity from an available resource, the instructional designer should run a pilot of the activity to assess for any needed changes before starting training with the program. After running the simulation, the activity should be evaluated based on simulation design, effectiveness, feasibility, and any possible ethical issues.

Conclusion

Simulation-based education can be an effective instructional message design to promote learning, engagement, and real-world performance as students learn psychomotor, cognitive, and affective skills in a safe learning environment with little risk to themselves or patients. Once students gain proficiency in the simulation lab, they can transfer their new skills to the clinical setting as long as the simulation is well designed. Simulations offer a problem-based learning approach that utilizes stimulus and response to provide real-time feedback to students to help reinforce learning and promote self-efficacy. Instructional designers should select a type of simulation that aligns with the learning goals, student characteristics, the learning domain of the task, as well as available fiscal and physical resources. When designing the message of the simulation, instructional designers should include enough fidelity so that the scenario aligns close enough to live clinical experiences that it enhances transferability of skills, but still exclude unnecessary details to reduce the learner's extraneous load. The message design should align with principles of multimedia design theory and include scaffolding to assist with schmata development. Lastly, the instructional development should include scripts for all non-student participants, a list of needed supplies, a description on how to set up the simulation, a pre-brief script for students, a debriefing plan, and a set of lifesavers to for situations where the simulation may go off track.

Simulation technology continues to evolve and holds great promise for the future of healthcare education, and it is even moving into healthcare practice. For instance, surgeons who learned skills in a virtual lab may perform robotic surgery on live patients with the assistance of virtual or augmented reality. Patients undergoing systematic desensitization therapy may be able to do so in a safe environment with a virtual exposure to their phobia. Patients undergoing cognitive behavioral therapy can complete simulations that link their heartbeat to actions on a computer screen to assist the patient in learning how to use relaxation skills in stressful situations. As technology becomes more accessible, the potential for its instructional message design use in the healthcare field exponentially increases.

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Instructional Message Design:
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Chapter 8: Designing with Disabilities in Mind

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8. Designing with Disabilities in Mind

Brittney Heath

Key Points:

- Keep it simple!
- Use universal design strategies that work for all audiences
- Have one theme, chunk long information, and use visuals to support
- When presenting designs make sure there is a way to take notes

Key Words:
Individualized Educational Program (IEP), Universal Design for Learning (UDL), Autism Spectrum Disorder (ASD), Specific Learning Disability (SLD), Attention Deficit/Hyperactivity Disorder (ADHD)

Abstract

Instructional message designs are everywhere, and not everyone that interacts with the messages do so with ease. We need to begin thinking about those with disabilities while we are creating our designs to make understanding the importance of each message easier for everyone. Some strategies that can be used are: chunking information, using one main theme, and visual supports. This chapter focuses on a few common disabilities that can easily be

accommodated: Autism Spectrum Disorder, Specific Learning Disabilities, and Attention Deficit/Hyperactivity Disorder.

Introduction

Instructional Message Design is defined as "how various media and delivery systems might be used more effectively to help optimize instructional communications within context-specific instructional situations and learner needs" (Bishop, 2014). It is important for instructional designers and teachers to customize instructional message designs for all learners that will come in contact with their messages, including learners with disabilities. There are millions of learners that have been formally diagnosed and if we do not start creating instructional designs with disabilities in mind our profession will quickly be dismissed for something new. The best advice for educators and instructional designers to keep those with special needs in mind is to always think about their disabilities when designing and to keep it simple. This chapter will focus on instructional design strategies for common learning disabilities with a focus specifically on Specific Learning Disabilities, Attention Deficit Hyperactivity Disorder, and Autism Spectrum Disorder. While these disabilities by no means cover all that can be diagnosed it is a great start to the conversation to make our instructional message designs accessible to everyone.

Background

Messages are all around us on billboards, television ads, street signs, milk cartons, textbooks, etc. The list goes on and on and not every person that sees these messages can understand them easily. While we all have a bad day where focusing on these messages is difficult, those with disabilities often, if not always, struggle comprehending and retaining information from the thousands of messages we see everyday. Students in pre-kindergarten through 12th grade can be formally diagnosed with a disability and given an Individualized Education Program (IEP). The IEP follows them through primary education to assist the student in conquering the areas they have a deficit in due to their specific disabilities (see Sec.

300.320 definition of individualized education program, US Department of Education, 2017).

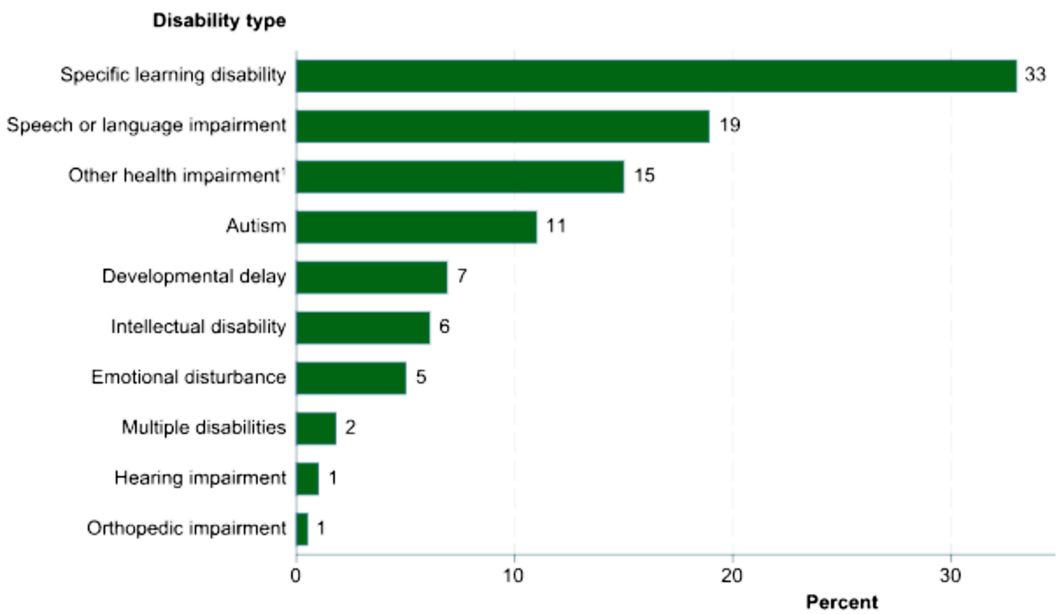
An IEP organizes information about the student's demographics, the conferences they had with teachers and families, the present level of performance, annual short and long term goals, the related services the child needs, transitioning goals from different school levels, and formally acknowledges the diagnosis of the child. This ever changing document shows how a "child's disability affects the child's involvement and progress in the general education curriculum [through] a statement of measurable annual goals, including academic and functional" (Sec. 300.320 definition of individualized education program). In 2015 anywhere from 15-25% of all students were diagnosed with a disability during their K-12 education that year. In 2017 these numbers were recorded as 1 in 5 (Horowitz et al., 2017). The number of diagnoses stayed consistent and even dropped slightly through the years to land near 14% in 2020. In total there are 7.3 million students in the 2019- 2020 school year that were diagnosed at some point previously in their k-12 public education, plus more students with disabilities are enrolled in private education (National Center for Education Statistics, 2021). If a quarter of the student body requires specific strategies to help them excel then it is in the best interest of all students that we use these instructional strategies all the time.

According to Christsy G. Keeler when the IEP is not being followed to the highest level is when student failure begins (Keeler & Horney, 2007). So we as message designers and teachers need to make sure that we are following the IEP. We need to make sure that the strategies and supports on an IEP, like chunking, audio/visual supports, and note taking, are used in all designs to ensure that the IEP is followed no matter the situation. What instructional design supports can be used to ensure that all needs are being met, even those not formally diagnosed? It is best practice to use techniques to make learning and comprehension easier for all students, so then it is also best practice to continue using these strategies when designing messages for everyone that has a bad day and for all of these students with disabilities that grew up.

To best understand the strategies used by special education teachers you first need to understand the disabilities that the strategies are designed for. Some of the most common disabilities that affect students ability to read and comprehend messages are Specific Learning Disabilities (SLD), Attention Deficit Hyperactivity Disorder (ADHD), and Autism Spectrum Disorder (ASD) (Sec. 300.320 definition of individualized education program, 2017). Refer to the figure below for how many students are in each category. Each person has their own unique qualities of the disability, but there are general characteristics that are seen across the board.

Figure 1

Different Types of Diagnosed Disabilities



Note. This figure showcases different types of diagnosed disabilities and how many students were diagnosed with each disability for the 2019-2020 school year across the United States. ADHD can be categorized under Other Health Impairments as 'alertness due to chronic or acute health problems'. (Sec. 300.320 definition of individualized education program, 2017). Modified from https://nces.ed.gov/programs/coe/indicator/cgg.

Common Learning Disabilities to Accommodate For

Specific Learning Disabilities have been defined as a "disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations" (Life Development Center, 2021). A very wide scope of individuals struggle with comprehending instructional messages due to the diagnosis in one of the Specific Learning Disability (SLD) categories.

The Virginia Department of Education recommends that instructional messages be modified to meet the learning level needs of the individual when possible. If you are creating an instructional message design on a large scale it is recommended that you review the prerequisite skills or knowledge before starting new information (Virginia Department of Education, 2021). For example, if you are designing an advertisement for a new price on a car you would want to state the make, model, and year of the vehicle along with the old price before stating the new price.

Another strategy that works well with those diagnosed with Specific Learning Disabilities is to allow plenty of time before asking the audience to respond to prompts and when the situation lends itself, provide preferential seating toward the front or side of the room (Virginia Department of Education, 2021). Those with SLD can use preferential seating in a variety of ways. Sitting in the front row eliminates distractions of the rest of the audience moving so they can focus on the presentation. Sitting on the end of a row allows them to easily exit the room when they need to refocus. It also is easier for the presenter to see their hands raised if they have questions if they are not in the middle of the crowd.

According to educational psychologists, using precise language also helps all with disabilities but is especially helpful for those with Specific Learning Disabilities. Using less text and having your instructional message straight and to the point helps them focus on the task and understand the information presented. This means to "omit vague terms - such as perhaps, and so on, maybe, and usually- from explanations and responses" (Eggen & Kauchak, 2016). Richard Mayer created a theory around this idea called the Coherence Principle stating that when extraneous material is excluded people will learn easier. Mayer's Coherence Principle is broken into three complementary sections "where learning is improved when: 1) interesting but irrelevant words and pictures are excluded 2) interesting but irrelevant sounds and music are excluded 3) unneeded words and symbols are eliminated" (Mayer, 2009). Using precise terms and excluding unnecessary items allows those with disabilities to focus on decoding the important aspects of each instructional design.

Attention Deficit/Hyperactivity Disorder (ADHD) is a disorder with three categories of characteristics. "inattentive – where the person can't seem to get focused or stay focused on a task or activity; hyperactive-impulsive – where the person is very active and often acts without thinking; or combined – where you see both characteristics (Virginia Department of Education, 2021). Since ADHD has mostly behavioral characteristics, we as instructional message designers must create messages that catch the attention of these individuals and keep them engaged. We can do this by using bright colors, catchy slogans, or activating their prior knowledge. Our challenge as designers comes when we are presenting our creations to an individual with ADHD which we will explain later in the chapter.

Autism Spectrum Disorder (ASD) as the name suggests has a wide spectrum of characteristics associated with the diagnosis. Cognitively, it is accepted that ASD has mild to severe deficiencies in learning and intellectual ability. The main characteristic of Autism is deficiencies in social interactions across the spectrum in all areas of interaction. "Many individuals [diagnosed with ASD] display challenging behavior including aggression, self injurious behavior, darting or wandering away, and over activity" (Virginia Department of Education, 2021). When all of this is combined into one individual the needs are great. Struggles with understanding information, lack of focus, and inability to read social cues from images and teachers forces instructional designers to take a step back and reflect on the content and design of each message. As individuals with Autism

Spectrum Disorder transition from high school to adulthood their struggles do not change but the supports available do.

It is recommended by the Virginia Department of Education, VDOE, that instructors use visual supports, structured routines, and accommodations to reduce cognitive load times for students with ASD (Virginia Department of Education, 2021). While the Department of Education works specifically for primary education the strategies they recommend are great for all areas of instruction, work, and life. For individuals who have mild to severe deficiencies in intellectual ability, the VDOE suggests using visual schedules, minimally distracting and clear work spaces along with a standard routine and expectation. A visual schedule is what it sounds like; a schedule typically broken down into hour or 30 minute blocks with pictures to represent the task to be completed at that time. For instance if a child got up at 8:00 am and got ready for the day there would be an image of clothing or a toothbrush next to that time on the visual schedule to let them know to get dressed or brush their teeth. They also can be manipulated for the individual with autism to remove an image when they complete a task or if they want to change the task. For individuals with clear social deficits the VDOE recommends using video examples, using timers to transition, having frequent breaks, and providing a space to unwind when the environment becomes too much to handle (Virginia Department of Education, 2021). Sensory overload is common for those diagnosed with Autism Spectrum Disorder, so having a place they can go to relax with dimmed lights and no people allows them to calm down from all the stimuli they receive while working or interacting with instructional messages. To also help keep those with ASD from sensory overload, designers should refer back to Mayer's principle and exclude any extraneous words and images (Mayer, 2009).

Figure 2
Visual Schedules

Note. Visual schedules are typically broken down into 30 minute or hour sections with an image to tell the reader what is happening at the time.

Instructional Message Design

Just as special education teachers look at the data and get to know their students, instructional designers must study their audience and look at data from previous or similar projects. Any young student, and any adult learner, can successfully use your instructional message designs if you think about the strategies used to keep it simple, yet in the past instructional designers have forgotten about disabilities when planning a message.

Rieber & Estes in accessibility and instructional technology stated "leading scholars of instructional technology have largely ignored the issue of how to provide equal access to learning and education for people with disabilities". In their review of all 690 articles published in Educational Technology Research & Development through 2013, only six pertained to people with disabilities (i.e. Garcia & Cuello, 2010; Hertzog & et al., 1989; Hollins & Foley, 2013; Mintz & Aagaard, 2012; Neuman, 1991; Tzeng & Schwen, 2003) (Rieber & Estes, 2017). The answer to making sure that special education students and adults with disabilities are not forgotten is to use a universal message design that ensures all people benefit from and can successfully use the designs we create.

We need to create instructional messages with a universal design for learning (UDL). UDL can be simplified into its three principles where everyone is engaged, represented, and is able to express themselves/act on their own. "A core value shared by Universal Design and UDL is that there are primary and secondary audiences who benefit from proactive, inclusive designs" (Rieber & Estes, 2017). UDL is used in the classroom with closed captions videos and large font on presentations, but it can also be used in everyday life after education. "Not only does a person in a wheelchair benefit from the convenience of a universally designed building with an elevator and ramp but so does a delivery person wheeling packages into the building on a dolly, a teenager on crutches who is unable to climb stairs, and a child who finds the ramp preferable to the stairs" (Rieber & Estes, 2017). Similarly, an educational video that is closed-captioned is of benefit to those with a hearing impairment as well as those in a noisy student center, café, when english is a second language, or in the quiet of home when others are asleep and turning the volume up may not be desirable (Rieber & Estes, 2017).

Creating a universally designed message means keeping things simple and thinking about those with needs in all categories. Once we start thinking and designing this way it will be more time efficient and cost effective than changing our designs later on for those with disabilities and diversities. "The combination of audio, video, text, and other means to convey meaning has the potential to provide students, with a range of abilities and disabilities, greater access to curricula and learning opportunities" (Hashey & Stahl, 2014, p. 71).

Although we as instructional designers need to keep things simple, we must still ensure that our designs are done with fidelity and rigor. Use strategies to make it easier to understand, do not change the expectations or requirements of the audience. If you have no expectations you do not have a great design (Vanderbilt University, 2022). The audience still has to learn something even with strategies in place. An example as an educational designer of keeping fidelity is that when designing a math curriculum for algebra they could use 1 or 2 digit numbers in the equations instead of 3 digit numbers or use numbers that divide evenly into each other. This simplifies the question for students that have a learning deficit in math, but still asks them to solve a complex formula. Using this example designers also should start with the small or simple numbers and slowly work toward more difficult ones, potentially ending the curriculum with an extra enrichment activity that uses 4 or 5 digit numbers for those that excel in math.

To keep your designs simple enough for people with disabilities and for those who are having a tough time focusing we need to start learning about the audience's psychology and the way they think. “Cognitive learning theories, theories that explain learning in terms of changes in the mental structures and processes involved in acquiring, organizing, and using knowledge (Eggen & Kauchak, 2016). While someone is interacting with your instructional message designs to help them acquire and retain information, focus on one main idea, topic, color, etc. Using Mayer’s Coherence Principle of eliminating extraneous information and images helps instructional designers create that main theme for each design message (Mayer, R., 2009).

Having one main message will help keep the audience's attention. Educationally defined as the “process of selectively focusing on one stimulus in the environment while ignoring others” (Eggen & Kauchak, 2016) attention is vital for having your design used properly. Once your design gets someone's attention, they have to perceive it as a meaningful message or they will find the next stimulus to focus on. Using a schema, a cognitive structure to represent information in a way that connects it to prior experiences, is a great way to make a message meaningful. For example, if I wanted to design a message about a new strawberry milk I would add a picture of a cow and a strawberry to the design.

Another tool to help with attention is chunking information on the design. Chunking is breaking information into smaller pieces by mentally, or physically, putting information into meaningful units

(Eggen & Kauchak, 2016). Paragraphs are a great way to show chunking. Can you imagine reading a novel without a single paragraph break? That would be too much for me to handle on a great day let alone someone who struggles with reading, comprehension, or focus. Recognition of chunking and schemas will help keep the audience's cognitive load, the amount of mental activity used to create a working memory, manageable (Eggen & Kauchak, 2016). People do not have unlimited memory storage for short term or long term memories. It is important to note that the more difficult it is to cognitively read a message the higher the cognitive load, and therefore more memory storage is used. It is our cognitive thinking processes that move information from one type of memory to the other. The larger the memory the harder it is for someone with cognitive processing disabilities to transfer and use the information remembered (Eggen & Kauchak, 2016).

Everyone is capable of comprehending messages in our designs if they are created and presented in a way that is both accessible and meaningful. To do that we need to use Universal Designs, schema, chunking, etc. to provide multiple opportunities for a variety of learning preferences, styles, diversity, and disabilities to successfully interact with our message designs. We also need to represent our message in multiple ways when possible, using text in multiple languages or reading levels and images and multimedia graphics. "By representing focused content in multiple ways and allowing learners multiple ways to act and express knowledge, UDL promises to develop recognition skills and strategic thinking" (Rieber & Estes, 2017).

Figure 3
Strategies that Work

	Chunking	Precise Language	Review Prerequistites	Time to Respond	Routines	Visual Schedules	Clear Workspace	UDL	1 Topic/Theme
SLD	X	X	X	X				X	X
ASD	X				X	X	X	X	X
ADHD		X	X	X	X	X	X	X	X
All Students	X	X	X	X	X	X	X	X	X

Note. This graphic created by the author, Brittney Heath, depicts different strategies that successfully helps those with disabilities decode the messages in each instructional design. The “x” represents that the strategy works for that given disability.

Online learning

Education and message design change yearly, if not even more often, and as instructional designers we need to be ready for these changes. The biggest change in the last few years is the mass influx of use on online learning platforms and the idea of learning solely online. “Online interaction between teachers and students is either synchronous, with teacher–student interactions occurring in real time (e.g., video chat), or asynchronous, with interactions occurring at different times (e.g., e-mail). Another approach to online education, blended learning, combines online learning opportunities with more traditional, face-to-face settings” (Hashey & Stahl, 2014). As students with disabilities are increasing each year it comes as no surprise that some of those students are enrolling in a form of online education. According to Mary F. Rice, students with disabilities are the fastest growing population in online learning platforms (Rice & Ortiz, 2020).

Online learning platforms like Google Classroom, Canvas, Blackboard, Moodle, Masterclass, etc. are used by children and adults all around the country to gain knowledge or a skill. These sites receive general maintenance updates as needed, but there are rarely big changes being made. Old platforms have old ways of thinking, ways invented long before instructional designers thought about accommodating those with disabilities or using universal designs. These outdated platforms, old unaccommodating layouts, and cognitive overloading platforms are the reason we see high failure rates among students with disabilities in the online world (Grabinger et al., 2008). Even Zoom, a newer web conferencing service used during the COVID-19 pandemic, is not special education friendly. Students with disabilities often use a form of assistive technology to help them get the most out of an instructional message. For example, a student with a visual deficit might use screen-reader software to have text read aloud, or a student with a specific learning disability may need larger fonts or spacing between characters. Neither of these supports are available in web conferencing for online education (Hill, 2020). Online instructional messages do have their advantages for those diagnosed with disabilities though too. Those on Autism Spectrum Disorder are characterized with social deficits, so communicating on an online platform like canvas is less of a hardship for them. Educators also commented that they saw more eye contact and better social skills in zoom than in the classroom as students on the spectrum only had to look at their screen instead of a person directly to make eye contact (Hill, 2020).

Keep It Simple

Whether you are creating new instructional message designs or updating old ones the basic idea to make sure everyone can benefit from your instructional designs is to keep it simple. "The first step for practicing accessibility design is the simplest, but perhaps the most important: begin by making a commitment to do so on every instructional project you begin" (Rieber & Estes, 2017).

Just like a teacher when they are teaching elementary students how to read, we as designers need to use the same simple strategies. To teach comprehension, teachers activate prior knowledge, clarify big ideas, use graphic organizers, images, and use books with a specific text structure. This means when we are designing instructional messages we should use phrases or images that activate the reader's prior knowledge and connects to something they already have long term memories for. Each design should have one central message idea with a few main colors.

Effective teaching, and instructional design, is when "instruction promotes as much learning as possible in all students"

(Eggen & Kauchak, 2016). Keeping our designs simple and effective by thinking about those with disabilities during each step of the design process can be done with two questions. First, what is important for the audience to get out of your message design? If this is done effectively then question two is easy, what do we want the audience to be able to do (Eggen & Kauchak, 2016)? If your instructional design does not have a physical/tangible component to do after reading, then what do you want them to think about or say after interacting with your instructional message design?

To teach, and design, effectively we as creators have to be organized. Lesson plans, presentations, graphic designs all need to have some form of organization or the audience will not be able to read and follow the information in a meaningful way. A great way to stay organized is to prepare as much as possible as far in advance as you can, always start on time, and smoothly transition from one project to another (Eggen & Kauchak, 2016). You also should have some form of an established routine to keep yourself organized as you work on creating multiple instructional designs and larger projects. The most effective teachers and instructional designers have a main emphasis on one topic or one theme at a time. Using an emphasis on verbal and visual cues helps bring the focus to the important information on an instructional message design (Eggen & Kauchak, 2016). For instance, if I wanted to add emphasis to a specific sentence in my chapter I could bold it, use a large pull out quote, or add an image with the definition to draw your attention to that specific paragraph.

By keeping the instructional design simple for the audience it also keeps it simple for you as a designer. Making simple changes to break up text, use less text, and use only necessary images takes less time in the long run.

Accessibility

You as an instructional message designer can use all of these strategies and create the most amazing designs, but none of that matters unless it is accessible in a way that your audience can easily understand and use. The key ideas of accessibility are that it should have accessibility through the general design and literacy.

The general design should have a clear organization of goals and themes so that the content of the instructional message can be presented in multiple ways (Rice & Ortiz, 2020). Teachers can teach students to write notes through a printed out Powerpoint, graphic organizer, fill in the blank notes, and a piece of blank notebook paper. Instructional design messages need to be made in the same way whenever possible. Having these options allows the audience to find a way to use your instructional designs in a way that best suits their needs at that moment. This can translate to a billboard, flyer, brochure, tv ad, etc. for the same company asking you to create their designs.

To keep instructional design messages accessible a designer can inform the audience when a change in routine or design is coming (Rice & Ortiz, 2020). Giving individuals with disabilities this forewarning of upcoming changes allows them time to think and absorb the idea of the changes. This warning is especially helpful to individuals diagnosed with Autism Spectrum Disorder and others that have deficits in social settings. Since the disability makes it difficult to read social cues and the individuals are typically on a strict schedule any small change can become too much new stimulus to handle.

Part of accessibility is having the content be at a literacy level the audience can understand. This concept is something we all instinctively do. Parents read picture books to their children instead of reading an Advanced Placement (AP) chemistry book. R. Scott Grabinger explains that if we put the accommodations in our instructional message designs then the audience will not have to go look for help in decoding our messages. This means having lower reading level writing and explanations of how to use each feature (Grabinger et al., 2008). Having accommodations throughout the instructional message design is another part of the Universal Design for Learning that was mentioned earlier in the chapter.

Presentation Designs

A static design is great, but often instructional designers have to create for a company or school that will present the design later on so we need to keep in mind specific strategies for presentations that will allow anyone in the audience, including those with disabilities, to get the most out of the instructional message design.

As an audience member the hardest part of gaining information is decoding and comprehending the text as it is spoken in the presentation as slides are changed. To assist in decoding presenters can wear a microphone and have text to speech software to bring the words to the individual (Vanderbilt University, 2022). As helpful as seeing the words on a slide show are, not everything spoken is in the presentation so it is incredibly helpful to have every word written. Having this text copy of the exact presentation will allow those with disabilities having a deficit focusing on multiple stimuli, like ADHD, the chance to focus on the presentation now and the content later. You can also provide the entire audience with paper to take their own notes if they so pleased.

Watching a presentation also gets difficult when you have to remember and identify key concepts to use later. This again can be done with note taking, but it is best addressed by using a graphic organizer or other visual cues in the presentation (Vanderbilt University, 2022). For example, if I were designing an instructional message for a large company I would create a graphic organizer showcasing where each job title is ranked, then show just that title of the graphic organizer when I address the job requirements of that particular position. This way you can also identify the key information because if it is not key it will not be in the graphic organizer or have a visual attached to it (Vanderbilt University, 2022).

Now I understand some of these strategies and techniques to include those with disabilities are easier to implement than others, and that is ok. As long as you as an instructional message designer are trying to implement and constantly thinking about those with disabilities and deficits then you are already succeeding at creating a great message design. It might take you longer to create messages this way at the beginning, but it will soon become natural for you to work on it for every design. Also understand that teaching with these accommodations will also take more time for the audience in the beginning, but they too will get accustomed to the changes (Vanderbilt University, 2022).

Conclusion

It is important for instructional designers and teachers to customize instructional message designs for all learners that will come in contact with their messages, including learners with disabilities. There are millions of learners that have been formally diagnosed and if we do not start creating instructional designs with disabilities in mind our profession will quickly be dismissed for something new. When you are creating, keep your instructional designs simple. When it comes to colors and images stick to one main theme with precise wording. If your design is longer, chunk information and use visuals to support the content. During a presentation of your instructional message design make sure that there is a way for the audience to take notes and when possible provide exact text of what is said.

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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 9: Messaging for Performance - Instructional Message Design in Human Performance Technology

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Chapter 9: Messaging for Performance - Instructional Message Design in Human Performance Technology

Bradley Sanders

Key Points:

- Human performance technology (HPT) utilizes systematic methods to close systemic performance gaps
- Performance improvement is the application of instructional and non-instructional interventions.
- Established principles for instructional message design can be applied to instructional interventions within HPT

Abstract

Human performance technology (HPT) is the practice of applying systematic models and methods to uncover the causes of systemic performance issues, particularly within organizations. HPT seeks to improve human performance outcomes by placing an emphasis on the investigation of causal factors outside of training and education deficiencies; only looking for those causes after all factors outside of the individual have been exhausted. In these instances, instructional interventions are chosen to close the identified performance gap and improve performance. This chapter defines HPT as a practice and provides the professional foundation of prominent models and methods used to improve performance. In its application, HPT then uses interventions that are both instructional and non-instructional to achieve the desired performance outcome. The chapter then culminates in an examination of various examples of

instructional messaging practices as they are applied to achieving human performance outcomes. The chapter concludes with a discussion of message design practices organizations can apply to help them navigate the difficulties associated with performance change.

"Efficiency is doing better what is already being done."
-Peter Drucker

Introduction

Any individual, organization, team, business, or military who has ever endeavored to improve their ability to accomplish their goals has conducted performance improvement. In all of these cases the entity formulates an idea of some desired future state, recognizes its current state, and defines the difference between the "Is" and the "Should" (Rummler & Brache, 2013). One might look at performance improvement as merely the actions taken to improve, but actions taken without first defining a destination results, at best, in aimless wandering, and, at worst, in squandered resources or lost lives. Performance improvement is a process of identifying need and cause as well as the subsequent definition of current and future state. Only after these have been identified can the mechanism of transit from current to future state – the intervention – be developed and implemented. Human Performance Technology (HPT) formalizes this process through systematic approaches to clearly answer the essential questions of performance, then leverages multidisciplinary tools of intervention to close performance gaps.

What is HPT?

Definitions of HPT abound. Kang and Molenda (2018) highlight a history of 31 published definitions, but the International Society of Performance Improvement (ISPI) recognizes HPT as a "systematic combination of several fundamental subprocesses [that]…determine need…determine causes…design solutions…ensure solution's conformity and feasibility, [and]…evaluate results and impact…” (as cited in Kang & Molenda, 2018, pp. 201). Across the numerous definitions of HPT, essential themes remain consistent. Where human performance improvement is the changing of behavior, HPT is the professional practice – the technology – of applying scientific principles to engineer that change in behavior (Gilbert, 2007). Chyung (2008) provides six essential characteristics of HPT.

1. Lawful - Human performance is lawful and can be examined through interdisciplinary methodologies.
2. Observable - Empirically supported through scientific observation.
3. Results Oriented – Change is measurable and enhances value.
4. Reactive and Proactive – Employed to eliminate barriers (reactive), change conditions that may create barriers (proactive), or improve current performance.
5. Systematic and Systemic – Applies proven methodologies (HPT models) while recognizing the systemic (layers of systems) nature of individuals and organizations.
6. Flexible – Interventions may be instructional or non-instructional based upon the need, cause, and goal.

Why HPT?

HPT is an applied field. That is, it is actuated through practice of the models and frameworks developed by academia and professional organizations like ISPI. In its application, HPT systematically improves organizational productivity through the design and development of “interventions that are results-oriented, comprehensive, and systemic” (Pershing, 2006, Ch. 2 A Definition of HPT). This focus on results represents one of many strengths of HPT. Whereas the theoretical fields merely admire problems, HPT engages them head-on. Tosti’s (2010) four principles help define those attributes of HPT that set it apart from other approaches.

Tosti's Four Principles

Results

Organizational development (OD) is another field that shares applicability with HPT but where OD starts with an analysis of behavior and then scaffolds up from there, HPT begins with the desired outcome and works regressively to determine systemic causation, constructing an intervention that achieves the desired outcome. In this sense, HPT is free to investigate performance factors outside of the individual.

Systems

HPT views organizations and the individuals that comprise those organizations as systems. Whereas OD focuses heavily on internal factors of the individual, the systems perspective of HPT accounts for external factors that may influence the individual's performance like their environment, resources, direction, and feedback. Change that occurs above the systemic level will likely only ever be superficial because it does not address the root causation of the poor performance.

Value

The effective application of HPT creates value for the organization. Value can be measured in a number of ways (traditionally in terms of return on investment), but adding value is ultimately about helping an organization achieve its strategic goals. Astute HPT practitioners of HPT may conduct their front-end analysis and identify that a problem or opportunity does indeed exist, but for any number of factors the best action would be to take no action. A level of discernment should be applied that determines if the prospective intervention would ultimately serve to help the organization achieve its objectives, or would it be intervening merely for the sake of intervening? Gilbert calls this "worthy performance," a concept to be addressed later in this chapter.

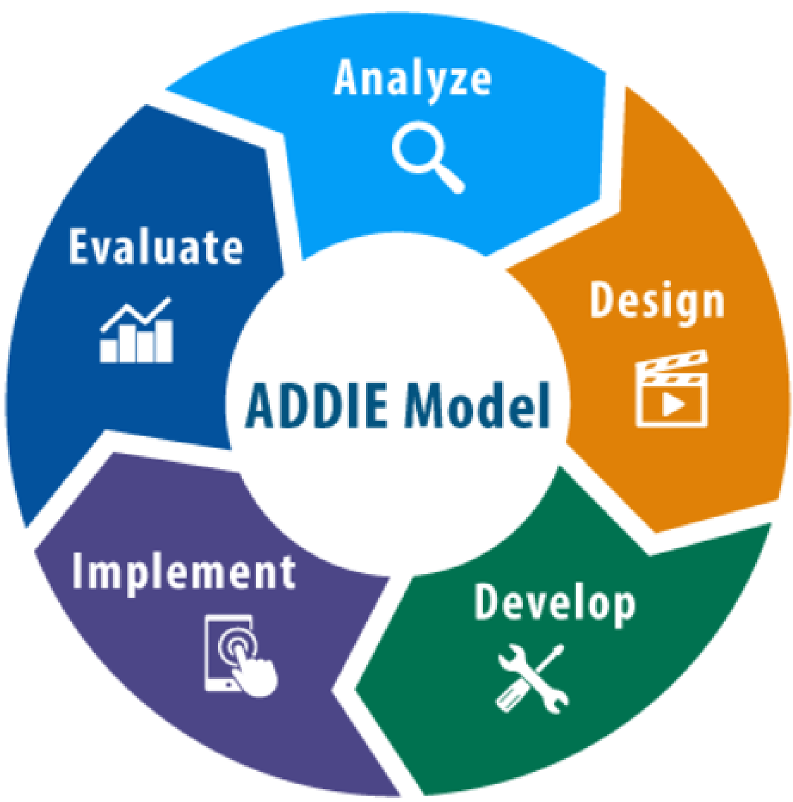
Partnerships

HPT is consultative. A client engages with a consultant about a perceived performance gap, and the two entities work together to uncover the cause and develop a solution. It is inherently a collaborative endeavor. Successful partnerships between client and consultant exhibit openness, respect, shared power, and a commitment to support.

How HPT is Applied

Models have a unifying effect that helps "gain consensus regarding performance improvement" (Dessinger, Moseley, & Van Tiem, 2012, pp.10). Models organize theoretically supported thought into actionable processes or thought structures. Any conversation of HPT would be wholly incomplete without at least acknowledging the ADDIE process, and while debate exists as to whether ADDIE is a formal model or merely the aggregate of best practices (Molenda, 2015). Most established HPT and instructional design models follow a very similar structure (see Figure 1).

Figure 1
Classic ADDIE



Note. The classic ADDIE model describes the process from idea creation to idea deployment and support and can be applied in many, many HPT environments to guide design.
(modified from https://www.edapp.com/blog/the-addie-model/)

As ADDIE suggests, any HPT intervention must first understand the problem or opportunity. Different models may substitute the word, but a theme of analysis is consistent. Analysis is arguably the most important step in the process because it is where the systems perspective is applied. A thorough analysis helps uncover the systemic issues that will be corrected throughout the rest of the process. A number of notable models focus on this first phase.

Analysis Models

Behavioral Engineering Model (BEM)

In a departure from Skinner's behaviorist theories that approached training and education through application of stimulus and reward for desired behavior, Gilbert (2007) distinguishes accomplishment from behavior to define Worthy Performance. Rather than focusing on the behavior itself as the cause, the BEM invites practitioners to first examine the environment of the individual and the possible influence it may have on the individual's performance (see Figure 2). After deconstructing any environmental factors, the BEM examines the individual. Even here, the model examines those elements of the individual concerned with the resources and faculties of that individual. Essentially, the model attempts to identify any possible causal factors affecting behavior outside of insufficient training. To Tosti's characteristic of Value, the BEM's approach is essential because instructional interventions are likely the most costly and time consuming option an organization can take to improve performance.

Figure 2
The Behavioral Engineering Model

	Information	***Instrumentation***	***Motivation***
Environment	Data	Resources	Incentives
Individual	Knowledge	Capacity	Motives

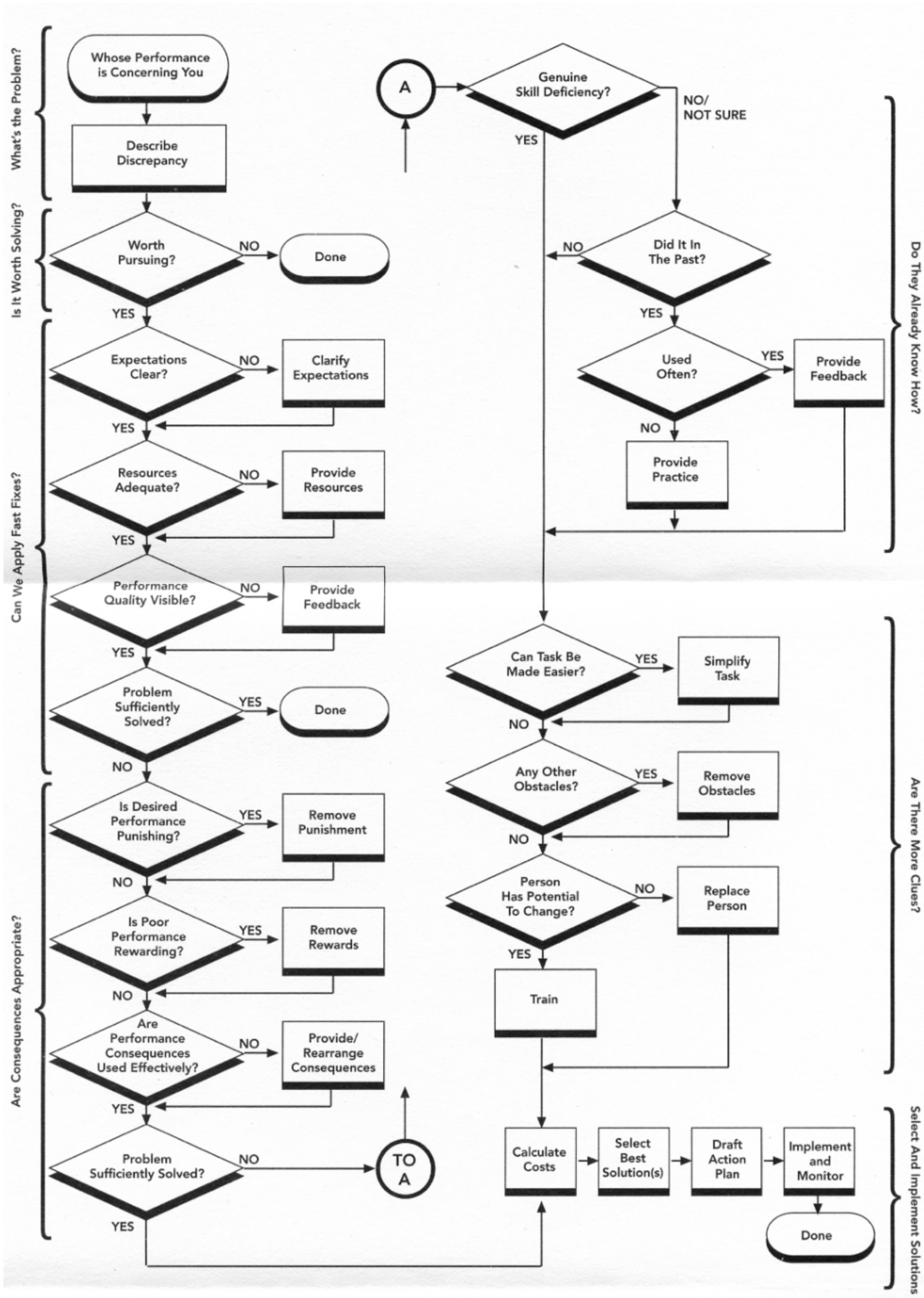
Note. The Behavioral Engineer Model, performance issues are caused by gaps between goals and existing status. Change can be achieved by analyzing data, resource, and incentives gaps in the organization's environment, and knowledge, capacity, and motive gaps in the individuals in the organization, (modified from Gilbert, 2007)

7 Step Analysis

Mager and Pipe's (1997) comprehensive flow chart forms a systematically executable analysis process that uncovers performance causation, and before discussing solutions, asks multiple questions that try to uncover easy solutions before instructional interventions are introduced (see Figure 3).

Figure 3

The Performance Analysis Flow Diagram



Note. (modified from Mager and Pipe, 1997)

9 Variable Framework

Like Gilbert, Mager, and Pipe, Rummler and Brache's (2013) nine performance variables form a framework for analysis of the organization as a system. The model aims to ensure that both vertical and horizontal alignment occur throughout the organization. Job goals, for example, should be aligned to accomplish organizational goals. Similarly, job management must be structured in such a way as to support the accomplishment of job goals (see Figure 4).

Figure 4

Three Levels of Performance

THE THREE PERFORMANCE NEEDS

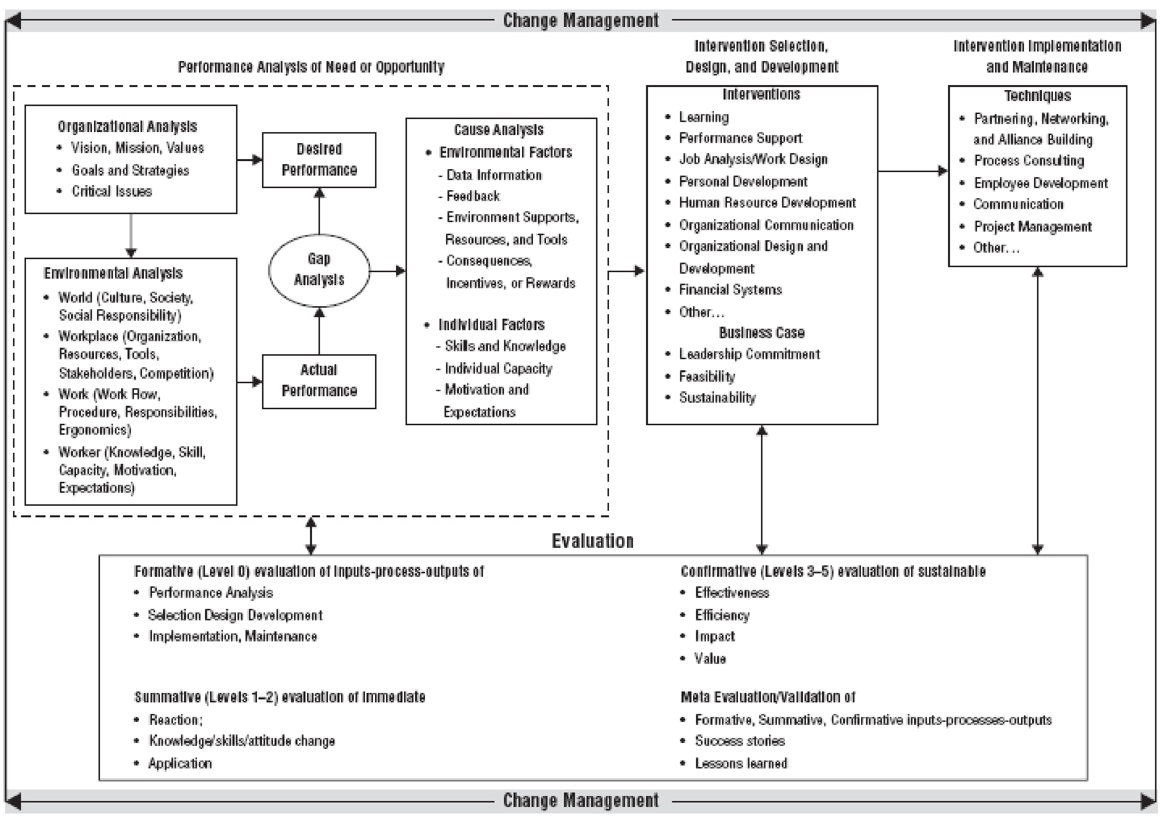
	Goals	Design	Management
Organization Level	Organization Goals	Organization Design	Organization Management
Process Level	Process Goals	Process Design	Process Management
Job/Performer Level	Job Goals	Job Design	Job Management

Note. This model describes three layers in a system, the organization layer where strategy is created, the process level where that strategy is turned into workflows, and the performer level where staff implement the workflow (modified from Rummler and Brache, 2013).

ISPI Model for HPT

Building from ADDIE, Van Tiem, Moseley, and Dessinger's (2012) Performance Improvement/HPT Model emphasizes focus on front-end analysis through gap and cause analysis and introduces it as both a linear and iterative approach (see Figure 5). Whereas ADDIE is most basically applied in a linear fashion – from A to E and then back to A again – the 2012 ISPI (International Society for Performance Improvement) model incorporates the evaluation phase throughout the rest of the process phases (Dessinger et al., 2012).

Figure 5
The ISPI Model for HPT



Note. The ISP HPT model describes a systemic phased approach from needs analysis to solution evaluation (modified from Van Tiem et al., 2012).

Interventions – HPT in Action

No matter the model or process you follow, at some point performance improvement requires action. As has been previously shown, sometimes the best action is to take no action at all. In a more practical sense, however, the practice of performance improvement can and will result in direct intervention to remedy the gap identified during the analysis phase.

Non-instructional Interventions

In some cases, instruction is neither practical nor would it be effective. The aforementioned models present systematic methods of analysis that emphasize alignment at various levels of a system; organizations being systems. Once a performance gap has been identified, the most appropriate intervention may simply recognize that there are not enough employees to perform a task rather than a need to better train existing employees. Mager and Pipe's (1997) performance analysis model seeks a "quick fix" in Step 3 by asking if the employees are properly equipped through physical and cognitive resources to perform the task. Gilbert's Worthy Performance balances the cost of improving the behavior against the negative effects of a behavior (Kaufman, 2019). Finally, Rummler and Brach's (2013) nine variable framework seeks to uncover systemic causes other than training prior to following the path towards a training intervention.

Instructional Interventions

It may be said that all instruction is a performance intervention, but not all performance interventions take the form of instruction. Sometimes, training and education is the most practical answer to performance gaps. The intervention then becomes instructional. For new hires, the obvious performance gap exists between their unfamiliarity with the new job and the requirements of that job. In academic settings, the performance gap is perpetual. Thus, the intervention is continual as children progress through their education. Instructional interventions are but one tool of HPT to achieve the performance goal, but the design of instructional interventions requires a certain level of instructional design expertise. Whereas non-instructional interventions could be something as simple as identifying the lack of defined policy on a given subject, effective instructional interventions require design that is informed by knowledge of learning theory and may be aided by technical knowledge like graphic design.

Intervention example: Compliance at Apple, Inc.

Corporate ethics and ethical compliance are relatively new concepts within the business landscape (Waugh, 2019). Recent social change is creating both legal and ethical requirements for diversity, equity, and inclusion (DEI) initiatives to be added to the more typical compliance programs of sexual harassment, equal opportunity, and ethical corporate behavior. Any new enforceable policy inherently creates a performance gap on its effective date. Organizational members should receive training on these issues to make them aware of official policy, train them on reporting procedures, and raise awareness of available resources for any aggrieved party.

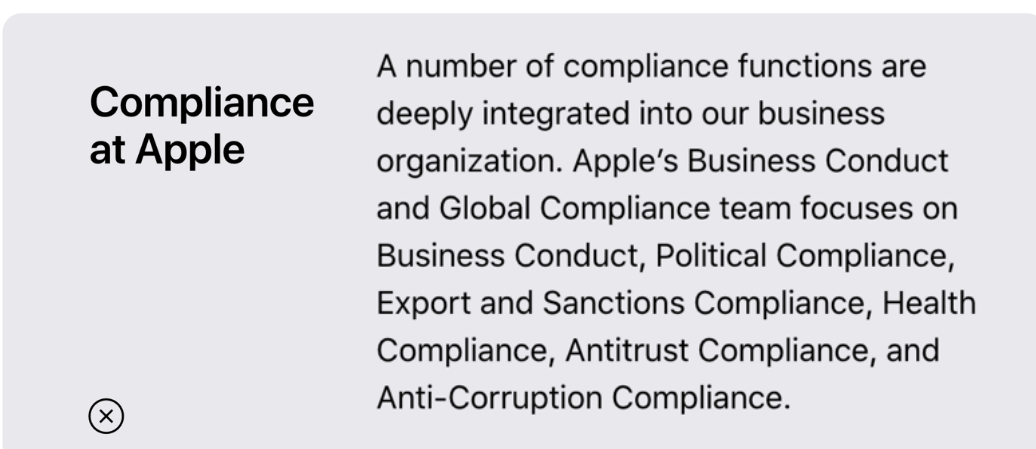
Apple Inc. has developed a robust compliance program which they make available to the public through their website. An entire page is dedicated to highlight the training that Apple employees receive on compliance issues, see Figure 6 (Apple, 2021a).

Figure 6
Business ethics at Apple

Note. (modified from Apple, 2021a)

But is training enough? When reviewing the parent Ethics and Compliance page (Apple, 2021a) the sections of the page often extoll the benefits of the policy in terms of training that employees receive on the policy. They also note that employees must sign a document acknowledging they have read the policies, see Figure 7 (Apple, 2021b). Does simply providing the training guarantee a development or change in behavior that ensures employees adopt to ethical approaches of Apple Inc.?

Figure 7
Apple and business ethics compliance



Note. (Modified from Apple, 2021b)

A slightly deeper examination reveals evidence of non-instructional approaches at work. The compliance policies themselves are non-instructional interventions. Looking back to Rummler and Brach's (2013) nine variable framework, establishing policy at the organization level is the first step in ensuring alignment can be created at the process and performer levels. The Ethics and Compliance parent page describes Apple's philosophy of compliance and their aspirational goal for business ethics with a quote from CEO, Tim Cook. Training is but one component of Apple's overall compliance program. Compliance, by Apple's description, is integrated throughout its entire organization and they conduct internal, and independent external assessments to ensure effectiveness of their program (Apple, 2021a).

Instructional Messaging

When instructional interventions are selected, appropriate message design delivers the intended learning outcome to the learner to create a change in behavior which, in turn, addresses the performance gap identified during the analysis phase. How this instructional goal is achieved is a matter of instructional messaging. Messaging can be thought of as both a vehicle (the medium through which the instructional content is delivered) and the information inside of that vehicle (the instructional content). While the instructional content is of pre-eminent importance, the vehicle through which it is delivered (traditional instruction, infographic job aid, asynchronous self-paced online instruction, public service announcement advertisements) also plays a significant role in message design.

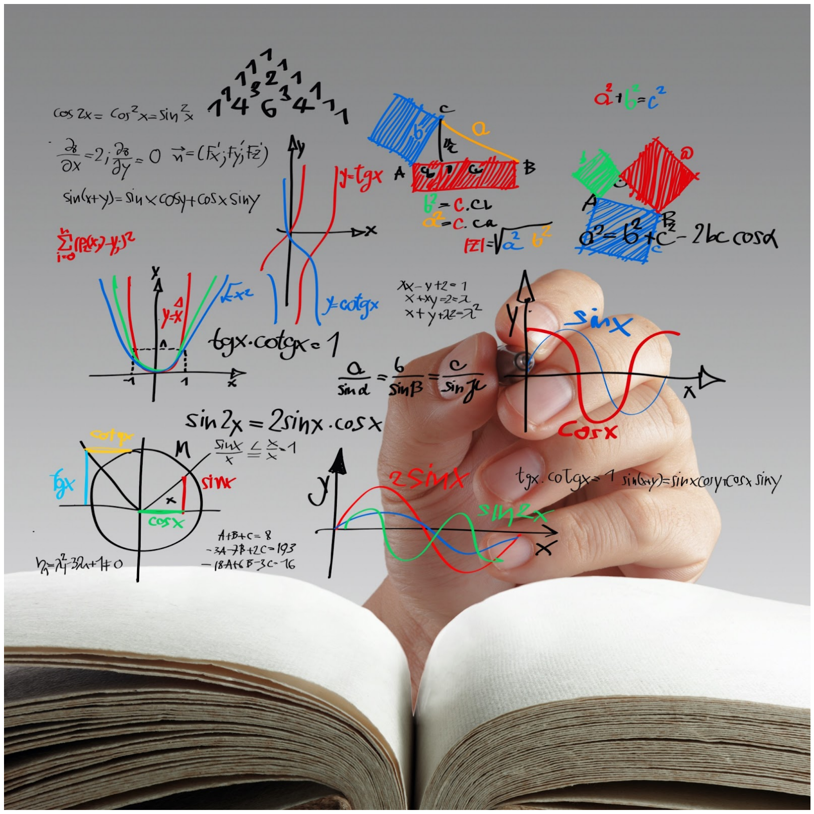
Instructional message design as a distinct field of study seems to have fallen out of favor amidst the transition from instruction centered to learner centered design that took place during the 1990's (Bishop, 2013). While limited research or commentary exists beyond Fleming and Levie's (1993) seminal work, elements of the field can still be seen in research on multimedia learning theory and cognitive load theory (Bishop, 2013). The unifying principle of all these fields is to develop and appropriately package an instructional message such that it suits the needs of the individual learner.

Instructional Messaging in HPT

Once an instructional intervention is selected, its design can take a number of different forms. Below are some examples of how instructional message design principles are incorporated into various instructional interventions.

Formal Instruction

The most obvious example of an instructional intervention is traditional training or education. As stated earlier, childhood education is itself an instructional intervention. In business and industry such interventions take the shape of classroom instruction or on-the-job training.



Formal instruction as an HPT intervention
can be very effective

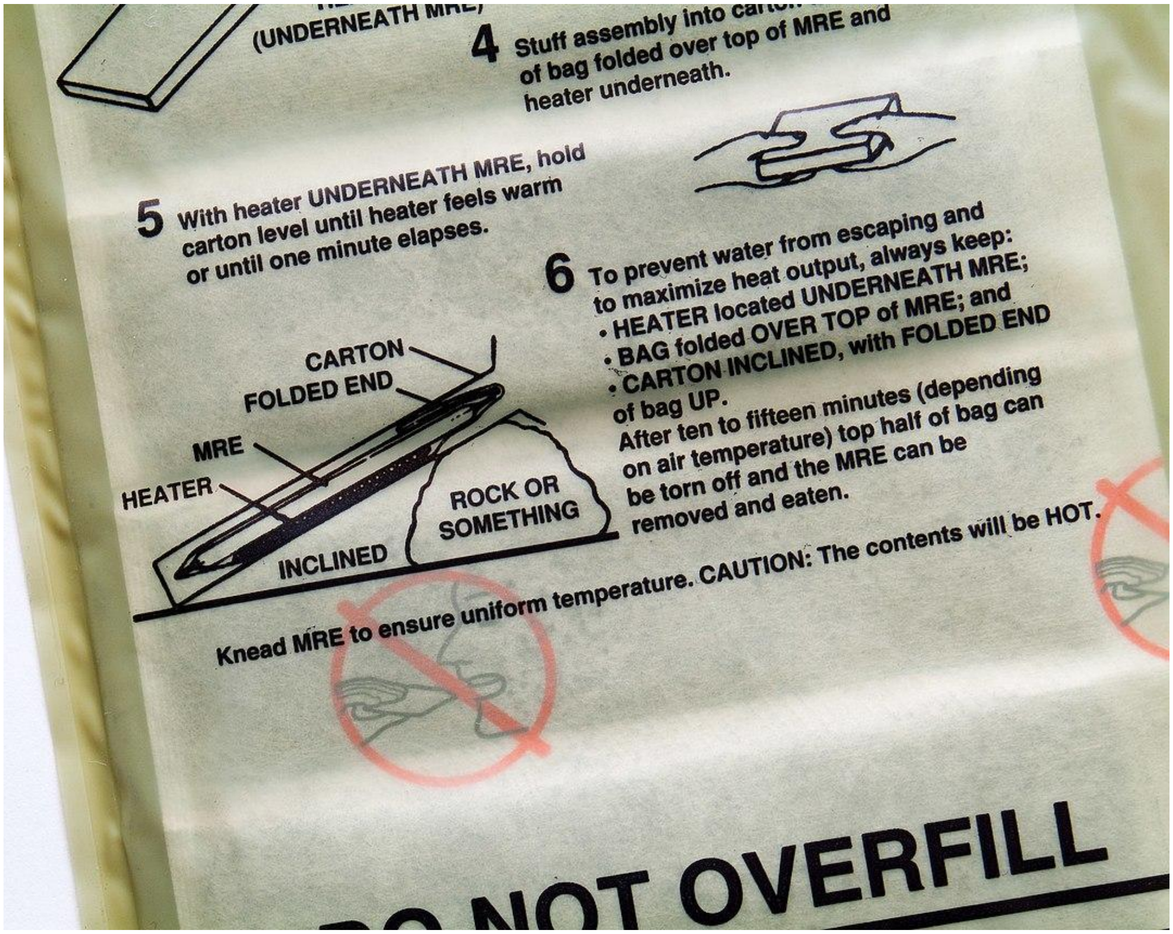
In either case, message design examines the context of the learner, their environment, and the performance gap to be addressed. Providing instruction on advanced mathematics, for example, does not lend itself well to a short, but entertaining video explanation and then examination. Such concepts require detailed explanation with extensive practice. Conversely, a new safety initiative at a manufacturing plant, targeted at an audience who has likely received dozens of similar briefs, would be well served to take a fresh and humorous approach that gains and maintains the learners' attention.

Safety training is a critical instructional intervention

Job Aids

Job aids exist to simplify processes through design that is intended for continual use by an individual (Belland, 2013). They are useful tools to quickly inform an individual on a simple process or procedure. While it is possible to have a text-only job aid, such an approach negates the simplification principle of job aids. Common examples of job aids include aircraft safety cards. Message designers make the images clear and intuitive enough to explain to the learner how to perform the task even without the use of text. Not including text recognizes the learner audience which is composed of individuals from a multitude of backgrounds and languages. Another example is the iconic instruction card found inside military Meals Ready to Eat (MREs). The flameless heater includes a mix of graphics and text that can be easily deciphered by U.S. military servicemembers or international disaster recipients. Note the importance of placing the activated heater on an incline against a “rock or something.” (see Figure 8).

Figure 8
The Importance of Job Aids



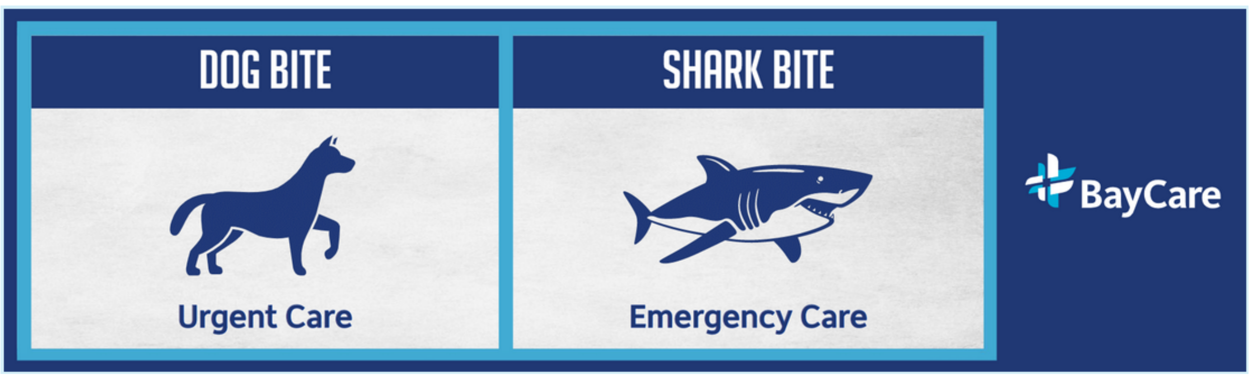
Note. A job aid may only be needed once, but for that one time it is a crucial help to our learner (modified from https://en.wikipedia.org/wiki/Flameless_ration_heater#/media/File:Flameless_Ration_Heater_0106.jpg)

Decision-making tools

A Tampa Bay hospital network identified a performance gap with their patients not understanding the difference between emergency care and urgent care. This lack of understanding caused emergency rooms to expend specialized resources on otherwise routine care. Urgent care facilities exist specifically to address acute but non-life threatening conditions. In order to educate the public on the different scenarios that would require emergency versus urgent care, BayCare created a number of billboard advertisements to be displayed throughout their region (Baycare, 2021). The instructional message is clear and its humor gains and maintains the audience's attention (see Figure 9). It has the added effect of creating conversation beyond the learner's passing sighting of the billboard as they joke about it with their friends. Such conversation further reinforces the learning goal behind the billboard.

Figure 9

Simple, Effective Instructional Message Design

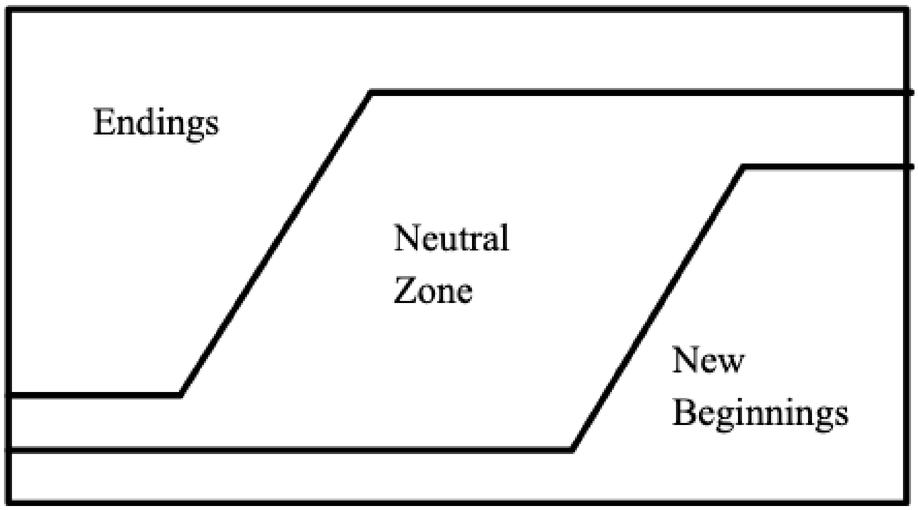


Note. (modified from https://baycare.org/services/emergency-care/er-vs-urgent-care)

Messaging for Change

Interventions whether instructional or non-instructional are implemented to produce a change in performance. Producing that change in performance is a cornerstone of HPT, but change is difficult and requires careful management. As Lencioni (2021) notes, "We don't hate change, we just struggle with the transition." Messaging forms a critical role in managing the change brought on through instructional and non-instructional interventions. William Bridges, a prominent author on corporate transition, assembled a framework for change management that can serve as a useful tool for HPT practitioners to help their clients more effectively integrate the change brought through the designed interventions and help their organizations navigate the transition. Lencioni (2021) presents a useful summary of Bridges' three-phased model (see Figure 10).

Figure 10
Bridge's Three-Phase Change Model



Note. Humans do not fear change they fear loss, this model describes the transition between ending a current status and transitioning to a new organizational state.
(Bridges' transition model as presented by Lencioni: https://de7pikzj4hvyk.cloudfront.net/wp-content/uploads/2021/05/04155840/Transition-Management.pdf)

Endings and Loss. Change is the end of one process, mode, or state of being, and the beginning of another. Endings are about individuals experiencing and reacting to loss in one of seven categories: loss of turf, meaning/purpose, attachments, control, structure, identity, or future. When an intervention determines that a new policy should be enacted or a new training paradigm adopted, individuals will undoubtedly experience some sense of loss over "the way things used to be." Accepting this loss is a matter of both personal choice by the individual and guidance from their leaders. Organizational leadership and change agents need to understand that successful change requires helping those who are affected by change to navigate the transition. Such assistance is done through effective messaging. In this sense, messaging is less a matter of font selection or multi-media platform and more focused on the message content; developing messaging that apprises team members of impending change. At a larger scale this may include flyers, mass-emails, or official statements from leadership announcing the change.

Navigating the Neutral Zone. Once change has been implemented individuals may find themselves in a zone of neutrality where they have to let go of the previous process or knowledge structure but have yet to fully adopt the change. Allowing an organization or its individuals to remain in this state prevents the full realization of the benefits brought through the intended intervention. When individuals find themselves in the neutral zone, messaging from leadership should be one of care and concern. Effective messaging demonstrates compassion for the specific type of loss experienced within the organization. It also reminds the organization of the intervention's purpose and what the future will look like once change has been implemented and adopted. Further, messaging in the neutral zone should define the path to the outcome and each individual's role in bringing about this change. At the macro level of the organization, effective messaging may take the form of imagery of the intended outcome. For example, moving to an upgraded facility represents a significant change for someone who may have worked in the same building for 20 years. They will undoubtedly experience loss of attachments and structure as their personal space and routines associated with the older facility fade away. Prominently displaying pictures or a model of the new building helps individuals like this understand the benefits of the change and provides an opportunity to see themselves in the future state.

Conclusion

HPT is the systematic application of performance improvement science that emphasizes a systems view of individuals and organizations. Through the conduct of a cause and gap analysis, HPT seeks to uncover the systemic attributes of performance problems and opportunities. Remedies for these problems are applied through performance interventions that can be either instructional or non-instructional in nature. HPT practitioners are different from instructional designers in that they are particularly specialized in uncovering and correcting performance issues caused by factors other than insufficient training or knowledge. In some cases, however, the most practical means of achieving the desired performance outcome is through an instructional intervention. Effectively designing instructional messages for instructional interventions is the practice of adroitly packaging the instructional content into the most appropriate vehicle to deliver that content to the specific learning audience within the context of their learning environment. This practice is guided by current research in audio/visual and multimedia learning theory and is contextualized within the broader fields of pedagogical and andragogical research.

Ultimately, the goal of instructional message design is to tailor instructional messaging in such a way that most effectively and most efficiently achieves the desired performance outcome. It should be noted that instructional message design is not contained to the instructional message alone. HPT practitioners must design interventions that are accompanied by tools that aid the organization in the successful implementation of the intervention. The practice of change management incorporates message design that assists learners in managing the difficulties of a transition by reminding them of the intervention's purpose and giving them a vision of the future.

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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 11: Game Literacy and Message Design

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Chapter 11: Game Literacy and Message Design

Jim Shifflett

Key Points

- *Game literacy* is an understanding of game mechanics, design principles, and gaming's role in culture.
- Instructional message design techniques, principles, and best practices can be used to contribute to a game's sense of immersion.
- Video games use a variety of mechanics to manage cognitive load including, uncluttered screen layout, multisensory cueing, and narrative tutorial missions to scaffold new players.

Abstract

The popularity of video games with today's learners requires that educators and instructional designers develop *game literacy*, or an understanding of game mechanics and design. The purpose of this chapter is to discuss game literacy within the context of instructional message design and to illustrate how video game designers apply and adapt principles of instructional message design to manage cognitive load through an immersive experience. These techniques include customizing the screen to display only necessary information and signaling changes in gameplay through sound cues and cinematic perspective. Game mechanics that foster germane load include tutorial missions and interface design. Similar to a narrative-driven video game, this chapter is divided into "quests" addressing cognitive load theory in video games. Completing each quest "unlocks" heuristics

derived from both educational research and game design. The chapter concludes with a "Boss Battle" against research gaps and challenges, notably the *expertise reversal effect* in game-based learning.

Press Start

Imagine investing $300-$500 in a machine that will overload your senses for hours at a time. If movie tickets seem expensive, this machine plays interactive movies lasting 40-100 hours for an additional admission price of $59.99. You will be immersed in strange worlds, distant planets, medieval fantasy battlefields, and dystopian cities. This machine will require you to perform complex tasks. Some of these tasks are designed to make you fail. Repeatedly. At first. Until you "git gud" at them. In fact, you may become so absorbed in meeting the challenge that you occasionally forget to eat, sleep, or practice good hygiene.

If none of this makes sense to you yet, then welcome - you have just taken the first step in developing your *game literacy*.

Game literacy is a type of *multiliteracy* (Gee, 2007; Sang, 2017) that includes knowledge of game design and mechanics, an understanding of gaming's role in culture, and the ability to "read" a visual medium such as video games (Chen et al., 2020). The New London Group (1996) coined the term *multiliteracies* to refer to the "increasing complexity and inter-relationship of different modes of meaning" (p. 78), including visual and multimodal design. The premise is that different media possess their own unique design languages, which users must learn to be considered "literate" in that medium. Print literacy is no longer sufficient for the modern world, which is inundated with visual and multimedia messages (Gee, 2007). People who play video games similarly learn a new way of interpreting and communicating information (Gee, 2007).

Chen et al. (2020) identified a lack of research into educators' game literacy, but they suggested that educators with high-level game literacy could critique educational games more effectively, motivate students through well-designed game-based learning activities, and develop stronger relationships with their students who also play games. Educators and instructional designers can develop game literacy through the "connoisseur" model by reviewing the classics in each game genre, critiquing games, and reading both scholarly works and popular criticism from gaming sites (Dickey, 2015).

A game designer's aim is to create immersive experiences (Hodent, 2018; Schell, 2020), just as instructional designers strive to create immersive learning experiences (Parrish, 2009). McDonald (2009) recommended that instructional designers borrow principles from popular media such as film to inform their practices, rather than try to apply "*traditional message design* and instructional design principles to film production" (p. 112-113, emphasis added). This chapter follows McDonald's recommendation and applies his approach to video games, another popular medium in which there are good examples of specialized principles that can inform instructional design (Gee, 2007). The purpose of this chapter is to discuss game literacy within the context of instructional message design and illustrate how video games adapt principles of instructional message design to manage cognitive load through an immersive, aesthetic experience. Educators and instructional designers can apply these same principles from video games across a variety of game-based and more traditional instructional contexts to motivate learners.

Backstory

It's in the Game

There are a variety of ways in which video games can be integrated into instructional contexts. However, even educators who play games as a hobby can be reluctant to incorporate them into their pedagogy (Alsawaier, 2018). One method is to make the game itself the subject, as did a recent college course that used the western game *Red Dead Redemption 2* as an access point to teach American history (Deveney, 2021). Another method is to use educational games, sometimes called "serious games," which are designed to effect changes in attitudes, behaviors, competencies, knowledge, and skills (Hodent, 2018; Jacobs, 2021). Two well-known examples are *The Oregon Trail* (1985) and *Darfur Is Dying* (2006). A third method is gamification, or incorporating game mechanics to motivate learners through strategies such as competitions, points, and badges (Alsawaier, 2018). A recent meta-analysis of gamification studies concluded that these strategies hold promise, but suggested that they have not yet been used to full effect to foster higher-order learning activities (Sailer & Homner, 2020). Furthermore, gamification has been criticized for being too reliant on external rewards and extrinsic motivation (Hodent, 2018; Kapp, 2012).

While much of the research on game-based learning has focused on strategies, games are popular largely because of the sense of immersion in their virtual worlds (Dickey, 2015). One approach to understand immersive game design is to view it through the lens of instructional message design. Message design has evolved from principles governing the visual presentation of instructional content to encompass the entire sensory and learning experience. Instructional message design has been defined as visual patterns, words, and images that impact learning or behavior (Fleming & Levie, 1993). For Seels et al. (1996), the focus on the visual presentation aspects of instructional message design distinguished it from instructional strategies. Larson and Lockee (2013) noted the historical emphasis on visual design but expressed the need for a more expansive, multisensory approach that included the design of virtual worlds and "aural, tactile, and olfactory messages" (p. 210). The increased focus on the entire sensory experience in instructional message design coincides with the increasingly multisensory experience of video games and augmented/virtual reality (Fisher et al., 2019).

Cognitive Overload

Early arcade-style video games such as *Donkey Kong* (1981) and *Super Mario Bros.* (1985) used fairly simple game design. The player would try to meet an objective within a game world limited to a single screen or level, often involving jumping from platform to platform. The complexity lay in the external constraints the game placed on the player: time limits, number of "lives," and side-scrolling levels that compelled the player in one direction and often pushed them into obstacles. Before video games were ported to early gaming consoles like the Atari and Nintendo, they were designed to take quarters at the arcade. They were difficult, but through repeated practice, and a lot of quarters, one could eventually learn to beat them by timing their actions just right. (Today's professional gamers often revisit arcade classics and try to challenge themselves through "speedrunning," or conducting the fastest, most efficient playthrough). By contrast, newer games, which cost $60 (or 240 quarters), have already secured the player's money. These games are instead designed to teach players how to play through scaffolding and problem-solving (Gee, 2007). Many newer games encourage exploration, experimentation, and replay. Failure does not equal "Game Over."

As game technology has grown more advanced and realistic, which enables designers to tell stories and create entire virtual worlds (Dickey, 2015), games have evolved into increasingly complex, multisensory experiences with various interlocking systems (Fisher et al., 2019). Players can interact meaningfully with non-player characters (NPCs) or other human players online. They can see the impact of their actions on the game world, bringing prosperity or ruin with their decisions. Some role-playing games (RPGs) and strategy games have entire political and economic systems that players must learn to navigate. Consequently, many elements of modern video games are designed to reduce extraneous cognitive load to focus players' attention on the gameplay and narrative (Hodent, 2018).

Cognitive load theory (CLT) posits that a learner's working memory is dependent on the complexity of the material and the number of interactional elements (Sweller, 2020; Sweller et al., 2019). Effective instructional design facilitates the transfer of knowledge from working memory to long-term memory (Sweller, 2020), where information is stored for later retrieval. Long-term memory possesses much greater capacity because of the ability for learners to store large amounts of information as *schema*, or mechanisms for mental organization and retrieval (Sweller, 1988). Sweller et al. (2019) distinguished three types of cognitive load that can impact the transfer of information from working to long-term memory: *intrinsic*, *extraneous*, and *germane load*. Intrinsic load is determined by both the complexity of the material and the learner's prior knowledge and experience. Extraneous load is determined by how the information is presented and the demands it places on the learner's working memory. Effective message design will reduce extraneous load whereas poor design will increase it and divert the learner's essential cognitive processing resources away from the intrinsic difficulty of the content. Sweller et al. (2019) have refined the definition of germane load as the reallocation of cognitive processing resources *away* from extraneous load and *towards* intrinsic load.

Mayer and colleagues have developed a set of principles derived from extensive empirical research for managing cognitive load in multimedia learning environments. These include principles for reducing extraneous load (the *coherence*, *signaling*, and *contiguity* principles); managing intrinsic load (the *pre-training* and *segmenting principles*); and fostering germane load (the *personalization* and *embodiment principles*), such as the use of pedagogical agents (Mayer, 2017). Although the principles of multimedia learning were developed and tested using studies in online instructional contexts, Mayer (2017) advocated for future research examining whether these principles apply equally in media such as serious games as well as augmented and virtual reality.

However, many popular video games have already adapted principles of multimedia learning to manage cognitive load and create more engaging experiences for players. These techniques include customizing the screen to display only necessary information (the coherence principle); signaling changes in gameplay through sound, cinematics, or perspective shifts (the signaling/cueing principle); allowing players to compare gear stats quickly (the spatial contiguity principle); providing mission briefings to alert the player to key opportunities (the pre-training principle); and dividing the narrative experience into quests that can be conducted at the player's convenience (the segmenting principle). The opening tutorial mission found in many video games represents a well-known strategy for managing cognitive load and scaffolding new players with germane load. Video games have many more potential applications beyond improving hand-eye coordination, as has been commonly noted.

Pause Menu

Similar to a modern narrative-driven video game, the remainder of this chapter is divided into three "acts" on how video games manage cognitive load for players and scaffold them to success. Each act consists of quests, which open with a concept, principle, or theory of message design and multimedia learning; explain how and why video games use these design principles with specific examples; and then conclude with heuristic "skill unlocks" for educators and instructional designers derived from educational research and game design. "Leveling up" by unlocking new skills is an essential mechanic in many video games (Van Eck et al., 2018). The grand finale confronts current research gaps and challenges with a "Boss Battle" against the expertise reversal effect (Sweller et al., 2019).

This chapter assumes nothing about the reader's familiarity with video games and game design. Terminology will be defined in context. The more accessible term "player" is used instead of "gamer" to highlight the connection with "play" as a general learning activity (see also Salen & Zimmerman, 2004; Sutton-Smith, 1997; Vygotsky, 1934; 1978). Brief descriptive case studies of popular narrative-driven games in the action, adventure, and role-playing (RPG) genres will be used to illustrate the relevant principles of instructional message design (interested readers are encouraged to visit YouTube to see gameplay examples in action). It is worth noting that the best-selling games each year are frequently first-person shooters (FPS) and esports. These genres will not be represented as thoroughly here - not because they lack instructional value but because other genres better illustrate certain principles of message design. The focus on certain genres underscores the wide variety of video games and gameplay experiences.

Tutorial Mission

A significant contribution video games have made to our understanding of cognitive load and the implications for players is the development of the tutorial mission. A tutorial mission is the introductory level of the game that scaffolds the player by reducing the difficulty, providing hints when necessary, and enhancing their sense of competence through easily achievable objectives (Alexiou & Schippers, 2018). Effective tutorials introduce players to the fundamental mechanics that will prove most useful later in the game when developing generalizations or problem-solving (Gee, 2007). Tutorials are often short but exciting missions and may serve as the beginning of the game's narrative or start in the middle of the action (*in media res*). Rather than teach a complex mechanic superficially through a tutorial mission in which players do no more than "Press X to Jump," effective tutorials invest the player in a meaningful and contextual story mission (Hodent, 2018). Players learn the game's core mechanics within the context of its narrative and are motivated to do so by the compelling action.

There are variations of the tutorial mission that leverage different cognitive load effects, notably the worked example and faded example effects (Sweller, 2020). Worked examples reduce element interactivity and provide learners with the rationale for each step in a problem-solving procedure. According to Sweller (2020), worked examples with explicit explanations are more effective for novices than requiring them to solve problems. Tutorials may first demonstrate for the player how to complete a task and then ask them to perform the task. There may be required criteria for successful completion before the player can advance. Some games periodically return to the tutorial mission format throughout the game to introduce new game systems and mechanics, which reinforces previously learned skills through consolidation (Hodent, 2018) and distributed practice (McCrudden & McNamara, 2018).

Case Study: "A Rock and a Hard Place"

Uncharted 2: Among Thieves (2009) opens *in media res* (Latin: "in the midst of things") with an intriguing, disorienting cinematic cutscene starring intrepid adventurer Nathan Drake, the protagonist players met in the previous game. Drake seemingly sits upright in an abandoned train car, looks at his hands and says, "That's *blood*...that's *my* blood...that's a *lot* of my blood." The growing awareness that he (and by extension, the player) is bleeding profusely from the abdomen immediately piques the player's interest as well as several pressing questions. However, those questions will need to wait because debris suddenly flies across the screen and smashes open the rear door of the train car, revealing the ground far below. Drake is not sitting upright at all, but suspended horizontally in mid-air, and soon follows the debris through the rear door himself and ends up clutching a railing (see Figure 1). The game's camera zooms out and we see a flaming train wreck high in the mountains, the last two cars hanging jackknifed over a cliff. At this point, the player takes control of Drake.

Figure 1
Tutorial Mission from Uncharted 2: Among Thieves *(2009)*

Throughout the mission, the player must navigate Drake to safety by climbing pieces of the hanging train car. The camera pans around as Drake traverses from the side of the train to the undercarriage to keep the player's perspective centered. Just as Drake reaches a gap, the tutorial flashes "Press X to jump" as just-in-time information. Falling debris will periodically set the player back to heighten the stress and introduce additional mechanics ("Hold L in the direction you want to swing and press X to jump"; see Figure 2). Jumping and swinging are two essential skills that players will use throughout the entire game to climb and navigate obstacles. Later in the game, the player will learn to drive vehicles and use weapons, but the tutorial mission is solely focused on these basic survival skills in a suspenseful context rather than presenting irrelevant mechanics (Hodent, 2018). The level gives the player the illusion that they are racing against time as the train lurches ever closer to falling off the cliff, but the lurches are scripted to occur as the player reaches various mini-checkpoints and are in fact pushing the player toward successful completion. These mini-checkpoints are signaled by both visual and audio cues (Hodent, 2018; Mayer, 2017). The opening tutorial concludes with Drake running through the last train car as it slides off the mountain, making a desperate leap and then collapsing in exhaustion after he crawls to safety. The player can empathize.

Figure 2
Relevant, Just-in-Time Instruction During the Tutorial Mission

Consider how this level has motivated the player through contextual, meaningful action (Hodent, 2018) while simultaneously managing their cognitive load in beginning a new game. Only essential information about basic navigation has been presented in accordance with the coherence principle (Mayer, 2017). The seamless shifts in camera perspective that continuously center the player's view eliminate the need to mentally rotate the screen as they navigate their way around each side of the train. Mentally rotating objects increases the time necessary to perceive them correctly (Shepard & Metzler, 1971), and when hanging from a train car, there is precious little time to expend on extraneous cognitive load. Players receive both visual and audio cues of imminent changes in the game environment, such as smashing glass and machine parts that creak, wobble, and threaten to break as Drake uses them for leverage. In only five minutes, the tutorial mission has invested players in an exciting mystery, introduced the core game mechanics of climbing and traversal, and taught them skills that will save their (Drake's) life later in the game.

Act I: Reduce Extraneous Load

Quest: The Coherence Principle

Multimedia learning is more effective when extraneous and irrelevant material are removed (Clark & Mayer, 2016; Mayer, 2017). To compensate and reduce extraneous load, many modern games remove unnecessary elements from the visual display. In deciding which systems and Heads Up Display (HUD) elements to incorporate, Hodent (2018) recommended that game developers focus on a few core pillars and mechanics. These mechanics should be challenging to the player because they serve the game's purpose, but extraneous elements and onerous navigation should be removed. Older games often featured various meters on the screen, such as a prominent health bar in the upper left corner. In newer games, taking damage is often revealed not by a draining health bar that draws attention away from the enemy, but by tunnel vision effects such as a red heartbeat and nerve pattern around the edges of the screen or a gradual fading to gray (Figure 3). In *Elder Scrolls V: Skyrim* (2011), the relevant meters for health, magic, and stamina are only displayed when those resources are consumed.

Figure 3
Damage Indicator from Call of Duty 2 *(2005)*

Quest: The Signaling/Cueing Principle

Highlighting essential information through typeface, arrows, spotlights, or callouts leads to more effective learning in multimedia environments (Clark & Mayer, 2016; Mayer, 2017). A special type of signaling/cueing in works of fiction is the *motif*, a repeated pattern, image, sound, or symbol. Motifs can draw learners' attention to essential information or act as cues to connect pieces of information (Taeger, 2020; Taeger & Yanchar, 2019). The use of narrative motifs follows the Gestalt principle of similarity, in which the learner will seek patterns and repetition to orient themselves; motifs also adhere to the principle of previous experience, in which learners will interpret information within the context of prior learning (Lohr, 2008). Each time a motif appears, it further consolidates the learner's understanding (Hodent, 2018). Narrative events in games are often connected through motifs, which can be illustrated in instructional contexts through recurring examples and ideas (Parrish, 2009).

In the specific context of game design, Hodent (2018) discussed the "priming effect," or signaling an imminent change in the game environment through visual cues. This can draw the player's attention more quickly to a threat or a point of interest. Video games use signaling/cueing techniques of various salience, including arrows, sound/musical cues, haptic/tactile cues, and perspective shifts. Stealth-based games, in which the player's objective is to remain hidden and blend in with their surroundings, cue the player that they are being detected with an indication arrow in the enemy's direction. Once their cover has been blown, the player might notice a dramatic musical change to signal a shift from exploration to combat mode (Hodent, 2018).

Modern game controllers provide haptic/tactile cues by rumbling or vibrating, such as when the player takes damage or drives a vehicle over rough terrain. Some games also use haptic cues when players near an objective or point of interest. This mechanic is often used as a character's mind's eye, enhanced senses, or "instinct." In *Red Dead Redemption 2* (2018), players can use treasure maps to find buried gold and valuables. The maps provide the player with visual clues only (no specific map points or place names), but once the player arrives in the general area, the controller will begin to vibrate. The closer the player gets to the treasure, the more intense the vibrations.

One of the more dramatic visual cues noticeably occurs in third-person perspective games and borrows a cinematic convention. These games often follow the protagonist from a just-behind (*The Witcher 3: Wild Hunt*, 2015) or over-the-shoulder perspective (*Batman: Arkham City*, 2011). The game's "camera" is placed at either a neutral or a slightly high-angle shot (Figure 4). When the player encounters enemies, however, the camera thrusts the protagonist forward into an extreme long and high-angle shot, showing the player their full surroundings, enemies, and the magnitude of the threat that they are facing (Figure 5).

Figure 4
Over-the-Shoulder Perspective in Batman: Arkham City *(2011)*

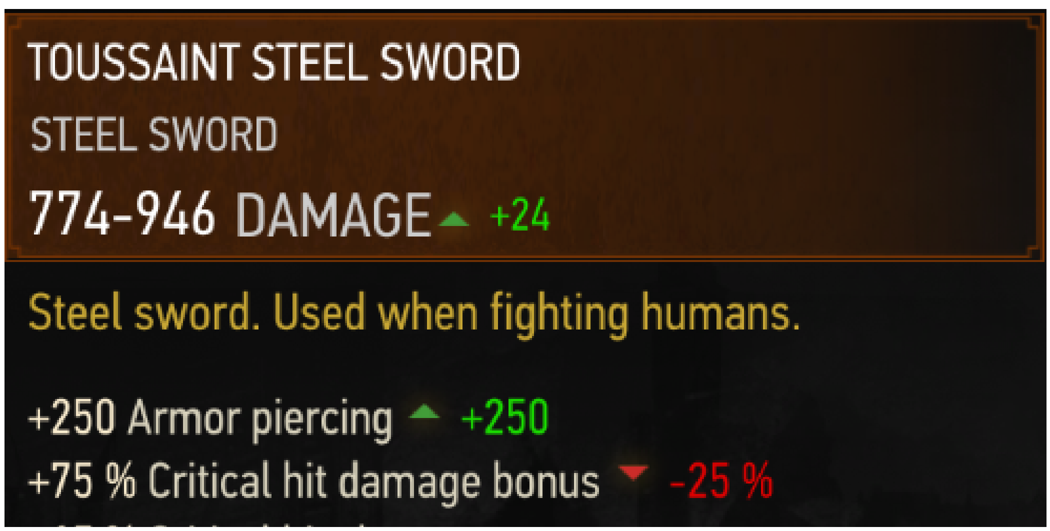
Note. Notice the just-in-time instructions at the bottom of the screen. The Bat Signal in the distance indicates the next objective in the game.

Figure 5
Perspective Shift During Combat Mode in Batman: Arkham City *(2011)*

Quest: Spatial Contiguity and the Split-Attention Effect

Placing corresponding text and graphics in closer proximity to each other reduces extraneous load (Clark & Mayer, 2016; Mayer, 2017) and avoids the split-attention effect, in which learners must mentally integrate two separate sources of information (Sweller et al., 2019). The spatial contiguity principle is useful in games in which players need to compare the stats for two similar items in their inventory. For example, if a player wanted to compare two swords for their speed and damage stats, they might need to equip one sword, jot down the various stats, and then repeat the process with the other sword. To streamline this process, many games use an inventory interface that allows the player to compare currently equipped items against other items of the same type in their inventory. Differences between the two items are displayed through bar graphs or colored up/green and down/red arrows (Figure 6). These contiguous visual displays indicate whether changing items would be an upgrade or downgrade in the player's overall gear strength.

Figure 6
Gear Stats Comparison from The Witcher 3: Wild Hunt *(2015)*



New Skills Unlocked: Extraneous Load Heuristics

Instructional Designer (Lvl. 1)	Use instructional motifs to highlight key concepts and connect ideas (Parrish, 2009; Taeger, 2020; Taeger & Yanchar, 2019).
Message Designer (Lvl. 1)	Integrate multiple sources of information into a single screen/page to avoid the split-attention effect (Sweller et al., 2019). Give the learners a way to compare information as easily as they compare gear stats.
Game Designer (Lvl. 1)	Provide just-in-time information when the learner needs it to complete an authentic task rather than overwhelm them with irrelevant information (Mayer, 2017).

Act II: Manage Intrinsic Load

Quest: The Pre-training Principle

Learners comprehend a multimedia lesson better when they receive pretraining in key concepts and elements (Clark & Mayer, 2016; Mayer, 2017). A comparable function in video games is the "loadout screen" in first-person shooters (FPS) and other action games. In these games players are usually limited to carrying only a few items from their inventory, which requires careful planning and selection. The loadout screen displays the mission map and other potential points of interest to help players develop a strategy before starting the mission. Another example occurs in the *Hitman* series, in which players control globetrotting assassin Agent 47. Each mission opens with a mission briefing by Agent 47's handler, Diana Burnwood. Diana introduces the mission's targets, backstories, and a few areas of interest in the environment that the player can exploit, always concluding with, "I'll leave you to prepare." Armed with this intel, the player then selects a limited number of items that may prove useful during gameplay. The player is free to explore and adapt during the mission itself, but the pretraining briefing directs their attention to mission objectives and effective strategies to complete them. The mission loadout structure encourages higher-order thinking by requiring players to analyze the mission's parameters and then synthesize and evaluate potential strategies.

Quest: The Segmenting Principle

Content with high intrinsic load is easier for learners to process when segmented into more manageable, self-paced chunks (Clark & Mayer, 2016; Mayer, 2017). One way in which video games segment content is through quests or missions. Narratives in video games, especially in the RPG and adventure genres, use a variety of quest types to tell the story. Educators and instructional designers can adapt the structure and conventions of quests for their message design (Dickey, 2015). Quest types include "fetch/FedEx quests," "escort quests," and "boss battles." In a fetch quest, players are tasked with retrieving an item in the game world and possibly delivering it to another location (Dickey, 2015). Games can sometimes string together several fetch quests to build a larger item that the player needs to complete an objective. Fetch quests are effective at introducing players to a new area and building confidence because they tend to be easier than other types of quests, but they also become tedious when overused (Dickey, 2015). An analogous activity in educational contexts would be asking learners simply to find and retrieve information with little variation.

In an escort quest, players protect a non-player character (NPC) and escort them to another location, usually attacked by enemies at several points along the way. Players assume a more expert role and assist the NPC in achieving their objective, but players often dislike these quests because NPCs are not always well-programmed to defend themselves or be helpful (Cerny, 2015). However, educators and instructional designers do not need to program competent NPCs; instead, they can consider how learners may use their newly acquired skills to help others, further consolidating these skills.

A boss battle is often the culmination of a larger quest line in which players must confront an enemy or guardian using the items and skills they have acquired throughout the game to that point. Bosses grow progressively more difficult, requiring players to problem-solve and use combinations of both learned and newly acquired skills. Boss battles resemble summative assessments in that players must demonstrate their learning in a new and challenging context.

The length of modern video games, some of which can take dozens of hours to finish the main storyline, has required developers to consider pacing and segmentation more carefully. Depending on the game's complexity, there can be a significant initial downgrading of players' abilities if there are long intervals between play sessions, which can be discouraging for players who have already invested time in learning to play (Hodent, 2018). The challenge is to design the game to accommodate a range of gaming habits, and there is evidence that longer intervals between play sessions may lead to deeper learning of the game's systems through the principle of distributed practice if the game continually reinforces its core mechanics (Hodent, 2018; Kapp, 2012; McCrudden & McNamara, 2018). McCrudden and McNamara (2018) found that distributing learning activities, study, and retrieval practice over time was more effective than "cramming." Hodent (2018) recommended teaching the game's most complex features over time through iterations, reminders, and consolidation. After the player learns one complex skill, they will continue practicing as they learn the next, consolidating the initial skill as they do so. The repetition also helps the player develop schema to interpret the game (Hodent, 2018) and other games using similar mechanics.

Distributed practice's implications for message design includes how best to present previously learned material efficiently but comprehensively such that learners/players can pick up where they left off. One method games use to remind players about previously learned material is to provide quick tips, tutorials, and narrative flashbacks during loading screens (Hodent, 2018). As games have grown more technologically advanced, loading screens have increased in duration, which developers have leveraged as learning and narrative devices (Avard, 2019).

New Skills Unlocked: Intrinsic Load Heuristics

Instructional Designer (Lvl. 2)	Remind learners of information and help consolidate learning between lessons with narrative flashbacks or helpful hints (Hodent, 2018).
Message Designer (Lvl. 2)	Adapt the pre-training principle (Mayer, 2017) into a "mission loadout" briefing to prepare learners before a lesson by highlighting key features and strategies that will enable them to be successful.
Game Designer (Lvl. 2)	Turn an instructional intervention into quests, culminating in a "boss battle" (Dickey, 2015).

Act III: Foster Germane Load

Quest: Pedagogical Agents

Pedagogical agents are virtual coaches who assist with learning and may be animated figures, avatars, or recordings of real people (Clark & Mayer, 2016). The pedagogical agent acts as a "beneficial navigator" (Mohammadhasani et al., 2018, p. 2301). Utilizing the embodiment principle, designers should consider using pedagogical agents who speak, gesture, and react like humans (Clark & Mayer, 2016; Mayer, 2017), which also preserves the sense of a social partnership between learner and instructor in online settings (Mayer, 2017). Pedagogical agents are more effective when they follow the personalization principle and speak conversationally and politely (Clark & Mayer, 2016; Mayer, 2017). Pedagogical agents can promote cognitive processing by serving as social cues (Clark & Mayer, 2016; Mayer, 2017), but there is also an emotional element that learners navigate by developing a connection with the agent. Dickey (2015) discussed the use of pedagogical agents in video games to evoke emotional responses from players and build deeper connections.

Players appreciate characters who are helpful (Cerny, 2015) and with whom they can empathize (Schell, 2020).

Characters in the game world must not only fulfill their roles in the narrative, but also serve as "mini-minions" to achieve the designer's intentions (Schell, 2020). Using a narrative structure can provide a message design strategy for the instructional arc. One popular structure for understanding narrative design has been the Hero's Journey/Monomyth (see Campbell, 1949), which has been recommended as a framework for both instructional designers (Dickey, 2015; Parrish, 2008; 2009) and game designers (Kapp, 2012; Schell, 2020). The counterparts of pedagogical agents in video games often include archetypal figures from the Hero's Journey, allies and sidekicks, and anthropomorphic animals or artificial intelligence (AI). In some cases, the pedagogical agent may even assume an antagonistic role, taunting the player while simultaneously teaching them the game's mechanics. One such example is the AI operating system GLaDOS from *Portal* (2007).

Clark and Mayer (2016) acknowledged that further research was needed to determine if and when pedagogical agents become too distracting or condescending for learners, which gestures are most effective, and which types of learners may benefit most from using agents. Schneider et al. (2018) found that while adding more anthropomorphic features to an agent, such as hair or eyebrows, increased motivation for some learners, it also increased extraneous cognitive load for learners with low prior knowledge. However, Javora et al. (2018) countered that anthropomorphic features may increase visual complexity but not extraneous load because the changes are limited to one element. Furthermore, Javora et al. argued, anthropomorphism creates "characters," which can assist learners with recalling the information presented as a story fragment or narrative. Li et al. (2019) concluded that pedagogical agents who used specific pointing gestures led to more effective learning in accordance with the cueing/signaling principle. Li et al.'s findings corroborate Cerny's (2015) recommendations to make AI sidekicks useful by having them react to the players' actions and reveal solutions when appropriate. In Mohammadhasani et al.'s (2018) study on the use of pedagogical agents with students with Attention-deficit/hyperactivity disorder (ADHD), students who worked with "Koosha" (Persian for "diligent") demonstrated significant improvements in both learning and motivation.

Quest: Instructional Interface Metaphors

An instructional interface metaphor presents information, menus, and navigational cues using a format familiar to the learner (Lohr, 2008). For example, the Home button in many interfaces is symbolized by a house icon, a comforting navigational cue to return to a more familiar place (Cheon & Grant, 2012). Computer desktop interfaces use the *folder* metaphor as an easily recognizable navigation system that also shows relationships between parts (*subfolders* and *files*) and the whole (Hodent, 2018; Lohr, 2008). Other common instructional interface metaphors include *outlines*, *desktops*, and *syllabi* templates. These metaphors are effective because they rely on the Gestalt principle of experience (Lohr, 2008) and existing schemas to which the learner can incorporate new information about what to expect and how to navigate an online course, website, or application.

In video games, the interface metaphor design aims for deeper immersion into the game world (Schell, 2020). Types of interfaces vary depending on the game's genre, and some genres require more substantial interface design (Dickey, 2015). An adventure game may store a player's item inventory in a virtual backpack (Dickey, 2015; Hodent, 2018), whereas RPGs often have more detailed interfaces for the various game systems such as inventories, collected documents, and quest logs (Dickey, 2015). Some games have highly customized interfaces to match their aesthetic. In *Red Dead Redemption 2* (2018), for example, players use a Sears & Roebuck-style catalog to purchase items from general stores (Figure 7).

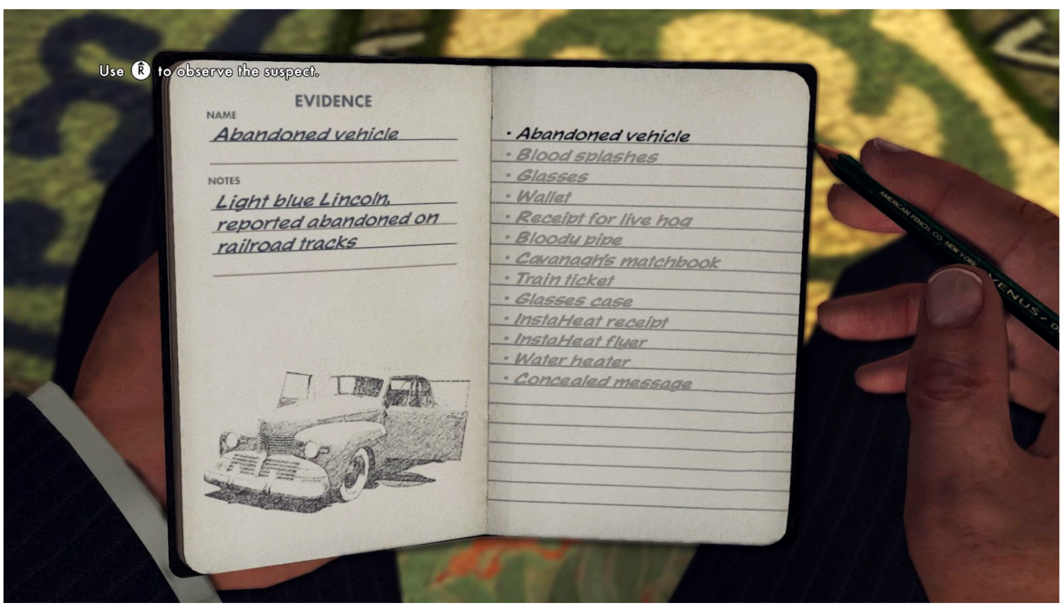
Figure 7

Comparison of the Game Catalog with a Sears & Roebuck Catalog

Note. The video game interface (top) removes much of the text clutter and increases the size of the salient details such as item name and price. It preserves the aesthetic of the original (bottom) but in a more readable format.

The core function of the game interface is to provide essential just-in-time information to the player. Players can typically pause the game at any time and consult the world map, item inventories, skills, controller schemes, and other options and settings. Frequently used interfaces, such as the world map or item inventory, may be accessible during the game with a single button. In the detective game *L.A. Noire* (2011), protagonist Cole Phelps keeps records of his investigations, clues, witness testimonies, and sketches in a notebook throughout the game. Players open the notebook with a single button to determine their next objective and to confront suspects with any evidence they have collected. The notebook contains records of both completed and active investigations, so players can return to previous cases to inform their decisions. The game's notebook drives the storyline and serves as a seamless interface for tracking history, progress, and items (Figure 8).

Figure 8
The Notebook Interface from L.A. Noire *(2011)*

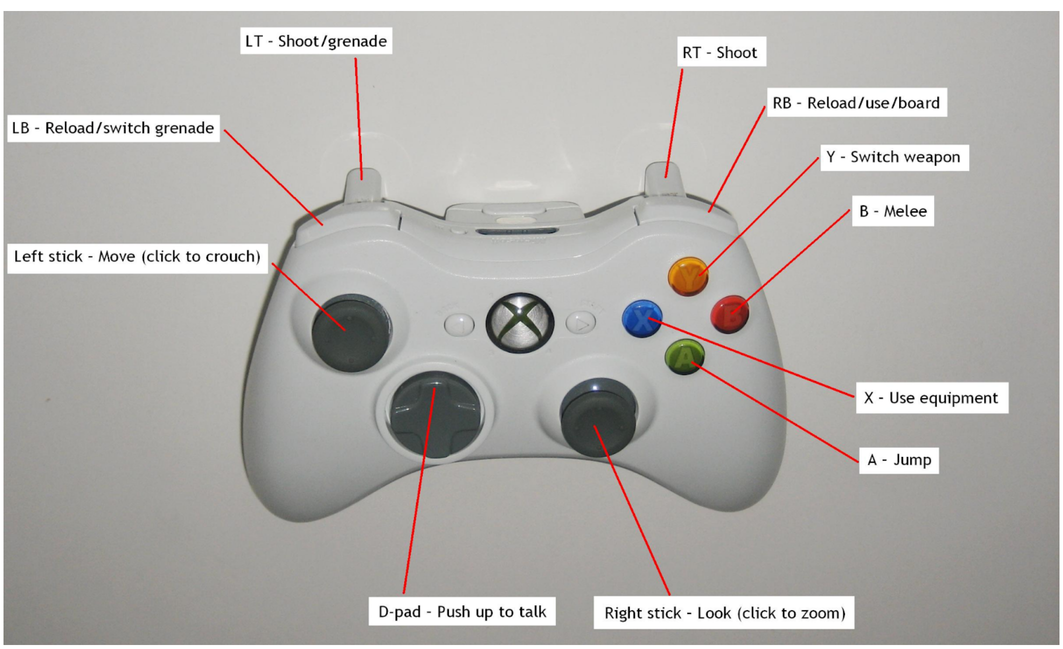


Note. When players select a piece of evidence from the list on the right, Detective Phelps will flip to another page in the notebook with more details. Notice the discreet reminder in the upper left corner that players can look up to observe the suspect's facial reactions and body language.

Effective interface metaphors can assist in schema development (Cheon & Grant, 2012). Just as instructional interface metaphors rely on learners' existing schemas, games likewise use players' prior experiences to present information about their mechanics and systems. Video game designers use common interfaces to help players develop schemas for understanding game mechanics and controls. Control schemes tend to be consistent across genres or in-game activities to capitalize on players' prior experiences and reduce the time needed to teach them the controls (Hodent, 2018). For example, most first-person shooters (FPS) tend to use the same or similar buttons for firing a weapon, crouching, running, and switching inventory items. Playing one FPS and learning the basic controls ensures that players can transfer their knowledge to other FPS games (Figure 9). Players expect similar genres or activities to conform to a standard controller scheme (Hodent, 2018). Using completely different controller schemes and mechanics for different activities introduces too much intrinsic and extraneous cognitive load for players, leading to frustration and negative experiences (Hodent, 2018).

Figure 9

A Typical Controller Scheme for an Action Game



Note. Image Credit: https://upload.wikimedia.org/wikipedia/commons/5/5c/Halo_3_control_scheme.jpg

Effective interfaces reveal the relationships between different parts of a system. An obvious example of using an interface for spatial awareness in games is the world map. Players can access the world map from the Pause menu or consult the mini-map compass in the bottom corner of the screen to get their bearings. The orientation of the mini-map and its relation to the player holds implications for the player's cognitive load. An allocentric mini-map always points North, whereas an egocentric mini-maps shifts in relation to which direction the player is facing (Hodent, 2018). If the mini-map is allocentric and the player is facing South, the player would need to mentally rotate the map 180 degrees to get their bearings. Shepard and Metzler (1971) discovered that participants' reaction times increased in proportion to the number of mental rotations necessary to determine if two presented shapes were the same. Puzzle games such as *Tetris* (1989) use this mental rotation effect to their advantage, often paired with a timer, to increase the challenge and heighten the stress for a player.

Figure 10

Skill Tree from Horizon Zero Dawn *(2017)*

Another example of interface as relationship is the skill tree (Figure 10). As players gain experience, they can spend experience points (XP) to unlock new skills. Unlocking new skills throughout the game is an effective way to reduce the cognitive load for new players and maintain the balance between skill and challenge to help players achieve a flow state (see Csikszentmihalyi, 1990). Branches of the skill tree are usually connected by a broad type of play style, such as Combat, Stealth, and Magic. Skills in each branch are usually linked sequentially or at least clustered by proximity (Lohr, 2008) so that players must work towards more powerful and useful skills by unlocking lower prerequisite skills. Based on their skill tree schema, players expect to unlock skills in a certain order (Hodent, 2018). Similar to how a tree grows, skills unlock from bottom to top (or top to bottom). If a skill tree does not follow this pattern, then the interface must include other visual cues such as contiguity and proximity to show the progression of how skills unlock.

Interface metaphors provide the player with not only information but also feedback in the form of judgment of their skills, rewards for their progress, and motivation for their next challenge (Schell, 2020). Van Eck et al. (2018) drew a parallel between health meters and inventories as types of assessment in which low values could prompt players to improve in those areas. In *The Sims 3* (2009), for example, player needs are represented by meters for attributes such as *Hunger*, *Comfort*, *Fun*, *Hygiene*, and *Bladder*. If the meter changes from *Green/Full* to *Red/Empty*, then the player needs to take appropriate actions to boost the meter back to green. Game designers strive for "juiciness" in their games, or redundant multisensory feedback for players' actions (Hicks et al., 2019; Schell, 2020). Audio feedback is often more "visceral" than visual feedback and can simulate touch more effectively (Schell, 2020, p. 434). Since many game controllers rumble and vibrate, a player may receive visual, auditory, and tactile feedback for their actions simultaneously.

Designers must take care that interface metaphors do not interfere or actively conflict with the intended message through too much juice. Hodent (2018) described a gaming phenomenon known as "red overload." Recall that modern games often present the damage meter through red tunnel vision that encroaches from the edges of the screen. Red also signifies threats because the color tends to contrast well with other colors in a game environment. In games where teams may be represented by blue and red, in which Team Red will recognize fellow members as red icons, the increasing red overload can interfere with a player's perception of their fellow teammates, incoming threats, and damage. For a comparable instructional effect, imagine a PowerPoint presentation that used red text, red highlights, and red arrows to call the learner's attention to essential information.

When developing an interface metaphor, the designer must also ensure that learners can interpret the metaphor correctly in context. Some computer and media interface metaphors reflect the experience of the programmers rather than that of the users and can be overly technocentric and indecipherable (Lohr, 2008). Learners may not have the requisite experience to make sense of the metaphor or understand how it connects information (Lohr, 2008). Conversely, learners may have the requisite experience to understand the metaphor but misinterpret it in context because it functions differently. For example, a magnifying glass is recognizable for its *search* or *examine* functions, but learners may instead perceive the magnifying glass in its *magnification/zoom* usage (Hodent, 2018).

The interface metaphor must present necessary information clearly and unambiguously, using the learner's prior experience as an access point. The interface itself should also not introduce any extraneous load that can interfere with the learner's processing and interpretation of content. Schell (2020) argued that the best interfaces are invisible and foster deeper immersion. The aesthetic and thematic uses of interface metaphors in video games illustrate sound message design principles that can be applied to instructional design. Games thrive on experimentation and a customized interface can reinvigorate the gaming experience (Schell, 2020). While some instructional interface metaphors may be more familiar to learners, consider developing an interface that complements the design's aesthetics and the essential concepts that learners should understand.

New Skills Unlocked: Germane Load Heuristics

Instructional Designer (Lvl. 3)	Provide the learner with a clear navigational path that clearly illustrates the parts in relation to the whole (Lohr, 2008). Meaningful interface design can support schema development in learners (Cheon & Grant, 2012).
Message Designer (Lvl. 3)	Design the learning interface to match the aesthetic and theme of your narrative structure (Dickey, 2015) using a metaphor familiar to your learners (Cheon & Grant, 2012; Lohr, 2008; Schell, 2020).
Game Designer (Lvl. 3)	Create a pedagogical agent as a mentor or sidekick to learners in their learning quest with whom they can build an emotional connection (Dickey, 2015; Parrish, 2009).

Boss Battle: "The Expert"

Although a large body of research has supported cognitive load theory (Petko et al., 2020), there are still gaps regarding the measurement of different types of load, its effects on different types of learners/players, and how it manifests in different game elements. De Jong (2010) challenged whether the three types of cognitive load could be empirically distinguished from each other. Intrinsic load is dependent on several variables, including the learner's knowledge base and element interactivity (Sweller, 2020), which makes total cognitive load nearly impossible to estimate (Hodent, 2018). Game designers extrapolate estimations of cognitive load through UX (user experience) testing that measures eye movement, reaction times, and qualitative survey data (Hodent, 2018). However, qualitative collection techniques such as surveys can be unreliable and physiological tests can be intrusive (de Jong, 2010).

The use of games and gamification strategies may benefit some students to the disadvantage of others without careful, intentional design that accommodates learners with various levels of game expertise. In a study conducted by Lee and Heeter (2017), gaming experts experienced a false sense of understanding when playing an educational game because they relied on their pre-existing schema for game mechanics instead of attending to the educational message and particularities of the new game. One of the major exceptions addressed in cognitive load theory and the principles of multimedia learning is the *expertise reversal effect* (Sweller et al., 2011). Strategies that may benefit learners with little experience may also impose increased extraneous load on experts and consequently diminish their performance (Sweller et al., 2011). In the study, gaming experts with high working memory were less likely to use the game's help functions than their non-gaming counterparts with comparable working memory (Lee & Heeter, 2017). Lee and Heeter (2017) recommended that game designers integrate educational content into the game's mechanics as well as the narrative to ensure that gaming experts direct resources to processing the unfamiliar educational content.

Different game elements may result in different cognitive load effects. Complex, multisensory video games with visual effects, dialogue, sound effects, and musical soundtracks increase perceptual load, or the resources needed to process sensory information (Fisher et al., 2019). Fisher et al. (2019) found that increased perceptual load in the visual or auditory channel increased reaction times within the same modality only, but increased extraneous cognitive load increased reaction times across modalities. Therefore, increased visual load (such as flashing lights or fog) should impact reaction times to visual cues without significantly impacting reaction times to audio or musical cues, which is likely the intention of the increased visual load for the gameplay experience. Extraneous cognitive load, such as reversing the directional controls to convey disorientation, will impact reaction times in both modalities. The speed and pacing of a level can also affect players' perceptions of cognitive load. Petko et al. (2020) identified correlations between the speed of a vertically scrolling educational game with learners' achievement and perceptions of load. Faster pacing led to a perception of increased intrinsic load even though the game's content had not changed, and slower pacing was considered distracting and increased extraneous load. Petko et al. (2020) suggested that games may be more complex than other types of media and that the results of changing variables such as pacing can be more difficult to predict.

Video games have applied principles of multimedia learning and cognitive load effects to both scaffold and engage players. However, designers must recognize that estimating cognitive load requires analysis of the learners and their prior knowledge. Educators and instructional designers using game-based learning strategies must also be careful to ensure that educational content is delivered through both the game's content *and* mechanics so that learners are neither advantaged or disadvantaged by their level of gaming expertise.

New Game?

Game-based learning and game design does not require any specialized knowledge of programming or technical expertise (Dickey, 2015; Kiili & Tuomi, 2019). Educators can instead consider low-tech and middle-tech approaches (Van Eck et al., 2018). The availability and easy use of flashy visuals in many educational apps can lead to increased extraneous cognitive load, but using a well-designed low-tech option instead can both enhance the message and increase learners' access to it (Larson & Lockee, 2013). Educators and instructional designers can also use principles of instructional message design adapted from video games to enhance more traditional instruction without needing to create materials as visually or interactionally complex as video games.

Van Eck et al. (2018) stated that video games are an effective medium for promoting situated learning and problem solving, but that these benefits were also often oversimplified. Studies have consistently demonstrated that gamification and game-based learning can lead to small, yet significant gains in cognitive, motivational, and behavioral outcomes (Sailer & Homner, 2020). To achieve greater effect sizes from using game-based learning strategies, the answer may lie in shifting our attention from surface-level strategies in video games towards deeper principles of instructional message design by following McDonald's (2009) challenge to the instructional design field to adapt what examples from popular media do well. Instead of relying on gamification strategies such as points and badges, games can be more effectively used by considering the immersive player and learner experience (Hodent, 2018). An immersive experience is better elicited through careful, intentional use of instructional message design principles that also enable the learner to be more successful.

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Instructional Message Design:
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Chapter 11: Instructional Message Design in E-Learning

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11. Instructional Message Design in E-Learning

Meghan Soldani

Key Points:

- Instructional message design greatly impacts e-learning. Effective instructional design engages learners and motivates them to participate and be in control of their own learning.
- User experience (UX) is one of the most important factors in designing an e-learning tool.
- Visuals, text and audio play an important role in successful instructional message design.

Abstract

Instructional message design is an essential aspect of an effective e-learning experience for learners. E-learning is the use of online and mobile technologies to develop learning material, content, and applications for online learners. As an instructional designer, it is important to analyze and know your audience, engage the user, use relevant information, and provide a good user experience. Other critical aspects of message design for e-learning include the reduction of extraneous cognitive load, the aesthetic look and feel of the design, designing for learner motivation, and a focused simplicity of design. User engagement can also be encouraged by relevant content and context, and the instructor's or facilitator's active participation in discussion, chat, projects, and group activities.

Introduction

What is eLearning? "There are numerous definitions of the word "eLearning". These range from Wikipedia's "Electronic learning (or e-Learning) is a type of education where the medium of instruction is computer technology", to "the use of computers in a systematic four step process: presented (Step A), practiced (Step B), assessed (Step C) and reviewed (Step D)" (Brown & Voltz, 2005). All have valid points. According to Clark and Mayer (2008), e-learning is any instruction that is delivered on a computer which has the following characteristics: it includes content relevant to the learning feature, uses instructional methods such as examples or practice exercises to help learning, uses a variety of media elements to deliver the content and methods, builds new knowledge and skills which are linked to improved organizational performance. Thus, the goal of e-learning is to build transferable skills and abilities" (Steen, 2008). Throughout this chapter we will discuss the importance of instructional message design when creating an e-learning tool. We will look at how to improve the user experience, different design best practices used in e-learning, how to design an effective e-learning tool and lastly, how important it is becoming to create an e-learning tool that is compatible across different devices.

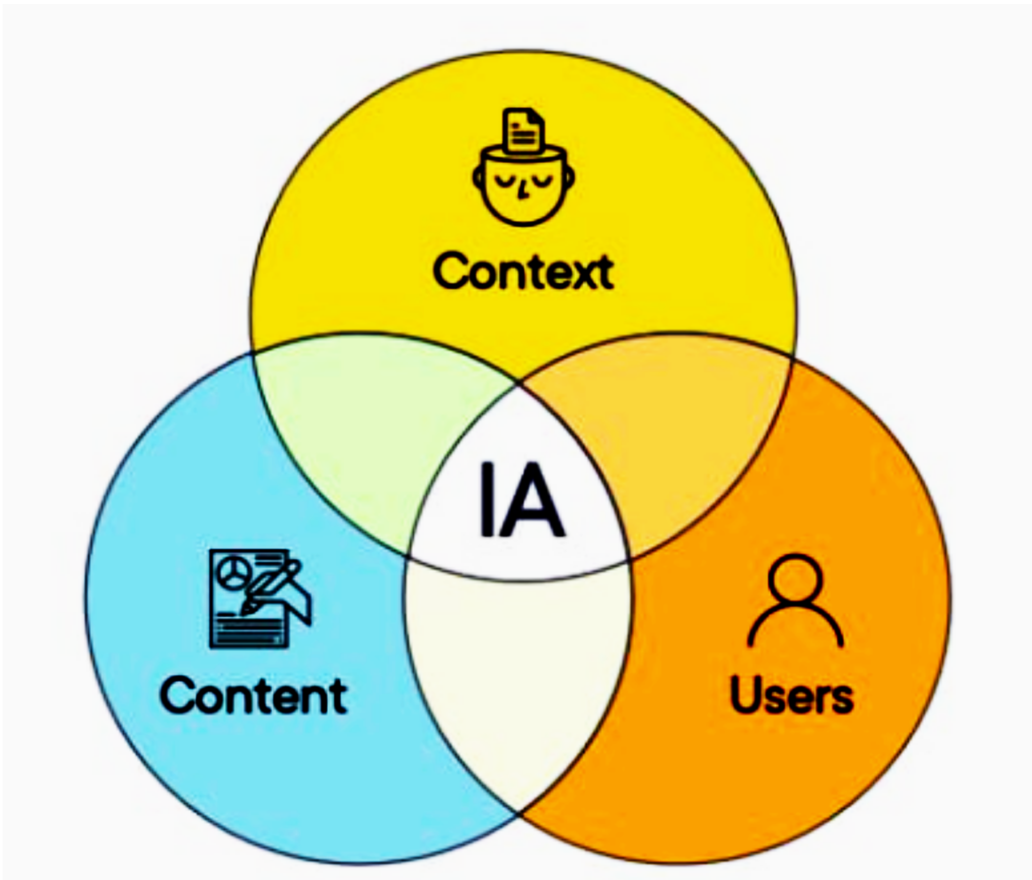
Importance of User Experience

Instructional message design when creating an e-learning tool is very important for many reasons. When a learning tool is made, the purpose of that tool is to help the learner achieve the learning goals set out. Good instructional design helps the learners retain knowledge. If a company puts out an e-learning tool, the hopes are that those that are using that tool can then retain that information and use it in their real life situations. Good instructional design engages learners. To be as effective as possible in engaging your learner, it is essential that the designer understands who their audience is. Good user experience (UX) is also essential when developing an accessible and engaging tool. UX has a direct impact on the learners' engagement and achievement. Another reason that instructional message design is so important in e-learning is that it will help communicate messages to the learner which helps them achieve those learning goals and outcomes. The last important factor of instructional message design in e-learning that we will discuss is how it inspires and motivates learners to acquire more knowledge.

User experience is defined as how a user interacts with the experiences of a product, system, or service. It includes a person's perceptions of utility, ease of use, and efficiency ("User Experience", 2021, p. 1). UX is essential to consider when designing an e-learning tool. Making an e-learning tool that is accessible and engaging to learners will allow them to learn more efficiently, motivate them to learn, and keep them on task. What results in a good user experience?

There are five key components that we will touch on that are vital when creating a good UX. A well-organized information architecture is important to ensure that users find the tool easy to use and allows them to effectively complete the task. "Information architecture helps build a structure that connects content with functionality of the web platform" (Khindri, 2020). Figure 1 illustrates the relationship between the elements that help create the best user experience design. As you can see IA, or "information architecture", is at the center of the circles. When context, users and content are all taken into consideration, this design strategy fosters the best user experience.

Figure 1
Information Architecture

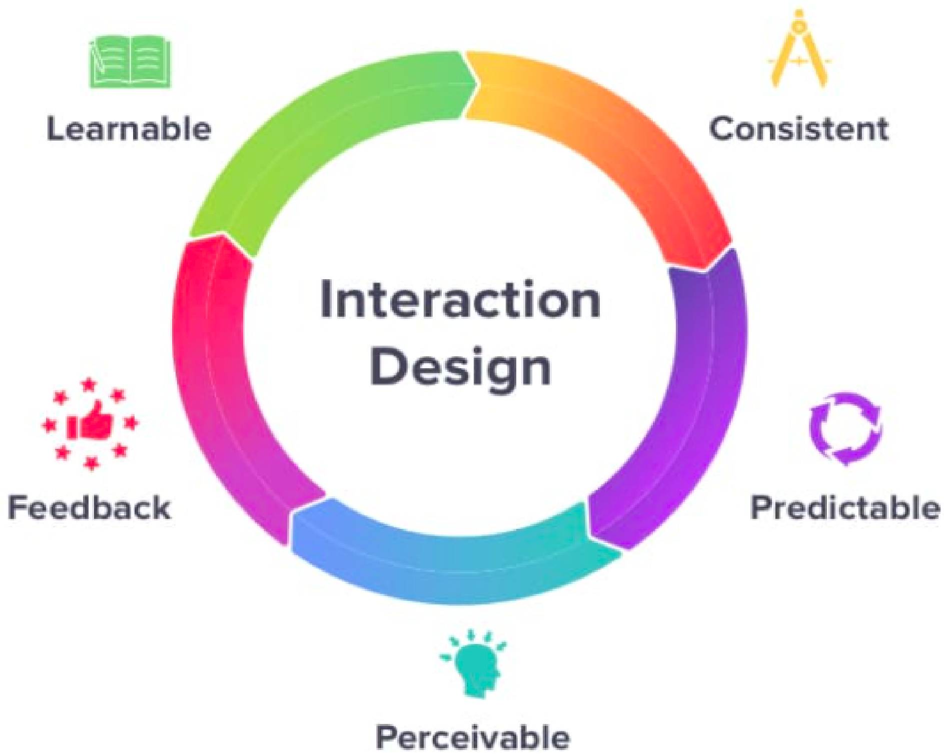


Note. Information architecture is the center of creating an effective context+users+content user experience (modified from Khindri, 2020).

It is important to look at the target audience, to ensure that the information is relevant to them. The information that the audience is looking for should be loud and clear and easy to find and understand. Knowing the audience is also the driving force to include appropriate text, icons, images, etc. that will engage that audience. (Khindri, 2020)

Interaction Oriented Design is essential to engage your users. Personalizing the experience through touch, sound, feel and aesthetics will draw your audience in and engage them. To achieve this experience it is important to focus on words, visual presentation, and designing to touchpoints (buttons of the screen that initiates a system reaction) and response. The designers should be careful not to overload the learner with extraneous features and focus the design on relevant, intrinsic functionality and content (see also the cognitive load and multimedia learning chapters in this volume). Words on your call-to-action buttons embedded into the design should be legible, easy to understand and when clicked, respond with the correct action. The visuals that are included in the design should reflect the words and content in the tool. These visuals should only be included if they are relevant and impact the learning of the user in a positive way. When it comes to designing to touchpoints, the tool should be the same no matter what platform it is being accessed on. Whether it be an ipad, phone or desktop; all of the elements of the tool should be the same. This creates a unified experience for the user. Response relates to how quickly the tool responds to the user's action. Call-to-action buttons should lead the user to the intended result, quickly, see Figure 2, (Khindri, 2020).

Figure 2
Interaction Design Model



Note. Interaction Design in this model comprises the five aspects of learnability, consistency, predictability, perception, and feedback (modified from Khindri, 2020).

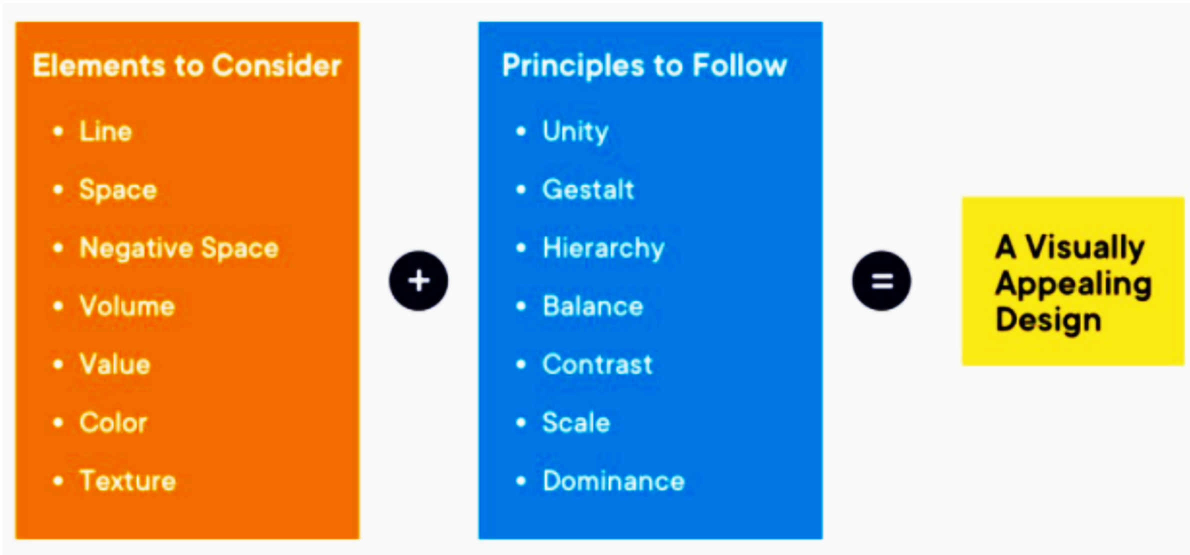
Usability is an important aspect to consider when creating an e-learning tool. This allows the user to use the tool easily and without confusion. It is helpful if the site or tool is as simple as possible, without losing any of the content and functionality. Extra features should be available only when the user needs them. Users will be more successful and satisfied if they can easily navigate through the tool (Khindri, 2020).

Planned User Research ensures that the content is relevant to the user. "When designing to enhance the user experience, it becomes imperative to understand user behavior, preferences, mindset, and objectives so that the final design copy perfectly resonates with their needs" (Khindri, 2020). This goes back to how knowing your audience is imperative when creating an e-learning tool.

Visual aesthetics of the design is the last element we will discuss. This impacts a user's first impression and plays an important role in UX. The look, feel, and functionality (or potential lack thereof) can impact the learners sense of content, instructor, and institutional credibility (David & Glow, 2010). When a learner first visits an e-learning app, site, product, or other message design, the aesthetics are the first thing they see, making a great impression is a critical aspect of emotional connection and motivation (West et al. 2020). The visual aesthetics refers to the layout, spacing, colors, graphics, font, and images of the tool. The visuals and layout of the e-learning tool should engage the user through interaction as well.

The aesthetics of the tool you design affects how receptive the user is to the tool, it also shows who you are as a company, tool, and brand. Aesthetics also help you against your competitors. If you have created an effective and aesthetically pleasing site/tool and your competitor's site/tool has a lot of helpful information but it lacks aesthetics, users are more likely to be drawn to use the site that is more pleasing to them (Khindri, 2020). Figure 3 illustrates the design elements and design principles to consider and apply.

Figure 3
Visually Appealing Design



Note. This graphic gives you a summary of elements to consider and the corresponding principals to create a visually powerful design (modified from Khindri, 2020).

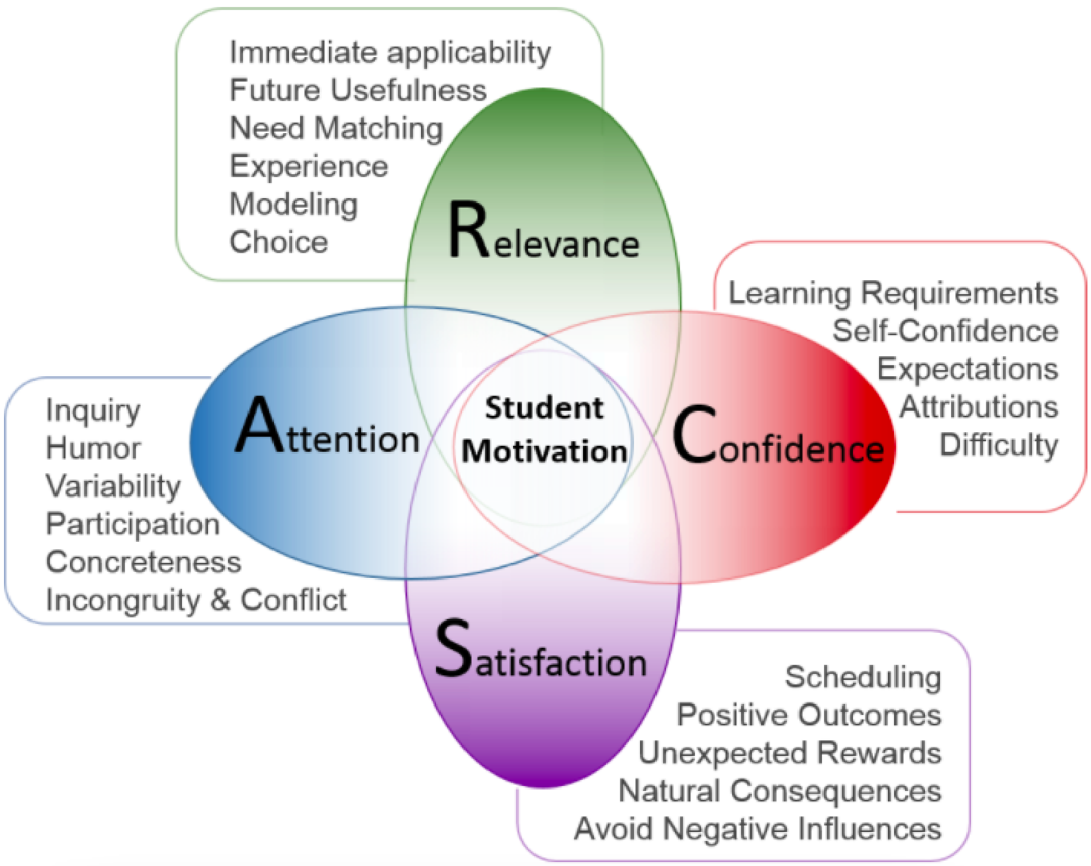
Design Models for e-Learning

There are many different design models that have been successful and widely used throughout the history of message design for e-learning. Stimulating a students' motivation to learn is very important in e-learning. Motivation and emotional support can greatly improve an e-learning tool (Wang et al., 2012). Keller's ARCS model is important because it is based on learner motivation (Keller, 1987; 2009). ARCS is an acronym for the four elements of learner motivation: attention, relevance, confidence and satisfaction. When creating an e-learning tool, these four elements can engage the learner and allow them to be more successful. Grabbing the attention of the learner is important to engage them. This can be done in a variety of ways: through humor, real world examples, or conflict. Relevance can be achieved by linking content to the previous experiences of your audience, when the information is necessary knowledge for the user to deal with a current problem (they are motivated to learn information that will equip them with skills to fix a problem that they are facing). Confidence is a huge part of the learning process. If a user/learner thinks they can be successful, they are more motivated to engage in that process. To instill confidence in users, creating a tool that gives them immediate feedback and praise will motivate them to continue learning. Also, giving them some control in their learning will help them believe that they are responsible for their own success. Lastly, satisfaction is a key element to this design model. Users receiving praise when they are successful is important for their motivation. Also, when users feel that the information that they are learning will be useful in the future, it will give them the satisfaction that their learning was worth their time and commitment (Papas, 2015).

Keller's ARCS model is all based on a learners/users motivation. Motivation affects how an individual pays attention to information and processes that information. Being motivated allows learners to put all of their effort, energy and time into something to complete the task. If you know your audience and what motivates them, the e-learning tool you create will help those learners be more successful and engaged.

Figure 4

Keller's ARCS Motivation Model



Note. Keller's ARCS (Attention, Relevance, Confidence, Satisfaction) model summary with components that all relate back to student motivation (modified from Souders, 2021).

There are many different ways to inspire motivation in learners. Challenging learners, without overwhelming or frustrating them is motivational. If an activity is too hard users may become discouraged and if it is too easy they may become bored. Again, going back to knowing your audience and giving them a balanced task is critical. Going back to relevance, if the activity is related to an experience the user has had, then they are more likely to be motivated and engaged in that task. Also, making a tool that is interactive will engage and motivate the learner (Souders, 2021). Other engagement strategies include group chat and discussion boards with active instructor participation, student presentations, and monitored (to help ensure workload fairness) group projects (Abou-Khalil et al., 2021)

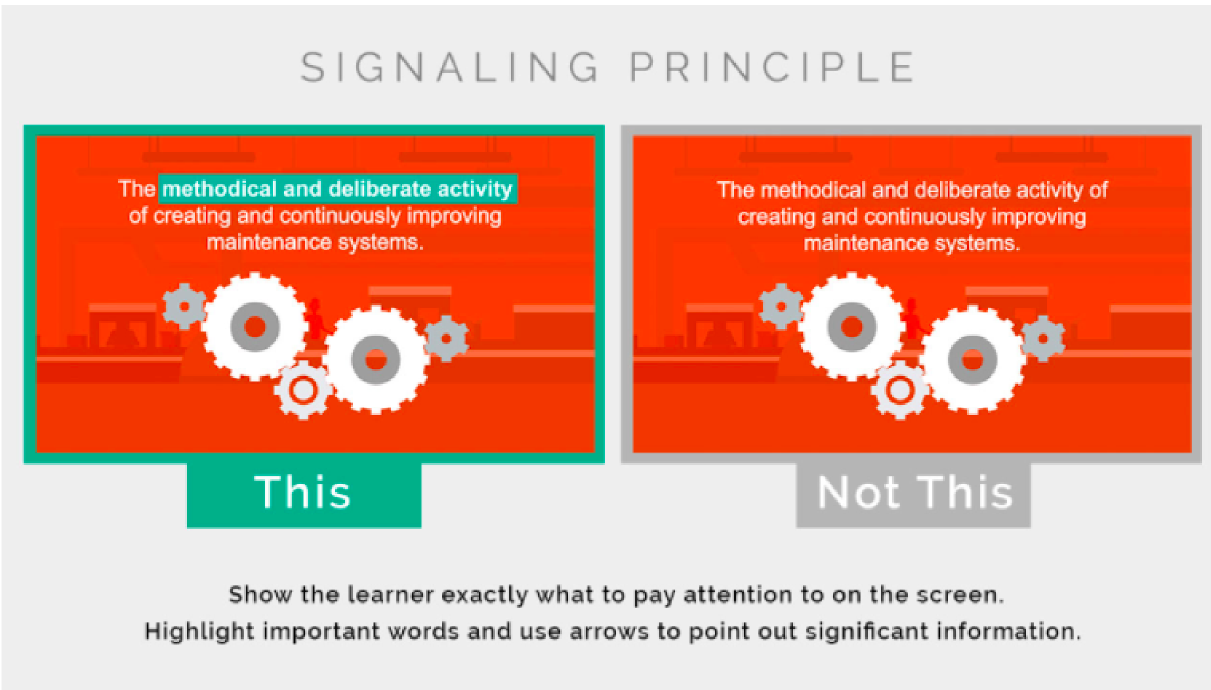
The user-centered design (UCD) is another design model that has become popular in e-learning design (Wang et al., 2012). This model is defined as "an approach to creating experiences for people with their needs in mind where usability is the primary focus" (Wang et al., 2012). The interface should be easy to use and understand, the status and learner's location in the e-learning tool should be evident and navigable, and results of choices should be evident (Abras, et al., 2004). This strategy also relates to Keller's ARCS model and the aspect of relevance. Including the needs of the learner and looking at what that group of people need instructionally, will positively affect how the e-learning tool can be made into an effective solution. Making the information in the e-learning tool relevant to the specific user, will also make the experience more purposeful and motivate the learner.

How to Design an Effective e-Learning Tool

One aspect of using instructional message design when creating an e-learning tool is multimedia learning. "Multimedia learning can be defined as a form of computer-aided instruction that uses at least two communication modalities concurrently. This means learning through the combined use of visuals (through pictures, animations, text, and videos) and audio (through narrated voiceover)" (DeBell, 2020). When designing an e-learning tool with multimedia, it is important to keep it simple. Humans learn best when distracting materials are not interfering with their learning. When including visuals, make sure that the images are easy to comprehend. If not, are they benefiting the user or just distracting them? Reduce and simplify the e-learning tool as much as you can while it is still providing the information needed to be effective.

Signaling is also helpful for the user of your e-learning tool. Many times there can be an overwhelming amount of information, highlighting the most important content will help the learner focus on what they need to be taking away most from that information. The tool then becomes less overwhelming and more direct.

Figure 5
The Signaling Principle



Note. Drawing attention shows the learner the most important information and what they should be focusing on (modified from DeBell, 2020 https://waterbearlearning.com/mayers-principles-multimedia-learning/).

The redundancy principle states that "humans learn best with narration and graphics, as opposed to narration, graphics, and text." (DeBell, 2020). If your tool includes an audio narration of the information being provided, it is best to avoid including complex text as well. Having graphics and blocks of text on a single page or slide can overwhelm the learner. Every user learns differently so it might also be effective to give users the option of turning on or off, to show or hide, any available captions as the narration is going. If you do use presentation text and visuals on the same screen, then it is important to pay close attention to the negative space in between your text and visuals. Users learn better when relevant text and visuals are placed close together on the screen or slide. This will make it easier for users to associate the text and visual together when learning, rather than having to decide which text goes along with the visual that they are looking at.

Audio is important to include, as mentioned before, all users are going to have a different learning style or preference. This audio should be easy to understand and should occur at the same time as the visual or text on the screen/page. The corresponding words and visuals should be presented together. It is also essential to make sure that the voice that is included in the audio is more informal than formal. Users learn best from a conversational voice rather than a formal academic voice (DeBell, 2020).

Another aspect to consider when designing an e-learning tool is segmenting. Users learn more successfully when they have control over their learning. Including a ‘next’ button, or questions about previous given information will break up the material rather than having one continuous stream of information. Also, it helps learners if the designer includes helpful and useful information rather than always a video of a presenter talking.

Text plays a major role in designing an effective e-learning tool as well. Clarity and legibility of text can enhance learner experience and learning. Also, the organization of the text on the page can have an affect on the user. As previously stated, making sure that text is relevant and located near important visuals will help with the organization of the text. Once a textual layout or template is established, the structure of the material should remain consistent. This structure also includes the length of the text. The user should be able to read the bulk of the information on one page and relevant text should only occupy from 25 to 40% of the total space on the page (Istrate, 2009).

e-Learning Design Across Different Devices

"Responsive e-learning design (often referred to as 'mobile-friendly content') is the practice of designing online courses that look and work great on any device." (Karaolis, 2020). This allows a course to adapt its sizing, layout and interactions to the screen size it is being accessed on. There are a few ways to make sure that your learning tool incorporates responsive design. Using a single scrolling page allows for a modern and effective experience for the user. Earlier in this chapter we looked at how students learn more effectively if the learning is broken up into smaller chunks, rather than one continuous learning stream. This chucking of content will also help when creating a responsive e-learning design. Using that principle will help learners navigate through the tool and absorb more of the provided content. With that being said, make sure those smaller chunks are also not too content-heavy. Like we said before, keep it simple!

Why is responsive design important? "70% of learners feel more motivated accessing training on a mobile device, as opposed to a PC" (Pandey, 2018). This idea of mobile learning allows a seamless learning experience across devices. Being able to reach learners on different devices allows the designer to encourage self-directed learning and target personalized learning. Designers should test their content and e-learning systems on a variety of devices and screen sizes to ensure quality and consistency.

Conclusion

Instructional message design is essential in creating an effective e-learning experience. As an instructional designer, it is important to engage the user, use relevant information, know your audience and provide a good UX. The UX is going to effectively motivate the user of your e-learning tool, especially if it is easily accessible, well organized, interactive and aesthetically pleasing. A poorly designed UX will negatively impact motivation, student satisfaction, and learning effectiveness.

Motivation has a huge impact on a learner. Designing an e-learning tool that is not overwhelming but still challenges the user is important. Users should feel that their learning is related to real-world experiences and will be useful in the future. When a learner is motivated to learn, they will use more energy, effort and put in more time to understand the content.

When creating an e-learning tool it is important to pay close attention to how the visuals, text, and audio you include impacts the learning. People learn better when they have clear and concise material, the tool is easy to navigate, and the page/screen flows together.

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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

Chapter 12: Perception in Instructional Message Design

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Chapter 12: Perception in Instructional Message Design

Shuree Altantsetseg

Key Points:

- Perception is the learner's initial conversion of environmental input to working memory
- Well organized instructional message design leads to efficient perception and processing of communication
- Gestalt, neurology, ecology, and computation theories can all be applied to guide instructional message design
- Understanding perception can help instructional designers develop effective augmented reality, virtual reality, and immersive simulations

Abstract

This chapter aims to discuss perception from various academic disciplines and its relations and effects on information processing in instructional message design. Improved awareness of this concept assists instructional designers in conveying their message effectively and improves effective instruction in immersive learning environments. In this chapter, Gestalt, neurological, ecological, and computational perspectives and processes on perception are first discussed and followed by applications in instructional message design and instructional design.

Introduction

The concept of perception is an extensively studied topic in science and philosophy, and its definition without a unique perspective of context is incomplete. From a neurologist's perspective, Efron (1969) defined perception as "man's primary form of cognitive contact with the world around him" (p. 1). While from an ecologist's perspective, Gibson (2014) described this as "the process of information pickup that involves the exploratory activity of looking around, getting around, and looking at things." The Gestalt theory takes a closer look at the core visual pattern of an object, and Wertheimer (1934) said, "the perception is not a product of the sensations, but arose through a dynamic physical process in the brain." (Wagemans et al., 2012). Developments in computer science continue to build on the limits and aspects of human perception (Gordon, 2004). Instructional and message design and technology are prominent examples that are deriving major benefits from this evolution of ideas and theory. How learners become aware of and process communication from visuals is an intrinsic aspect of instructional message design. Instructional message design is the application of instructional design, technology, and theories in the design of learning environments, systems, job aids, and training (Fleming & Levie, 1993).

Historically, the value of perception theory in learning had long been rejected by learning theorists due to the lack of a direct connection to the learning process. It was criticized for paying too much attention to the information processing and being too obscure for the structural level of explanation of an object (Norberg, 1978). In the long run, a common ground between constructivist and cognitive perspectives benefited perception concepts in instructional design and message design processes in various ways, especially at the organizational and structural levels. Based on the perceptual concepts of grouping and picking up information, Bruner (1985) proposed scaffolding which refers to managing a task into components to complete a task. In task organization, this strategy is widely utilized in designing as an attention gaining and cognitive enhancement approach. Chunking is another information organization technique derived from the learner's perception (Miller, 1956). Placing text near pictures or placing similar elements near each other are common approaches we use in instructional message design (Wagemans et al., 2012). We use color as stimuli to attract a learner's attention or use several elements to reduce cognitive load according to the visual learning capacity. The core concept of self-perception and environment perception contribute to building effective simulations and immersive learning environments (Geuss et al., 2010). The role of perception in instructional design and message design is tremendous and ever-evolving.

We will look at perception from four different approaches throughout this chapter, including Gestalt, neurology, ecology, and computation. The sections are ordered in the highest to the lowest relations of perception to instructional and message design. Each section will briefly define perception from a specific area's standpoint to differentiate the approach from one another, followed by theoretical heuristics and instructional and message design applications. Perception research has discovered a broad list of sensory perceptions beyond sight, sound, touch, taste, and smell, but this chapter will focus on visual perception.

Gestalt Theory of Perception

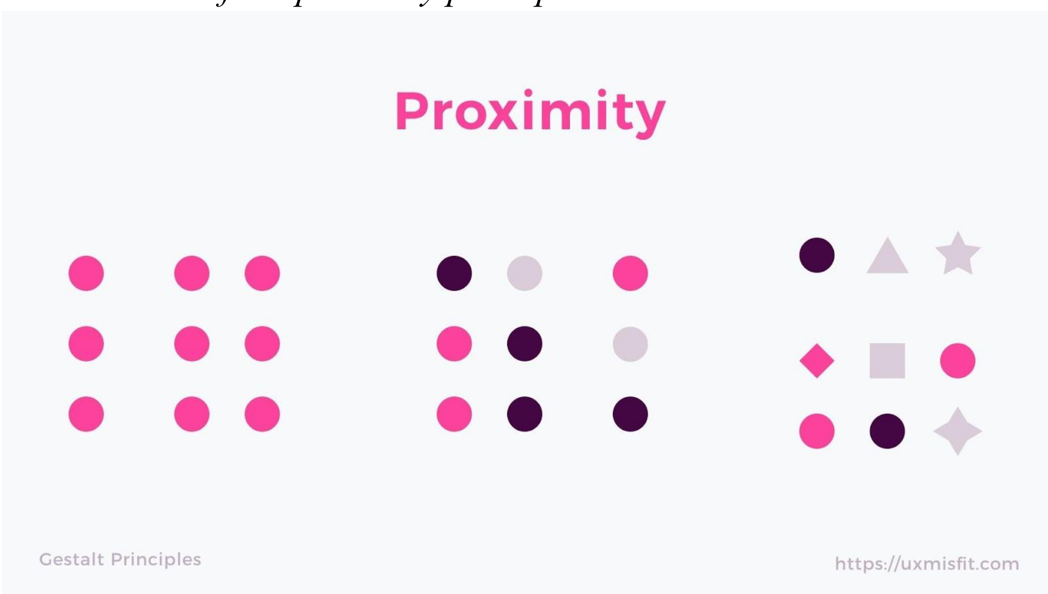
"The whole is greater than the sum of its parts" is the main principle of the gestalt theory of perception. It implies that when a person sees a visualization, a poster for instance, the viewer does not initially perceive text, titles, or paragraphs separately but looks at them as a whole (Wertheimer & Riezler, 1944). Wertheimer and Kurt viewed that the scientific fields created more concepts, assumptions, and principles in various contexts. Unfortunately, they treated the principle as a separate part. This, in turn, restricts a deep and complete explanation of the problem at an advanced level. Therefore, they believed that changing an approach would aid the science in general and proposed the idea of looking into the internal parts of the whole rather than the individual pieces. They believed that there must be the core factors that keep the harmony of the whole and believed in people perceiving a whole as a meaningful structure (Çeliköz, Erisen, & Sahin, 2019; Wagemans et al., 2012; Wertheimer & Riezler, 1944). In terms of visual perception, the gestalt principles consider that awareness is not additive but is rooted in the coherence of the structural characteristics of a whole. That is to say, they deny that the idea of stimuli that arises from the corresponding sensation and the association of sensations produce visual perception. They believed the condition of the whole presented in the brain and their internal cognitive interactions and organizations define perception (Wertheimer & Riezler, 1944; Wagemans et al., 2012). However, some technological advancement and neurology research suggest that sensation is the primary unit of the perceptual system (Wagemans et al., 2012). Nevertheless, the gestalt theory is tied up with learning theories in many aspects. A quick single-stimuli reaction is connected to behaviorism, and structural organization is associated with cognitive load theory (Smith-Gratto & Fisher, 1999). Although the gestalt theories had long been rejected by other fields, some principles, such as grouping and figure-ground perception, are important concepts in psychology, biology, learning, and in the film industry (Wagemans et al., 2012). Moreover, the central concept of the effective structure of visual statics is essential to visual screen design (Smith-Gratto & Fisher, 1999).

Visual screen design is a way of delivering a presentation through software, and it is based on the visual perception of the learner (Smith-Gratto & Fisher, 1999). Screen designers and instructional designers apply the gestalt theory (intentionally or unintentionally) to structure information in multimedia and instructional message design. Its coherence in screen design hugely assists students in interpreting and remembering materials and potentially reduces students' extraneous cognitive load (Smith-Gratto & Fisher, 1999). Chang et al.'s (2002) experiment of redesigning multimedia educational programs based on 12 gestalt principles showed the effectiveness of screen design and learning effectiveness. Out of 114 gestalt principle examples the proximity, similarity, common fate, continuity, closure, and figure-ground were the most effective to aid in organizing visualization, information, and materials (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012). The next section will illustrate how these gestalt principles apply to instructional and message design.

The Gestalt Law of Proximity. Max Wertheimer's first gestalt principle is the law of Proximity. It proposes that the elements placed nearer to each other are perceived as a group, whereas if their spacing is further apart, they are considered separate. Set options include triple, pair, and quartette, and many, many other combinations. However, some combinations require more attention and are perceptually challenging to grasp (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012;).

Figure 1

Variations of the proximity principle:



Note. Modified from https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/

In message design, strengthening the close relationship between the elements by putting them closer is ideal. This includes placing the captions closer to the picture, or headlines closer to the text, or even compound words closer to each other (Graham, 2008). Proximately creates organization, and lack of proximity creates disorganization, such as in the example below:

Figure 2

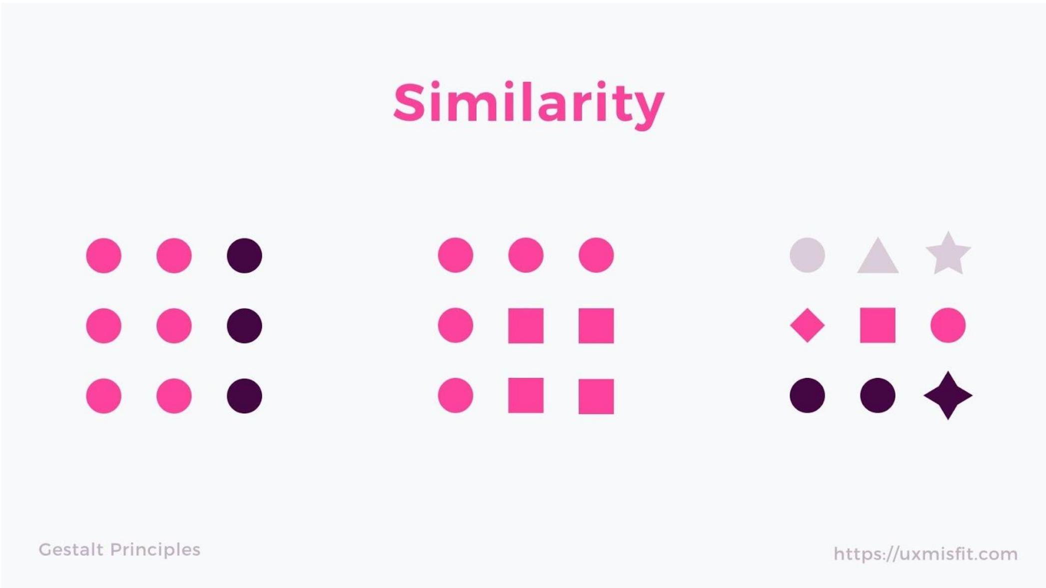
Variations in proximity create variation in disorganization and confusion:

A. The gestalt law of Proximity B. The gestalt law of Proximity

The gestalt law of Proximity The gestalt law of Similarity The gestalt law of Common fate Figure-ground articulation	The gestalt law of Proximity Law of Similarity Common fate Closure Figure-ground

Law of Similarity. The law of Similarity suggests the grouping of the elements with similar properties (color, shape, size, brightness, etc.) despite the spatial location. Integrating Similarity with Proximity makes the effect stronger (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 3
Variations of the Similarity Principle, the group of circles will tend to be the most cohesive group:



Note. the group of circles on the left are the most similar, and so creates the most recognizable visual pattern, https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/

However, if the distance between similar items is too far and placed nearer to the distinct item, it looks like a new group of distinct elements, see Figure 4.

Figure 4
The Similarity Principle and distance, closer objects will appear **associated** *together:*

http://www.scholarpedia.org/w/images/archive/3/33/20081210053322%21Todorovic-Gestalt_principles-Figure_3.jpg

Common Fate. When elements move together, they are perceived as a group, and this phenomenon is called common fate. The main distinction of the Common Fate from the Similarity is the idea that items should be changed in terms of position, size, and luminance. It is mainly used in motion pictures, 3D animation, and logos, see Figure 5 (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 5
The Common Fate Principle

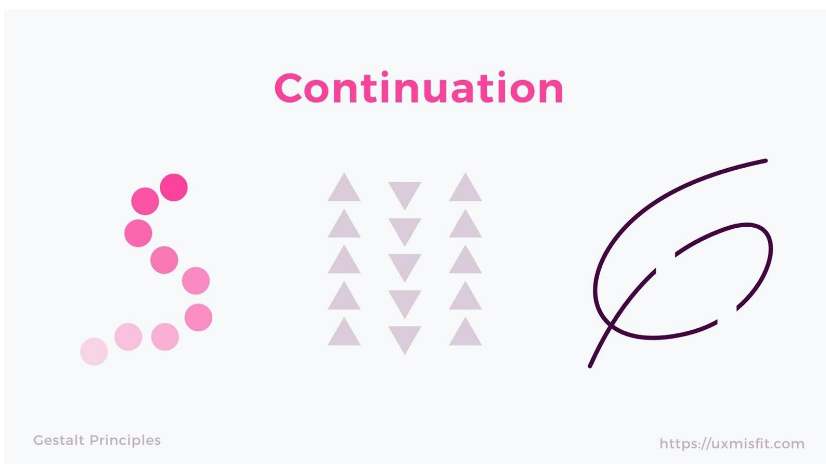
https://userpeek.com/blog/what-are-gestalt-principles/

https://logopond.com/lexlogo40513/showcase/detail/91660

Note. Examples of perceived motion in the Common Fate Principle in the perceived motion of the birds, fish, and golf club swing:

Good continuation. This principle refers to elements that are grouped together in a local pattern. Moreover, patterns can be integrated with the contrasting elements to form another meaning. For example, marketing professionals can create a motion picture or static image that incorporates different elements in message design. The relationship of the segments shows meaning as illustrated in the IBM logo, see Figure 6 (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 6
Examples of the Continuation Principle,



https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/

IBM®

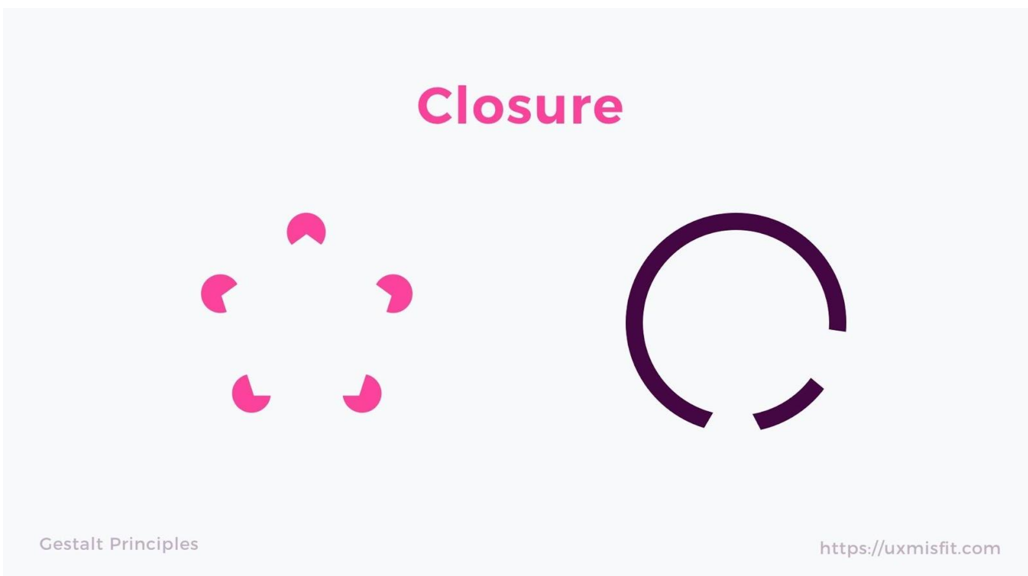
https://www.usertesting.com/blog/gestalt-principles

Note. Elements grouped together to create a visual pattern, the "IBM" logo is a classic example that is made up of rectangles, a few trapezoids, and a triangle:

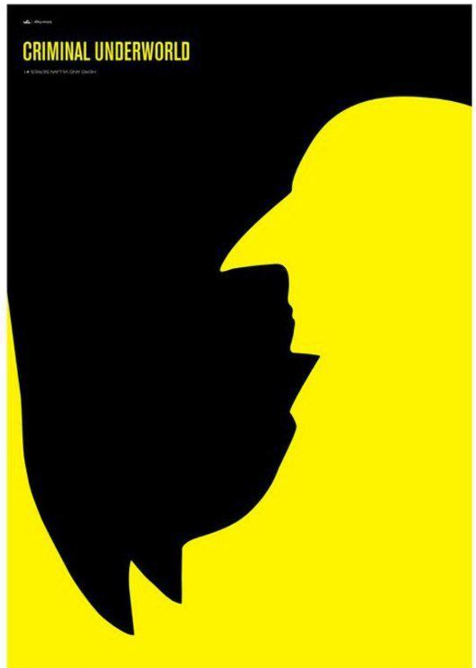
Closure. Elements like lines and dots are grouped together to show the end of the figure. Our natural visual perception tendency is to set boundaries in patterns and to create a mental closure based on given visible elements (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 7

Examples of the Closure Principle, lines and dots creating the perception of visual boundaries:



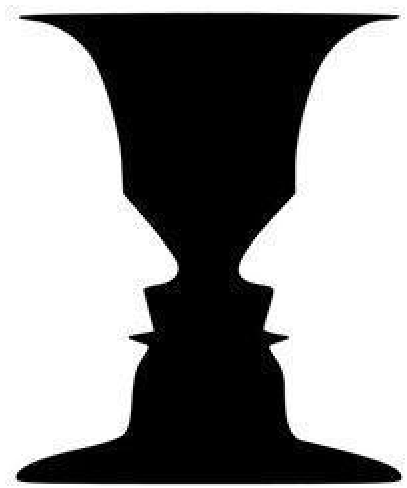
https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/



https://visme.co/blog/gestalt-design-principles/

The Law of Figure/Ground. The law of figure-ground describes two distinct parts in the visual field. A figure is mainly an object placed in the front part of the field, which primarily attracts the perceiver's attention. The figure's color, shape, and pattern separate it from the background. The object is closed mainly by the border to also show the separation from the background. In comparison, the ground having an irrelevant shape is simply a background placed at the back of the field, see Figure 8 (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 8
Examples *of the Law of Figure, the perceived separation of a figure from its background:*



https://www.interaction-design.org/literature/article/the-laws-of-figure-ground-praegnanz-closure-and-common-fate-gestalt-principles-3

The Neurological Approach to Perception

While the gestalt theory approached perception from a structural level and highlighted the core organization of the object, the neurological approach looks more into identifying how the information from light or vibration is interpreted into meaning in the brain. It also explains the main tasks of neurons in the visual system and their connections to cognitive and behavioral activities (Barry, 2020; Gordon, 2004). Because humans are thinking and feeling creatures, their internal thoughts and feelings are not directly observable. The inner and cognitive processes are therefore hard to detect (Winn, 1993). To understand the effects of perception, it is necessary to understand human cognitive activity and the visual perceptual system.

Perception in neurology is a dynamic interactive system that arranges information from multiple channels through the optical system where millions of sequenced nerve cells work individually and in groups to activate responses based on feedback loops of an image (Barry, 2020). Visual perception starts when light lands on an observer's eye and is captured by photoreceptors in the retina, which has cells that respond to the light. The rod cells of photoreceptors are activated in light to provide black-white vision, and the cone cells of photoreceptors respond to highlights and perceive color. Together these cells convert the light into impulses and sends them to subsequent pathways in various areas of the brain for processing (Goldstein, 1999; O'Connor, 2015).

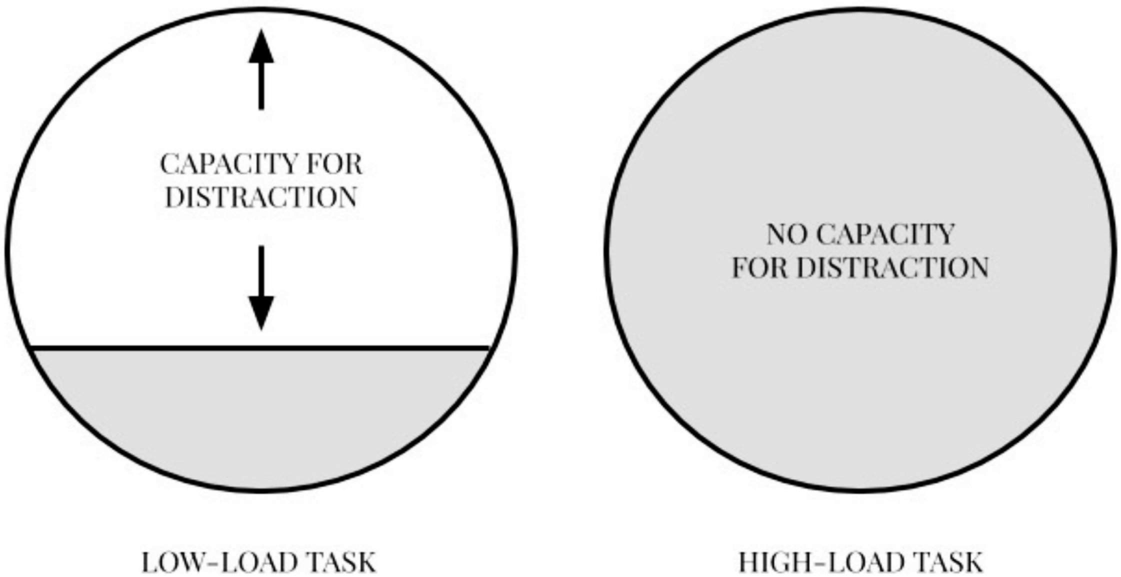
Impulses of visual information from the retina travel through multiple pathways in the brain to reach the visual cortex to be interpreted for their meaning. First, it passes through the thalamus path, passing the motor and sensory signal to the cerebral cortex, where all sensation, perception, and memory processes are held and processed (Pollen, 1999). Then the sensory information moves through to the cortical pathway and is finally transferred to the visual cortex areas. The visual cortex is composed of many interconnected regions and is where all light comes through the eyes and finds its meaning. Here, signals are transformed in hierarchical patterns and create visual perception. All information related to the object and its characteristics, including color, shape, and size, is processed in the visual area called the ventral stream (the "what" does this information mean stream).

In contrast, movement, location, and depth data are processed in the dorsal stream area (the "where" stream). Different areas in the distinct streams exchange information about the particular signal, make arrangements, and create the final perception (Pollen, 1999; Ungerleider et al., 1998). Moreover, while the information from the light is hierarchically identified in the ventral and dorsal streams to make meaning, it is also passed through the interconnected feedforward and feedback projections which play an essential role in keeping attention on the target information and discouraging the distracters caused by the eye movements and sensory-related stimuli (Dijkstra et al., 2017). Once the interpreted information is paid selective attention, it is transferred to short-term cognitive memory.

Perceptual load theory is a part of attention theory, and it refers to the amount of external information used in the perceptual processing of tasks in an attentive process (Lavie & Tsal, 1994). The perceptual load theory aims to describe how we diminish the distractors in learning, but it has a limited capacity (Lavie, 1995). When the high perceptual load is assigned to the task, the irrelevant information is ignored because perceptual information fully occupies the capacity and leaves no space for the distractors. The level of perceptual load decides if task-irrelevant objects are disregarded (Lavia et al., 2009). This process allows humans to focus their attention.

Regarding visual perceptual load, this concept includes the recognition of items such as color, shape, and patterns. The complexity of the items, including the integration and usages, are applied to the image, text, and task (Bahrami et al., 1995; Lavia et al., 2009). In multimedia instructional design scenarios, the perceptual load extends to visual, auditory, and cross-modals and it illustrates how their correlation removes the focus or supports one another (Norberg, 1978). Although the interactions between the perceptual and cognitive loads are unclear, their role in attention processes is enormous. Figure 9 illustrates this idea:

Figure 9
Low-load tasks may leave a margin for distraction without interrupting overall learning:



https://nesslabs.com/focused-mind

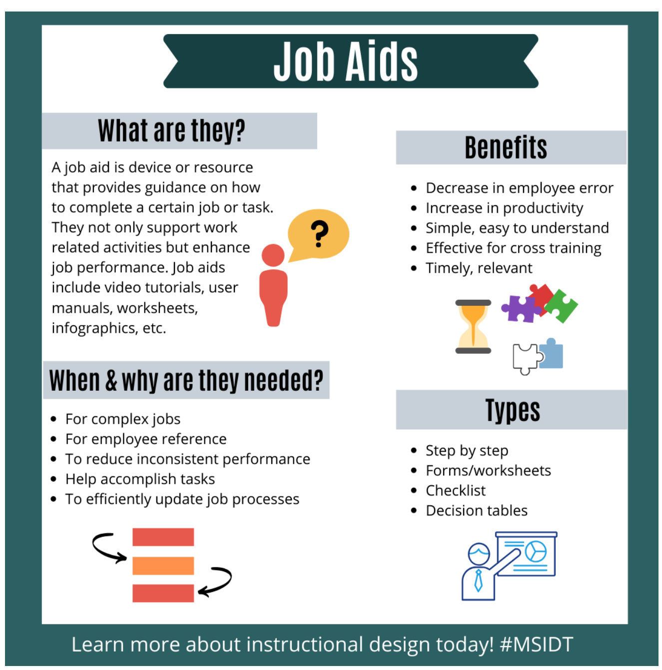
Applications in Instructional Message Design

In the designing process, a visual perceptual load can be controlled in three different ways by adding or reducing task difficulty (Murphy, Groeger & Greene, 2016). The first strategy is to vary the number of items. For instance, displaying only text leads to a low-load perception giving distractors more space, or the learner more opportunity to be distracted. In contrast, text with pictures and graphics is considered a high load perception, which reduces the impact of the distractors. Furthermore, the ultimate capacity for stimuli detection is hard to define due to shared capacity modalities, including motion, size, spatial, and duration (Eayrs & Lavie, 2018). Thus, it is safe to say that designers should avoid overuse of the same pattern in their message design and vary the objects (but not to the point that it causes distractions), see Figure 10.

Figure 10

Examples of low-load (top) which is a text-heavy design and high-load (bottom) which diversified items in the design perception in message design through diversifying *items:*

https://marketbusinessnews.com/financial-glossary/job-aids/

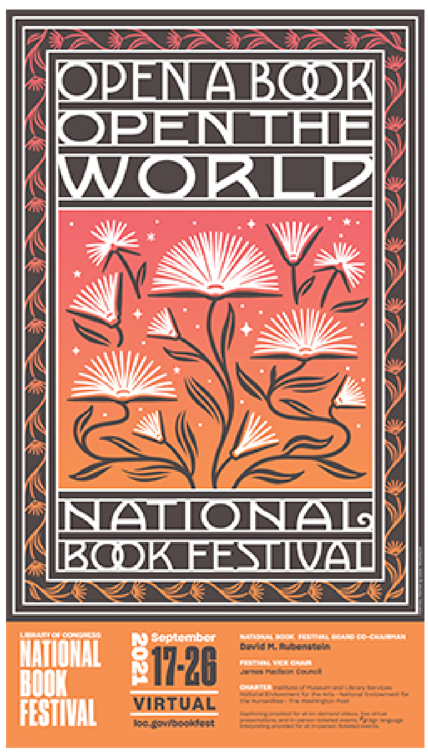


https://www.pinterest.com/pin/157344580719230237/

The second way to manipulate visual perceptual load is to apply similarity and dissimilarity concepts to the items (Murphy et al., 2016). Looking at an example of text and a picture on the same poster, the picture can be surrounded by texts with the same size, space, and angle to create a low-level perception example. Whereas in a high-level perception example, a picture can be flanked by the text of different sizes, possibly with the title text bigger, text with different colors highlighting information, and text in a different location, see Figure 11.

Figure 11

Examples of high-load perception (top example) of low-load (bottom example) and in message design through Similarity and Dissimilarity:



https://www.loc.gov/static/programs/national-book-festival/images/posters/nbf2021poster.pdf

https://templates.office.com/en-ie/supportive-posters-tm22888552

The third one is more of a strategic intervention in manipulating the perceptual load of a visual design by maintaining display consistency. Unlike previous methods, this approach requires participants' judgment of an item or object (Murphy, Groeger & Greene, 2016). Asking a perceiver to identify or differentiate an item that belongs to a specific category is an example of this method. For instance, inquiring which picture contained more color is a low level-perceptual task strategy, while asking which image had more blue or bluish color (asking a more complex question) is a high-level perceptual task strategy.

Although the core concept of perceptual load theory is minimizing distractors, instructional message designers should note that it does not always lead to greater outcomes. For instance, Lavie & De Fockert's (2003) experiments on the relationships between the high-level perceptual load and task difficulty resulted in improved task performance when reducing contrast and presentation duration; size and contrast of the target item; and reducing the eccentric position, resulted in decreased processing of irrelevant distractors.

In his book *Perception Principle*, Winn (1993) excellently integrated the gestalt theory and cognitive load theory. Due to behavioral changes, what is happening in cognition is hard to detect, and how people perceive messages can also deviate from the original one. So manipulating messages in the early stage was encouraged by Winn (1993) to direct a perceiver to interpret the message correctly. He recommended many direct applications categorized as pre-attentive, attentive, and interpretation levels and added recommendations on visual elements such as text and charts. Some of Winn's suggestions include:

In the preattentive process,

- The receiver does not employ any cognitive resource to interpret visuals, so overall, visuals are organized and interpreted based solely on the receiver's direct experience, and there is a chance of misinterpretation. So instructional message designers should take into account the organization of the visuals considering the pre-attentive process to deliver a message appropriately.
- When an abrupt change appears in the message design, neurons are activated and cognitive resources utlized. Changes can be illustrated from light to dark, one color to another, or one texture to another texture. So message designers should ensure to make clear changes such as color, contrast.
- Design elements such as dots, lines, and edges represent the visuals' width, length, and position. When this boundary is lost or becomes vague, a well-structured and interpretation of message design also fails. So the boundaries have to be clearly shown.
- If the image is big in size, a perceiver sees the details first, whereas if the picture is small, they see the bigger picture of the image. Also, when looking at the details, people look at the middle-level of details first, and from this point, they focus on small details or enlarge the picture. So message designers should carefully choose a picture size and details depending on which they emphasize.
- Human vision processes information horizontally and vertically, then diagonally.
- Generally, images are read from left to right.

In the attentive process,

- At an attentive level, perception is selective due to limited memory capacity, so designers should avoid too many details and be considerate of which information in the selection should look important.
- Contrasting color, brightness, shape, size, type, and motion cultivate attention. So some color in a black and white picture, bold typing, and color highlights can effectively draw the attention of a perceiver.
- When the overall brightness of the picture is either high or low, it is difficult to see the changes and differences, but if the overall brightness is kept moderate, changes are easy to detect.
- Too little time for the sequences from item to item prevents the perceiver from reading the message and too much time distracts the perceiver’s attention, so balancing the pace of the sequence is crucial.
- Items such as lines and arrows are used to guide and maintain attention.
- Pictures tend to be read like text, left to right and top to bottom.
- When information is chunked and organized hierarchically, it is more easily remembered and processed.

Ecological and Computational Approach to Perception

The ecological approach to perception directly interprets what we see via ambient light (Gibson, 2014). Because many concepts discuss information processes from the environment and animals' interaction to it; they are not directly applied to instructional design and message design. However, the latest technology-driven learning has allowed ecological concepts, including environmental and self-perception, affordance, and locomotion, to be implemented in instructional simulation, simulation games, games, and virtual reality as a theoretical framework. This evolving ecological framework also includes a computational and computer science perspective, especially using artificial intelligence (Roman & Racek, 2019; Geuss et al., 2010). The computational approach uses mathematical, geometrical, computational methods, and an interface design approach to make abstract ideas of vision visible in reality (Stevens, 2012; Kitcher, 1988). The central role of integrating these approaches to perception is creating a learning environment in an immersive, virtual world (Roman & Racek, 2019). Learning environment design requires considerations of pedagogy, epistemology, methodology, and environmental attributes consisting of representations of real-life systems, such as objects, backgrounds, actions, and motions (Frey, 2018).

Allowing learner interaction with representations of a specific content area enables them to be involved in the make-believe world, create their own internal representation, and develop skills in a safe environment (Frey, 2018). However, this notion of having a real-life experience from a virtual one depends on the experiential modes. Schutz (1945) termed the experiential mode in media reception as the primary experience with humans' direct perception of a representation, activity, or condition without judgmental attitudes. Authenticity in experiences in the learning environment should transfer to learning effectiveness when those skills are transferred to the real world (Frey, 2018). Concepts offered by ecological approaches are used in an immersive environment to fulfill learners' experiential modes.

The Ecological Approach to Perception

According to Gibson's definition, the terrestrial environment, and ambient light are the keys to all interactions between living and nonliving things and information creation in ecology. The medium, substance, and surface are the primary source of information and allow visually oriented animals to interact with their environments through ambient light. He added that the information is enriched by events such as motion and surface changes. A single event becomes a basis or a unit of longer events, implying that longer events and activities have more information that needs to be processed (Gibson, 2014; James, 1981)

Gibson also distinguished self-perception from environmental perception in an optic array of light (Gordon, 2004; James, 1981). When a creature looks towards a specific location, it only sees certain angles through the light, not the whole surrounding. However, the angles of points are changed following the locational changes, resulting in a clearer and larger visibility of objects in the environment. This change in viewing angle is called the perspective structure change. Also, a shadow structure change is created due to the sun's movement, which leads to changes in the angle of the point observation even without the subject moving (Gibson, 2014; Gordon, 2004). So, the ambient optic array allows us to perceive information from 360 degrees and describes the visual scenario of when one object becomes visible, other objects or parts of objects become invisible or shadowed. As a result, environmental perception is created. For self-perception, when the head turns, part of the optical view or structure is removed, and an opposite view is visible. As a result, the viewer has a sense of their location within the environment. Also, a flow is a change in the perspective structure; in other words, shifts and movements in the environment, such as indoors and outdoors, impact how we perceive information. Gibson stressed that these two ways of receiving information, or environmental and self perception always follow each other and can not be treated separately (Gibson, 2014 ch: 5-7). The main reason the perception of the ecological units should be considered is that it allows instructional message designers a context to consider when designing virtual immersive environments.

Application in Instructional Message Design

Understanding perception and how learners interact with their learning environments is a key aspect of instructional message design. The ecological approach of processing information and developing an environmental and individual perception can be used to benefit the gamification and game-based designing process. In the video game world, a player's main activity is to receive information from the layout and then to quickly react to it to achieve a task. To receive information from the environment in a situation, a player can either turn their video game character's head (ambient vision) or move the head and body (ambulatory vision) through the environment. Conversely, the objects in the environmental layout could be changed by the designer according to these movements and to give further information. In either case, a player will react according to the information received. For example, when racing a car from the first-person point of view, the player gets data from the side banners and other cues, which are the motions in the layout. Simultaneously, they are also steering the which changes their view (Meldgaard, 2012). The player receives visual input from the environment and the motion of the car through that environment.

In virtual reality, the concept of general spatial perception in three-dimensional space becomes even more important (Geuss et al., 2010, Grabarczyk & Pokropski, 2016). Lately, numerous experiments have been conducted on various perceptual tasks, including sight, height, and kinesthesia (or the self perception of the location of the body) (Fath & Fajen, 2011; Kelly et al., 2017; Bhargava et al., 2020). These studies help illustrate the importance of authenticity. However, Linderoth (2012) notes that good games do not mean a great learning experience, and care has to be taken to be sure the learning experience matches the learning objectives.

Computational Approach to Perception

Marr (1976) first introduced the computational perception approach and initially aimed to figure out why a raw picture draft matches the people's anticipation of the actual picture. Marr's computational theory describes human vision processes as being analogous to how a computer system works, by taking inputs, processing them, and creating meaningful outputs. Computational theorists started off understanding the beginning point and process of the “primal sketch”, then shifted their gaze to 2-½ dimension (D) and 3 dimension (3-D). Later, it was broadened into a perception of each element, such as depth and spatial perception (Marr, 1976).

The primal sketch is the first initial representation of visual information. Marr and his fellow researchers first analyze the process of drawing/sketching, hoping to see whether the tokens of the sketch could match the retinal array of primitive (Gordon, 2004). Their experiment revealed the first layer fundamentals were types of edge, lines, thin bars, and blobs, called "primitives/tokens," and a combination of tokens builds up the bigger part and finally forms an image like a line. Once the individual lines become larger, the picture's intensity value becomes more vivid, leading to the primal sketch of an object like a black drawing. The importance of this finding is that visual analysis is possible to be seen on the screen through a separate symbolic entity, which is computed and measured separately from the image and cooperates with other geometry shapes, which results in removing a considerable burden of handling the mass of data (Marr, 1976).

The primary sketch leads to a 2-½ D sketch which is an internal transitory phase of cognitive information processing to create visualization. The 2-½ D sketch keeps the concept of the viewer-centered visualization. At this stage, the optical surface of the picture becomes visible; however, it only shows the side a viewer is seeing, not the whole surrounding 3-D object or environment. So the hypothesis based on this idea was that our vision could not imagine the entire surrounding environment, whereas this is more likely a mental process, meaning we create the 3-D process in the brain; it has nothing to do with our eyes (Kitcher, 1988; Stevens, 2012).

The last stage of the computational process is the cognitive representations of 3-D dimensional shapes created from the 2-½ D forms (Marr & Nishihara, 1978). The 3-D representation in a learner’s mind is formed by the initial primitive objects consisting of the types of shapes, their size, and placement in an object-centered coordinate system for computing. The integration of these conceptual phases, from primitive mental sketches, to 2-½ D concepts, that coalesce into

3-D mental representations of what the learner sees, plays a crucial role in the creation of an immersive environment.

Application in Instructional Message Design

Instructional message design and computational processing concepts can be applied to the evolving fields of artificial intelligence and machine learning. Recent studies related to visual perception and computation have led to tremendous advancements in various fields such as manufacturing, agriculture, intelligent driving, and image synthesis (Yang et al., 2020). *Machine vision* is the technology that enables computer vision algorithms, with image capture systems, and the robotic instructions for the inspection of an object or process (Perez et al., 2018). The use of machine vision significantly improved the quality and accuracy of the industry works (Yang et al., 2020). Namely, automatic detection and classification of surface textile defects based on machine vision remarkably lowered manufacturing surface defects such as spots, holes, and stains on metal and non-metal surfaces (Yang et al., 2020). By segregating extraneous objects from a target one, perceiving movements, and defining and completing desired actions, robots are able to perform daily and specialized tasks in the real world (Haazebroek et al., 2011; Perez et al., 2018). For example, agricultural robots using similar visual perception processes as humans, are used to distinguish fully grown apples from immature ones, even at night (Wei et al., 2018). Automatic vehicle driving is another example of how visual-based environmental perception becomes a source of information for safe autonomous driving (Yang et al., 2018). Future research will give us further insight into how instructional message design for human learners can be applied to help artificial learners learn.

Conclusion

Perception is the learner's initial sensory input and the subsequent processing of that information for meaning. Perception becomes an essential principle for multiple theories consisting of Gestalt, neurology, ecology, and computation and can all be applied to guide instructional message design. Understanding how humans process visual information can be applied to make more effective and efficient message designs. Moreover, understanding perception can help instructional designers develop and create augmented reality, virtual reality, and immersive simulations. In general, well-organized instructional message design leads to efficient perception and processing of communication.

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Chapter 13: Web Conferencing Best Practices for K-12 Online Teachers

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13. Web Conferencing Best Practices for K-12 Online Teachers

Melissa Hatfield & Miguel Ramlatchan

Key Points:

- Web conferencing is an effective tool to build social presence, provide access to education, and to create effective online virtual classroom environments.
- The diffusion and adoption of online web conferencing applications like Zoom accelerated rapidly during the COVID pandemic, though many teachers were unprepared.
- Best practice from instructional message design theories, models, and techniques can be used to make Zoom even more effective.
- Teachers should plan to use their eye-level cameras, use good lighting, share their presentations, and use the ever evolving affordances of the technology to keep students engaged.

Abstract

There is no shortage of online advice on how to use web conferencing applications like Zoom, that allow for real-time audio, video, and content engagement between teachers and students. While much of this advice is based on practitioner experience, a growing number of guides are now based on applied research and theory. This is one of those later guides, presenting best practices based not only on practical experience but on applied research from instructional

message design. While not meant to be an all-encompassing treatise on all things Zoom, this chapter does present and encourage the use of Zoom's functionality to build effective learning environments. Using this guide, and experimenting with the features that you'd like to use in your virtual class, will help you and your students have a great online experience and take advantage of the engagement, access, communication, and learning opportunities of online web conferencing.

Introduction

The lockdowns that began in March of 2020, from the start of the COVID-19 pandemic, created an unprecedented time in K-12 (secondary and postsecondary) education. Teachers were catapulted into a virtual classroom with little to no guidance on how to establish this new type of instruction. Teachers with 20+ years of experience felt like first-year educators because they didn't know how to transition to a virtual classroom. Many teachers experienced the single most traumatic and transformative event in their careers and in education by being forced to recreate lesson plans while quickly learning new technologies (Kaden, 2020). Trial and error were mixed with a substantial amount of patience. Many teachers were at a disadvantage, with not having the skills and tools necessary in their pedagogical approach, when tasked to design their virtual classroom. Experienced teachers found themselves seeking help from younger teachers and students who had experience with navigating the digital world. The COVID pandemic created an immediate need for guidance on how to create an engaging, online classroom through web conferencing that was safe, secure, and user-friendly. This guide presents research based guidelines and best practices to make it easier for teachers to implement and continue to support online virtual classrooms.

So, what is web conferencing? **Web conferencing is an online meeting or conference that takes place when the host and participants are in different locations**. They can be accessed by home computer, laptop, smartphone, or tablet if a reliable internet connection is available. There are many different web conferencing applications available such as Google Meet, Cisco WebEx, Microsoft

Teams, Blue Jeans, and Zoom to create a virtual classroom. When selecting a web conferencing application, it is important to remember what you do (teach) and what features you will need during class to achieve your pedagogical goals (Sweetman, 2021). Many services offer similar features such as breakout rooms, screen sharing, hand raising and chat boxes. Zoom was the most used technology-mediated learning web conferencing service by K-12 education, government agencies, and non-profits during the COVID-19 lockdown (Joia & Lorenzo, 2021). Zoom reported 10 million users in December 2019 and over 300 million by March 2020 (Bailenson, 2021). The name Zoom has become a verb due to the generalization of web conferencing software (Bailenson, 2021). Throughout this chapter, we will be exploring the many different features of these platforms with a focus on Zoom and how to incorporate its features into an effective instructional design.

Zoom and Instructional Message Design

Instructional message design is the use of tools, technology, and techniques to communicate with learners and achieve learning goals and objectives (Fleming & Levie, 1993). Message design best practices such as building social presence, reducing distractions, sharing video and content at the same time, and using the technology to foster communication and engagement can be used to optimize web conferencing environments. Recent studies in web conferencing have shown that extraneous cognitive loads have influenced the instructional process (Çakiroğlu & Aksoy, 2017). The design features of multimedia materials and the delivery settings are the contributing factors to extraneous cognitive load introduced by the teacher. The elements of extraneous cognitive load include modality, redundancy, signaling, coherence and temporal-spatial contiguity and it directly influences the instructional process (Çakiroğlu & Aksoy, 2017; Ramlatchan, 2022; Shaffer, 2022). When an instructional designer incorporates the many features that web conferencing has to offer, it can produce negative results with cognitive load. Weeding out irrelevant stimuli and technical themes will reduce extraneous cognitive load (Çakiroğlu & Aksoy, 2017). This can be done by using a principle called signaling which uses a cue to help the learner direct their attention to important text or visuals (Çakiroğlu & Aksoy, 2017).

Teachers must develop their semio-pedagogical skills to facilitate learning which is done through facial expressions, voice fluctuation, gestures, and images (Develotte et al., 2010). Semio-pedagogical skills are the ability for a meeting host to engage and foster collaboration in an online web conference. Another interesting find is that when the presentation and narration were balanced, the speaker's display was still a distractor to the learners (Çakiroğlu & Aksoy, 2017). Clarity of communication is important by keeping verbal and written communication simple (Hastie et al., 2007). Multimedia learning theory shows that audio and visual information is stored simultaneously in the brain but in different channels (Yu et al., 2015). Using, selecting, and integrating words and images to work with sounds and images in the presentation will connect prior knowledge to the information being presented (Yu et al., 2015). Empirical evidence suggests that the use of videos for lectures is a powerful tool for learning engagement because it increases the learner interest due to the use of several different formats (Yu et al., 2015). One study showed that seamless arrangements of visual elements produced higher academic performance overall by students (Yu et al., 2015). Most studies have shown that the only way a teacher's image would have a negative impact on a student's cognitive learning would be if the teacher's image became a visual obstacle that hides learning material (Yu et al., 2015).

Credibility and immediacy are the two parts of instructional design that contribute to the instructor's social presence online (Ramlatchan & Watson, 2020). This can be done through video features and production design techniques (Ramlatchan & Watson, 2020). Creating a blend of the teacher and graphics or any type of visual content will engage the learner and increase the teacher's credibility (Ramlatchan & Watson, 2020). Taking away the teacher's online presence will reduce the teacher's credibility and immediacy (Ramlatchan & Watson, 2020). Online learning can be an impersonal and potentially isolating experience. If a teacher can incorporate a personal touch that increases the emotional bond with the learners, then the learning process will be much deeper and meaningful. With the technology that students have grown up with across most developed countries, most students are already e-learners (Dalziel, J., 2016). They incorporate online technology learning into their daily lives for video games, hobbies, and personal interests. It is still the teacher's responsibility in developing and increasing a student's online learning capability.

Special Needs Students

Online web conferencing can be especially challenging for students with special needs. Utilizing web conferencing can be more psychologically demanding than face-to-face interaction (Williams, 2021). This is due to the greater need to concentrate on the presentation and the new proximity of people's faces if not a bank of virtual faces (Williams, 2021). This narrow visual proximity also reduces the ability to see body language which is a very important part of understanding and learning for autistic learners (Williams, 2021). There are over 7 million students with special needs in K-12 education (Hill, 2020). In a traditional classroom, these students have trained professionals who understand their unique ways of thinking (Hill, 2020). We must take this into consideration for neurodiverse learners in our online classrooms who may be struggling more than a neurotypical person would.

Students with disabilities, such as a visual impairment or hearing impaired, require assistive technology that some online platforms are not compatible with (Hill, 2020). When too many students are in the virtual classroom, those needing American Sign Language may not be able to see and understand the signs because each person becomes smaller in the online class (Hill, 2020). Zoom's built-in speech to text and auto-captioning capabilities are impressive, and can be helpful for students. Also, transcription services providers for true ADA compliant captions (98%+ accurate) are becoming much more adept at connecting to online web conferencing classes (some options include https://verbit.ai, https://captionmax.com, & https://www.ai-media.tv).

Some teachers have reported that their students with autism-spectrum disorder have found it much easier to look at peoples faces through a computer screen (Hill, 2020). Students with autism typically find it harder to make eye contact with people in a face-to-face setting so this has been a true benefit to online learning. Other teachers who work with students who have neurological and learning disabilities have reported similar stories (Hill, 2020). Students that normally will not speak in class, came alive during the Zoom classes (Hill, 2020). A teacher was able to walk outside with her laptop to show her "serious boys" monarch butterflies that were flying around in her front yard causing them to be spellbound by what they were seeing (Hill, 2020). The students can interact with each other more in a fun way such as getting to introduce their pets to their classmates. What would have been a stressful situation for neurodiverse students, has translated into a safe space for learning and coming alive (Hall, 2020). Parents also reported that their students were more engaged and connected with their class through the more intimate and personal style of learning (Hill, 2020). Finding ways to connect with special needs students during virtual classes can provide unique opportunities that create a lifetime of learning.

Designing Your Online Classroom

Excellent teaching uses the same principles with regards to classroom, online, and hybrid learning (Nilson & Goodson, 2017). When designing an online classroom, it is important to remember that many aspects and activities of in-person learning can be replicated in a well thought virtual classroom (Joia & Lorenzo, 2021). Developing "best practices" encompasses seven different strategies (Hastie et al., 2007). These strategies include:

- Purposefully increasing teacher and student interaction
- Fostering student cooperation and active learning
- Use the technology to provide prompt feedback
- Coaching and facilitating a student's time on a task
- Communication of expectations at the beginning
- Adapting to diverse talent in real-time
- Learning abilities are also part of the instructional strategies

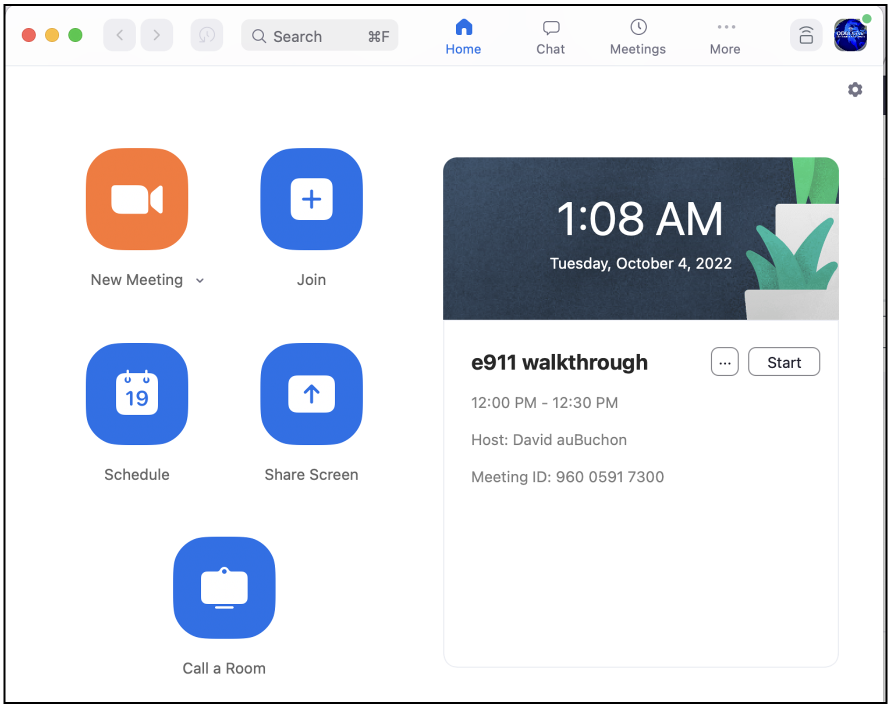
Teachers conducting a class in a live, virtual classroom have found that this requires a higher level of concentration which maximizes the students learning (Hastie et al., 2007). While there are many effective web conferencing tools, we focus on Zoom, though many of these best practices will apply in many live online learning environments.

Zoom Features

Once you establish your account (or are given your account login information by your organization's IT staff), you will be able to create each individual class by going to the Meeting tab in the Zoom Web Portal. From here click on the "Schedule a Meeting" tab and it will take you to the page where you will create your online classes (see Figure 1). You will name each of your classes in the Topic section and you can provide an optional description of the class. Next you will determine the time, duration, and frequency of the class meetings. Click on the checkmark that says "Recurring Meeting" to ensure that the meeting is accessible each day. Without clicking on this link, the class will only be accessible for the initial date set. A link as well as a password for your students to access the classroom will be generated here as well.

Figure 1

Once logged into the Zoom app you can schedule your class meetings:



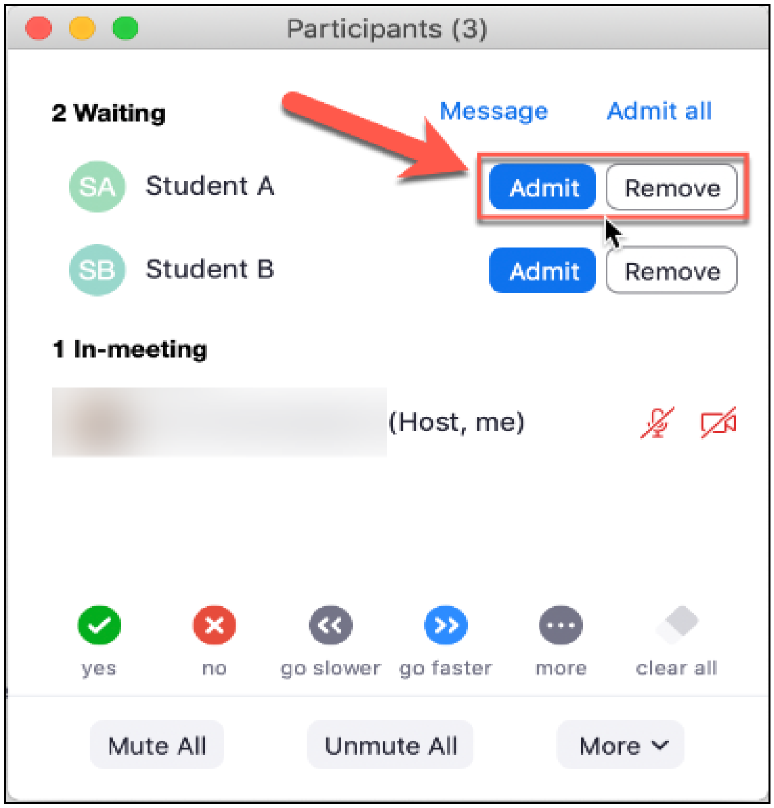
Note. Meetings can also be scheduled through the Zoom web interface by logging into Zoom.us with your host account.

You will want to be sure to post the Zoom meeting link and password for students in a secured location like in the online course or learning management system, such as Schoology or Canvas, that your school is using. The students will go to the home page in their LMS (Learning Management System, such as BlackBoard or Canvas) and click on the link to your classroom. A generated password by Zoom is available to post for student access to the class each day. This option is an extra security measure provided by the web conferencing platform that the teacher can decide if they want to include it when creating the class. Some teachers have opted to not require students to enter a password to ensure that students do not have any issues accessing the online classroom. Also, please be sure to keep your Zoom links private to avoid Zoom bombing, and do not post your links to social media or unwanted online participants can join your Zoom meeting.

Another great security feature is the “waiting room.” The teacher must allow the students access to join the class when using this feature (see Figure 2). A doorbell will chime letting you know that there are students waiting to be admitted to the meeting room. Students can be admitted one by one or all at the same time. This gives the teacher the ability to check the students names to make sure that they are on the class roster. It also displays the photo used by the student as their online identity. Teachers have reported inappropriate names as well as vulgar pictures used by some students. The teacher can deny access to anyone who attempts to join the class that is not on the roster or has inappropriate content that would be displayed to other students. Teachers can also remove a disruptive student during a class session. It has been reported that ill-intentioned online users accessed certain online classrooms during the lockdown and displayed pornographic material during K-12 classroom instruction (Kan, 2020). Safety in an online classroom is trickier with the online threat of hackers. Therefore, it is very important to secure an online classroom with all the security features available during any video conferencing meeting.

Figure 2

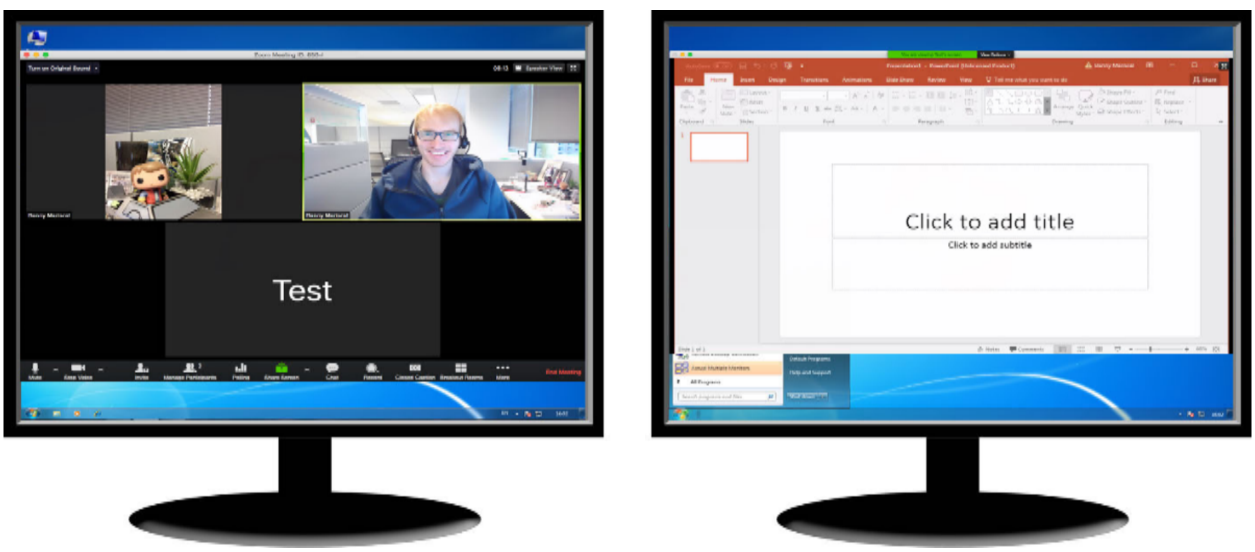
A helpful security feature is the implement a waiting room and manually admit recognized students



Teachers should use two computer screens when teaching in their Zoom classroom (Kaden, 2020). It can be one computer with two screens or two separate computers, see Figure 3 (Sweetman, 2021). This allows the teacher to share their screen with their presentation on one computer screen while watching the online chat room on the second computer screen. The teacher can also admit students from the waiting room to the virtual class and monitor student interaction in the Zoom classroom on the second screen. Sharing your screen allows the students to focus on the lesson at hand whether it is through a Nearpod, Google slides, websites, or PowerPoint presentations. Using the webcam on your computer during your class is beneficial to creating and nurturing the emotional connection with your students. It is important to note that in a traditional classroom setting, interpersonal distance and eye contact is a trade-off (Bailenson, 2021). By interacting in Zoom, the faces of those speaking appear larger than in a physical setting (Bailenson, 2021). A constant eye gaze can be overwhelming and exhausting for students. Zoom has an interface feature that can be set to hide the self-window which frames participants within the window (Bailenson, 2021). Incorporating PowerPoint presentations, Nearpods, and using the Whiteboard feature will reduce uncomfortable and tiring situations for students. Allowing students to turn off their cameras for small breaks during class is another option to reduce extraneous distractions.

Figure 3

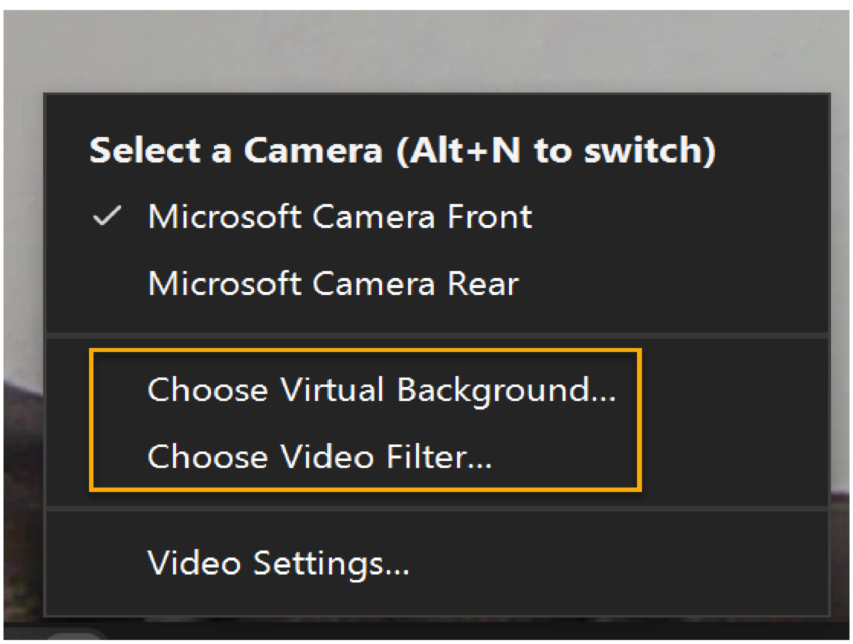
Using two screens, or two separate devices, can help teachers manage class logistics.



Note. The view of students, the chat, and the participant list can be kept on one monitor and the presentation and slides on the second. https://support.zoom.us/hc/en-us/articles/201362583-Using-Zoom-desktop-client-with-dual-monitors

Teachers and students don't usually go into each other's homes but, Zoom has changed this for us. We now get to see what our student’s homes look like or get a glimpse of the family pet. This has added to the learning experience and emotional connection (Sweetman, 2021). It can also be a distraction during the learning process if the learners are concentrating on the background of the other participants. To create an effective learning environment, it should be distraction free regardless of it being in person or virtual (Sweetman, 2021). If students are uncomfortable about other students “seeing” into their home, Zoom has a “Background and Filters” feature that allows the students to blur their background or to create a different background altogether (see Figure 4). This will help eliminate any embarrassment that students may have about their home and encourage interaction during class. When students have their cameras on, they are more likely to stay engaged with the lesson being taught. Students are also less likely to use their cell phones or not pay attention since they are being observed by their teacher.

Figure 4
Virtual or blurred backgrounds can be a great option for self conscious students to still share their camera views



One study compared using a webcam to a theater stage in that teachers can adapt their gestures and facial expressions to reflect their pedagogy (Develotte et al., 2021). This study also suggests that foreign language teachers should be taught online communication strategies that incorporate non-verbal skills. This would be achieved through body language and facial expressions to optimize the use of video conferencing (Develotte et al., 2021). According to Meyer's cognitive multimedia theory, language learners must be able to select appropriate words during the teacher's oral message (Develotte et al., 2021, Mayer, 2014). The learner must also organize the selected words and images into a coherent verbal and visual representation (Develotte et al., 2021). This study shows that it is important to create effective instructional design by using facial expressions and body language that correspond with the lesson. These findings translate into the need for a theater-like, professional environment during the Zoom class to promote cognitive learning.

Three other important features to enable are the audio, video, and annotation settings. It is best to enable the host and participant video as well as the audio for classroom participation. Teachers should do a practice session prior to hosting their first online class to make sure that the camera or webcam and audio features are working properly. Check the webcam and lighting to make sure that the camera is at eye-level, and you are centered on the screen (Ramlatchan & Watson, 2020). The lighting in front of you should be adjusted as needed to produce a clear and natural image. Too much lighting and it will wash out the image of your face. If there is not enough lighting, then everything will be dark and cast into shadows (Sweetman, 2021). If your computer's camera is not working properly then an external webcam may be a better option to provide a clear and quality picture. Background distractions should also be at a minimum to keep your students engaged during the live instruction. It is highly recommended to record a test run that you can go back and watch. This will allow you to check your lighting and adjust it as necessary to create a natural appearance. Listen to the audio to ensure that your computer's microphone is working properly and produces a quality sound. Working out any issues before your first live class will enhance your credibility, reduce any probability for technology hiccups, and help create a pleasant online classroom experience for you and your learners.

Enabling the annotation tab will allow students access to the interactive whiteboard feature. The annotation tool increases social presence for students as well as an emotional level of connection within the virtual classroom setting. The teacher can draw and annotate on the screen to add to the presentation or to make notes for the students to see (Hastie et al., 2007). This spontaneous drawing of diagrams or formulas is especially useful in hard skill classes like math, programming, and engineering.

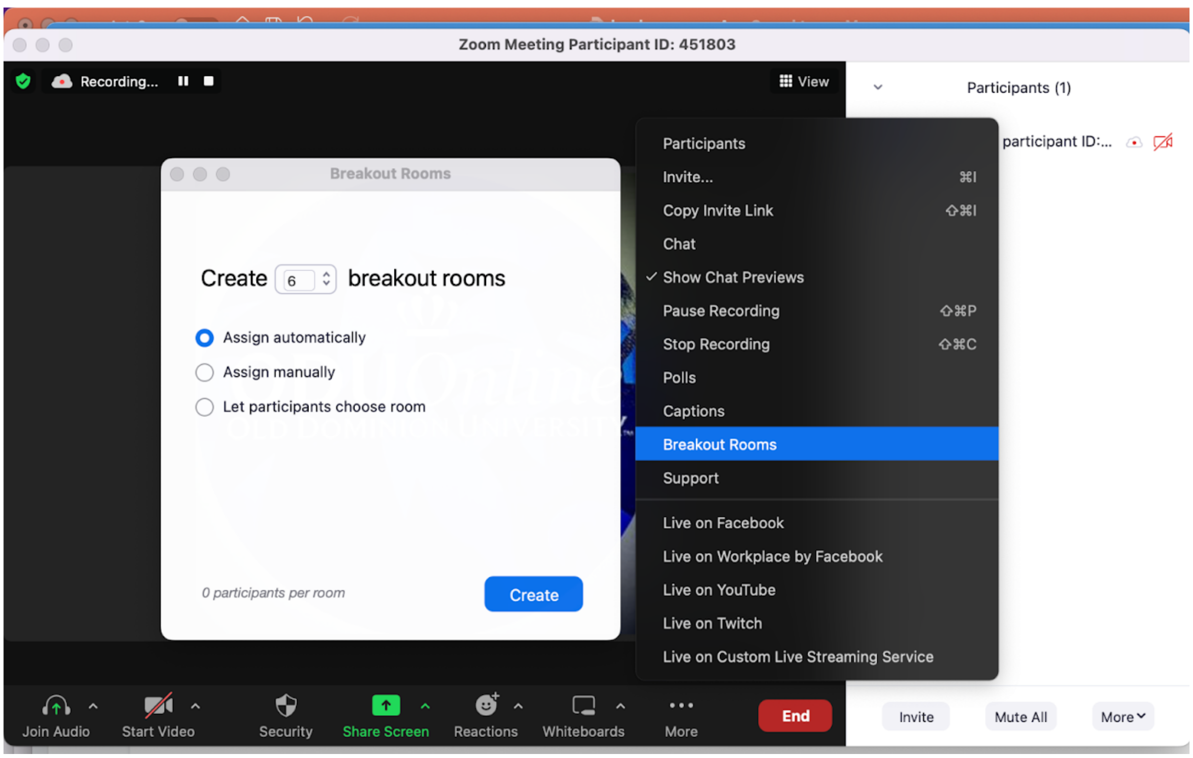
There is an option to mute the participants' audio upon entering the classroom. This is a preferred option to enable since background noise from some students may be distracting or even inappropriate. Students will still have the option to unmute their microphones to participate during class. Students can click on the “Raise Hand” feature in the participants tab. This will alert the teacher that the student has a question and is waiting for permission to unmute their mic. In classes where the students do not have their video on, this option helps teachers to know who has a question. This prevents interruption during the lesson as the teacher can determine at what point to allow the student to ask a question. It is best to take all safety precautions at the onset to minimize disruptions to maximize the learning process.

Breakout rooms can be preassigned for collaborative activities during class. Breakout rooms allow students to work in groups on class activities and projects. Breakout rooms can also be created during class by clicking on the Breakout Room tab at the bottom of the screen. The teacher can decide if they want Zoom to automatically assign the students to rooms or the teacher can assign them individually. It would be best to practice creating the breakout rooms prior to a live class. Teachers have tried to use the breakout room feature during class and have experienced negative results. One suggestion would be to create a breakout room session prior to class and individually assign the students to a room. This will allow you to practice with the feature and prevent any confusion during a live class.

Depending on the number of students in the class, you can decide how many students you want in each breakout session (see Figure 5). Breakout rooms are a great way to get students to collaborate with each other. Online learning can prevent important social interaction that students need. When designing daily instruction, incorporating a class discussion or lecture with a presentation followed by breakout rooms can foster engagement. This strategy of content presentation followed by group activity or project can increase learning effectiveness as well as support social presence.

Figure 5

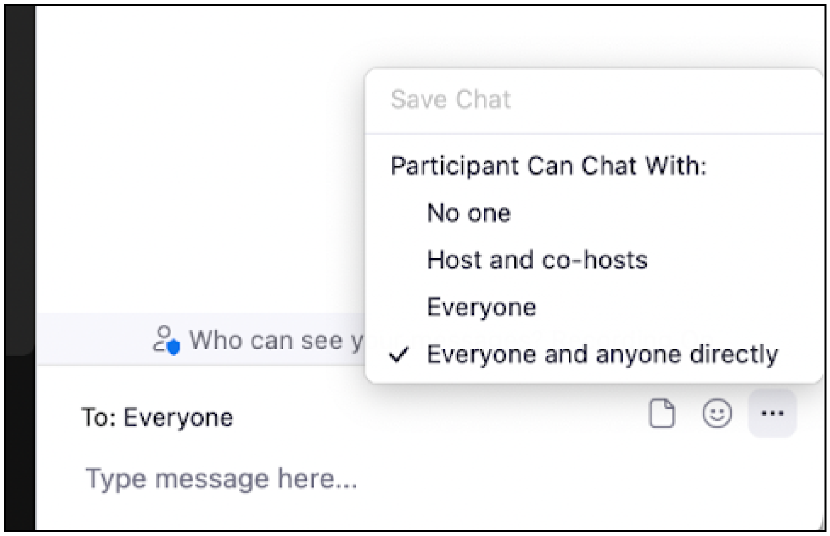
Breakout rooms can be used for student projects increasing overall engagement and social learning



The polling feature uses single or multiple-choice questions to gain feedback or to check for understanding from students. The teacher can determine which students are on track or may be falling behind. This feature is found in the Account Management tab. To enable this feature for all participants, navigate to the polling option to enable this feature. The polling feature can be used at the beginning of class to introduce a topic. It can also be used as a quiz or an exit ticket at the end of the lesson to check for understanding. A data report is generated for each poll that identifies the student and score. A maximum of 25 polls with 10 questions each can be created for each class. To start the poll, click "Launching Poll" and the students will be prompted to begin the poll. A timer begins and will stop the session when time has run out.

The chat box feature is a great way to encourage student interaction with each other. The lockdowns combined with online learning caused concern for student isolation. Some students thrived during the online experience because they were able to interact in a less intimidating way by using the chat box (Kaden, 2020). This is just another way to utilize web conferencing that encourages class participation. Some students that would normally not talk during a traditional classroom setting now feel empowered to interact. Typing into the chat box gives students the ability to ask a question or respond to other classmates. Teachers that want to ask a question that requires a short answer find the chat box to be an additive role to the overall experience (Sweetman, 2021). Sidebar conversations that students may have had one-on-one in a traditional classroom setting can now engage the entire class (Sweetman, 2021). A teacher can also message a student privately without drawing attention to the student. A study showed however, that even though the chat feature was merely available to students, it did not mean the students would use it (Develotte et al., 2010). This was due to students listening and taking notes during the virtual class and watching the computer screen (Develotte, et al, 2010). The students and teacher can all see the typed responses and can respond as well. While the chat allows for student-to-student interaction and learning, it could also be distracting and disruptive if left unmonitored. Chat settings are available by clicking on Participants and clicking on the ellipsis (the three dots) for more options (see Figure 6).

Figure 6
The chat can allow for constructive student collaboration



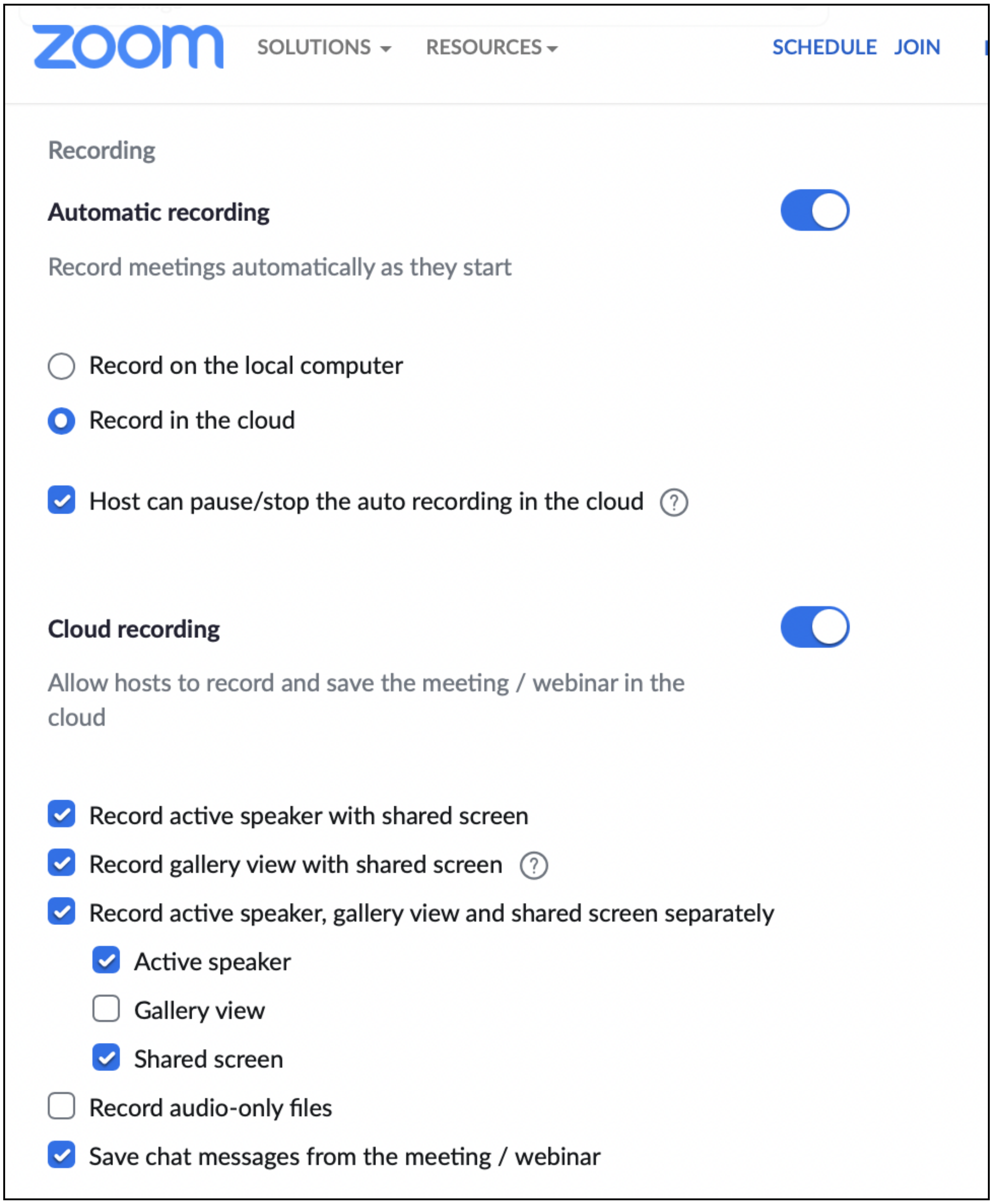
One important feature to disable when setting up the classroom is the private chat box. This can be done in the My Meeting Settings in Zoom. This is another safety feature that eliminates the students from inappropriate interactions with each other during class. Students will also not be able to upload files into the chat box. As educators in a virtual world, we want to make the most of the online experience. We are still responsible though for the safety and well-being of our students. Utilizing the breakout rooms and chat box features of Zoom promotes higher-order thinking skills through brainstorming, reflection, and collaboration among students (Joia & Lorenzo, 2021). The chat features allow learners to respond privately to the instructor, and add another option besides sending the question to everyone. Students who may lack self-confidence or self-efficacy will appreciate this option.

A great interactive tool that will enhance the learning process in Zoom is the "Whiteboard" feature. The teacher can post the lesson and students can draw or write on the screen using the annotation tools. This is such a great tool to use in a hard-skill course such as math or engineering for formulas and diagrams (Hastie et al., 2007). Utilizing the whiteboard combined with written and verbal chat allows the student to interact in a more spontaneous way (Hastie et al., 2007). The students use kinaesthetics, visuals, and auditory communications, and are therefore required to exert a higher level of thinking which equates to cognitive gain (Hastie et al., 2007). The teacher can check the students' understanding during the live class and make direct observations in real time. Students can use this important feature in breakout rooms too. The whiteboard feature brings a familiar feature of the traditional classroom to the virtual classroom. Teachers can create multiple whiteboards prior to class. These "worksheets" can then be used by students during teacher-led instruction or in breakout rooms (Hastie et al., 2007). This helps maximize learning while keeping extraneous cognitive load at a minimum. Zoom also has a feature called "Stamps" that pairs with the whiteboard. This feature allows students to place a predefined stamp (X, O) on the screen to demonstrate understanding of the instructional material (Sweetman, 2021). A variety of options can be shared on the screen for all students to place a stamp on (Sweetman, 2021). This provides feedback to the teacher to determine if the instruction being discussed is being retained and what areas need further instruction.

One last thing that is very important is to enable or confirm the box that says, "Automatically record meetings", see Figure 7. This and other Zoom Meeting settings are available when logging into Zoom.us with your host account.Most school districts will require teachers to record their online classes. This is in case they need to review the lessons for any discrepancies or complaints by parents. Students that use a smartphone or similar device during class may have difficulties accessing links or other instructional materials provided during class. If a student was absent from class, they can view the recorded lesson. The teacher can provide them with the link to watch the recorded lesson at a time of their own choosing. Some studies show that students like having access to the recorded lessons and access to any other online instructional tools used by the teacher (Joia & Lorenzo, 2020). This aids the students in cognitive learning and retention of content. Some students come from socioeconomic backgrounds to where internet connection may not be available in their homes (Sweetman, 2021). Many school districts are providing the technology needed for students to access the virtual classroom. Providing students with access to the recorded lessons in Zoom as well as the activities in the LMS (Learning Management System such as BlackBoard or Canvas) allows them to determine their growth throughout the course (Joia & Lorenzo, 2021). Zoom keeps the cloud recordings for 30 days after which they are deleted from your account. Email reminders are sent to the account holder seven days prior to the cloud recordings being deleted to recover the recordings. All Zoom cloud recordings are permanently deleted after 90 days (though your organization's IT department may have their own policy and process for long-term file retention).

Figure 7

Automatically recording in the cloud means never having to remember to press record



Note. Many additional features and settings options are available when logging into your online account at Zoom.us.

Beware of Zoom Fatigue

Non-verbal overload known as “Zoom Fatigue” has caught on quickly with four possible factors which include cognitive load, close-up eye gaze, limited physical mobility, and constant self-evaluation (Bailenson, 2021). Limited research has been done on the effects of the psychological effects of interacting with these web conferencing platforms for hours on end. Zoom’s interface design transforms everyone in the session to speakers regardless of who the speaker is at any moment (Bailenson, 2021). In regard to cognitive load, nonverbal communication is complex because users must send cues that are intentionally generated (Bailenson, 2021). Whether it is through nodding in an exaggerated way, waving before a meeting officially starts or just as it is ending, or lining yourself up in the middle of the screen with the camera’s view (Bailenson, 2021). Speaking 15% louder exerts more energy as compared to a normal conversational tone as during a traditional face-to-face meeting (Bailenson, 2021). Imagine raising your voice substantially throughout a workday (Bailenson, 2021).

Keeping an unrealistic constant gaze in Zoom gives the feeling of an unrealistic presence. In a face-to-face interaction, people do not hold a constant gaze. This seems to suggest that extraneous cognitive load is exacerbated through the extensive need for sending cues during the virtual setting. However, one study suggests that natural, nonverbal communication in an online setting enhances credibility because of the eye contact between the instructor and learners (Ramlatchan & Watson, 2020). Further research on nonverbal communication in web conferencing is required, especially given the recent explosive growth in platforms like Zoom. When setting up a virtual classroom, ask for feedback from students to determine the student’s comfort level. Provide short breaks during class to allow students to stand and stretch. This feedback can help reduce extraneous cognitive load from their surroundings and allow for better comprehension of the lesson being presented. Studies have shown that when a teacher incorporates a simple and minimalist instructional design, the students contribute more and end up demonstrating higher levels of learning (Hastie et al., 2007).

Summary and Conclusions:
Instructional Message Design and Zoom Best Practices

The foundations of instructional message design can be used to help improve our online web conferencing and virtual classrooms. There are several heuristics to help create effective synchronous, online learning environments (Hastie et al., 2007). Practical experience and applied research provide these best practices for our online teachers:

- Purposefully increasing teacher and student interaction:
    - Online teachers should turn on their cameras during class, and encourage students to also use their cameras,
        - Virtual backgrounds can be used to make students feel more comfortable during class.
        - Your school's privacy policies may let students keep their cameras off, but keep yours on.
    - Encourage students to use their microphones, but it is also okay to let them chat.
- Fostering student cooperation and active learning:
    - Encourage students to ask questions,
    - Ask specific, quiet students to answer questions as needed to keep everyone engaged,
    - Take breaks to avoid Zoom fatigue,
    - Allow students to use the chat to interact with the group,
        - But disable private chats to keep them from inappropriate activity,
        - Also take breaks to monitor the chat, answer or reply to questions, and to also be on the lookout for inappropriate activity.
- Use the technology to provide prompt feedback:
    - Two screens for the teacher tends to be a bit easier, to

manage the Zoom meeting and their/your presentation source at the same time,
  - The Zoom polling feature can be used for short, informal quizzes, to gauge understanding, or for real-time feedback.

- Coaching and facilitating a student's time on a task:

  - Breakout rooms can be used to organize students into activity or project teams, the teacher can then visit each of these rooms to check on the status of each team.

- Communication of expectations at the beginning:

  - Ask students to try to connect from quiet locations and to try to limit on cameras distractions,
  - Ask students to turn on their cameras and mute their microphones,
  - Ask students to be respectful of each other.

- Adapting to diverse talent in real-time:

  - Encourage students to share their ideas, on camera or by sharing their screens,
  - The Zoom whiteboard can also be used to spontaneously share ideas.

- Learning abilities are also part of the instructional strategies:

  - The teacher should turn on Zoom's auto audio captions for learners with special needs,
  - Shy and self conscious students can benefit from the use of chat for communications, they may be more open to sharing their thoughts.
  - Care and consideration should be taken for students who may lack reliable high-speed Internet access at home,
    - Though Zoom does a great job of maximizing available bandwidth, some students may not be able to send camera video or microphone audio.

- Other Zoom best practices:
    - o Do not over clutter your slides (and use dark fonts on light backgrounds, or light fonts on dark backgrounds),
    - o Record your classes and make them available to all students,
    - o Use a passcode to restrict access to your Zoom meetings,
    - o Two screens, displays, or devices for the teacher tends to be a bit easier, to manage the Zoom meeting and their presentation sources at the same time,
    - o Check your camera, microphone, presentation (and any embedded audio and video), unfamiliar Zoom features, and room lighting before class,
    - o Please do not Zoom and drive.

The ability for a student to be able to see their teacher and their teacher's content over the Internet is a powerful idea. This means that web conferencing systems can provide access to students in ways that were never as easy, reliable, or user-friendly. Though care has to be taken to maximize the affordances and effectiveness of applications like Zoom. For instance, extraneous overload and distractions are abundant, many teachers do not use the features effectively, and it is easy for students to feel isolated and alone, and thus lose motivation. Lessons plans, activities, and agendas have to be rethought to reach and keep the attention of online students. Through technology, teachers can recreate much of the face-to-face learning experience, and in some ways do more than what is possible in a traditional classroom. Instructional message design best practices in distraction reduction, using the technology to foster social presence, and the general ease of Zoom to create two-way communication systems, can help us better serve our students. Future research should continue to explore the many ways instructional design, message design, and web conferencing technologies can be used to create effective online learning environments, especially for K-12 learners.

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Chapter 14: Zoom Conferencing Best Practices for Professional Presentations, Conferences, and Events

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14. Zoom Conferencing Best Practices for Professional Presentations, Conferences, and Events

Brian Watkins & Miguel Ramlatchan

Key Points:

- Pre-planning, organization, attention to logistics, and presenter support is critical for complex multi-day, multi-track Zoom webinars and events.
- Pre-configuration and practice with the tools used to deliver a Zoom conference are key to the delivery of an effective presentation.
- Best practices in location, lighting, sound, camera setup, and presentation design are essential to holding the audience's attention and engagement.

Abstract

The adoption and diffusion of online web conferencing has allowed for expanded access to professional seminars, workshops and webinars. However, unlike in-person, face-to-face presentations, delivering a Zoom Meeting or Webinar creates a number of new and different concerns and configuration challenges that are not present in an in-person event. This chapter summarizes instructional message design best practices for Zoom conferencing and serves as a guide for how to set up your computing environment, physical location,

presentation, and how to keep your audience engaged. This section of our instructional message design book also presents a guide to planning for the delivering of more complex events that could feature simultaneous sessions across multiple days to thousands of participants. While Zoom is used to to illustrate the affordances and features of online web conferencing, these best practices can also be used to support events using other platforms.

Introduction

This guide is not meant to be a 'how-to-use Zoom' guide, but rather collects and consolidates the best practices that work for us when we coordinate and support online events. Given today's current climate, experience with limited opportunities for in-person meetings and presentations have escalated the transition to virtual presentations. Giving a presentation online using a web conference application is very different from delivering a presentation in person. A live presentation allows for immediate feedback from the audience, and there are fewer moving parts for something technical to go wrong. Audio and video quality and the availability of technical support are often cited as barriers to communication and the overall decreased effectiveness of meetings and events (McGill & Fidler, 2021; Wooten et al., 2020). Using an online web conferencing application requires one to think differently about the design of the presentation and how to keep the audience engaged.

Zoom is a very popular tool and is used to illustrate the webconferencing and instructional design heuristics in this guide. At the time of this writing Zoom Meetings are a great interactive solution for meetings. Zoom Webinars are great for larger conferences where participants can see presenters but can only interact via chat and Q&A. Zoom Events is an emerging service though is still in its beta testing phase. Many of the lessons learned presented here can apply to all three of Zoom's options. With so many moving parts to a Zoom Meeting or Webinar (computer, Internet, microphone, camera, lighting, location, etc.) the possibility for something to go wrong or to distract is extremely high. To deliver an effective presentation, certain precautions should be taken to minimize or eliminate those issues. Ensuring that a large, complex event goes smoothly requires the support and coordination of the efforts of technical staff, presenters, and participants (Catanzano, et al, 2020; Wlodarczyk, et al., 2020).

Attention should be paid to the design of the presentation so that the message is clear, concise, and easily readable. Delivering a presentation virtually can be distracting. The audience is tempted to work in other applications, look at email, or surf the Internet. It is important to minimize any extraneous cognitive loads as much as possible so that the viewer is motivated to focus on the intrinsic cognitive load, or the message that we are trying to deliver. In this guide a virtual online event is any professional workshop, seminar, symposium, or single-day and multi-day conferences, where event organizers, or facilitators, connect subject matter experts and learners using web conferencing technologies. The applied theories that form the foundation of instructional message design and the real-world experience of virtual and online event management staff, are presented here to inform and assist others planning for their own online events.

Instructional Message Design

Instructional message design is the use of tools, techniques, technology, and instructional design theory and best practice to create communication and learning systems. Zoom and other web conferencing technologies are one example of tools that can be used to connect learners and conference participants with presenters and subject matter experts. Applying research from communications theory, systems theory, cognitive load theory, and multimedia design theory can all lead to best practices in instructional message design for use in web conferencing (Ramlatchan, 2022). Communications theory describes a process where messages are encoded and distributed to devices that can decode those messages, with as little interference as possible. In a web conference this means a focused consideration on the presenter’s audio and video setup, the reliability of their Internet connections, the ability for conference participants to see and understand the message being sent to them, and the ability for participants to interact with presenters. Systems theory teaches us to consider all aspects of the resources, components, subsystems, and processes that lead to our overall system objectives. In complex Zoom events this means considering the needs of presenters, panelists, moderators, question screeners or chat ambassadors, and providing technical support for these participants as well as virtual attendees. Cognitive load theory tells us to reduce extraneous distractions so that our learners can focus their cognitive resources on intrinsic learning. In a Zoom conference that means minimizing distractions potentially caused by bad audio, poor video, and dysfunctional presentation design. Multimedia design theory teaches us that humans learn best when words and visuals are presented together. Applications like Zoom are an effective tool to natively accomplish multimedia presentations through real-time, interactive audio, video camera, and content visuals. We also know from previous research that viewers prefer the online social presence created by seeing both the presenter and the presenter's content at the same time (Ramlatchan & Watson, 2019). Conference participants also appreciate the immediacy and social presence in synchronous online environments (Ramlatchan & Whitehurst, 2019).

These instructional message design best practices can be used to enhance our professional presentation and create effective seminars, workshops, conferences, and other engaging events.

Applied Theory and Best Practices for Delivery of Business or Professional Presentations

Zoom is a cloud-based video or web conferencing service that can be used to virtually meet with others. Delivery of a business or professional presentation using the Zoom Webinar application presents unique challenges for both the presenter and the audience. The technology is ever changing, new features are always being added, and best practices are ever evolving to take advantage of these options. The following are some instructional message design best practices that a presenter can use to minimize technical issues, engage with the audience, and deliver a professional presentation.

Check your Computer

Technical problems will happen. Computers will crash and hard drives and applications will fail, especially at the most inopportune time. There are sometimes no way to predict when any one of these technology issues may happen, but there are steps and measures one can take to minimize computer issues. For instance, the computer(s) being used to host the Zoom presentation should be updated no later than 48-72 hours ahead of the presentation. This will allow for any troubleshooting and/or reinstallation of software that could be causing an issue. Keeping the operating systems of your devices up to date is also generally a secure computing best practice.

Your web conferencing and presentation software should also be updated as far in advance as possible with a minimum of 48-72 hours ahead of time. Caution should be taken when updating an operating system as there can be an unintended domino effect. For example, updating the operating system may require an update of the suite of Microsoft applications or could render an application not compatible. You'll want to test your systems in a live web conference with another online colleague to provide you feedback after you complete any major updates to your device. Also consider having a backup device, an older laptop or a tablet that you can add into the conference if your original experiences an issue. Examples of applications that should be updated, and other device setup considerations to employ prior to an important Zoom presentation include:

- ☐ Your installed Zoom application should be updated to the latest version (use the "Check for Updates" feature in Zoom),
- ☐ Your Presentation applications should be updated (PowerPoint, Keynote, Prezi…etc.),
- ☐ Close out any applications that are not needed, especially large applications that use memory and CPU resources, and applications that will send you alerts during your presentation (e.g. chats, email, Teams, etc.)
- ☐ Turn off screensavers and adjust the device's power settings to keep the device on during your presentation,
- ☐ Disconnect any peripherals not needed during the

presentation.

Internet Connectivity

Nothing can be more disruptive to an online webinar than a disruption or drop in Internet connectivity. Wireless connectivity makes it possible to work from many different locations but also comes with some issues that can disrupt a webinar like network traffic interruptions, susceptibility to interference, and wireless access reliability issues. It is always best to wire your Internet connectivity, a wired Internet connection provides the following benefits:

- ☐ Dedicated bandwidth improves connection stability,
- ☐ A wired Internet connection provides:
    - ☐ Faster Internet access,
    - ☐ Better reliability,
    - ☐ Better security,

If wireless (WiFi) connectivity is the only available option, position the presentation computer to be as close as possible to the network router or wireless access point. To conserve available bandwidth, consider limiting or removing any devices that might be sharing your wireless connectivity.

- ☐ Test your WiFi connectivity (e.g. using a site such as www.speedtest.net),
    - ☐ For minimal connectivity your sustained Internet speed needs to be at least 1 Mbps upload and 600 Kbps download (Zoom, 2022),
- ☐ If you are sharing your WiFi with any other devices, disconnect them until after your presentation,
- ☐ If you are presenting from a hotel or conference center, ask the support staff there for their high speed business or professional grade WiFi services or options (these services will cost more than the free guest WiFi but the success of your presentation is worth the cost).

Location

Location is important; the presenter should be free from any external distractions while trying to present. External noises may also distract the audience from focusing on the presenter and from information that is trying to be conveyed. For the presentation, find a location that is quiet, preferably a room with a door that can be closed. If the presentation is taking place in an office or home office, place a note on the door that says "Live Presentation in Progress". Please, no presentations from moving cars.

- ☐ In general, select a location with few distraction for yourself and the audience,
- ☐ A second monitor (or second device) for presenters is helpful, this way you can see your presentation, video from participants, and the chat at the same time.

Lighting Considerations

Good lighting can make the difference between a dark, grainy video and a bright, high-quality one (Rademacher, 2021). Proper lighting is often overlooked when presenting virtually but it is important to the success of making a connection with the audience and delivering an effective presentation.

- ☐ Position yourself with your light source in front of you,
- ☐ Windows are great light sources, though try not to have a window directly behind you,
- ☐ An LED light ring for your cameras, or just a strategically placed lamp, can significantly improve your camera quality.

It is important to light from the front and not from behind, and remember to keep the lighting source in front of you so it provides for even light and minimizes any shadows. The web camera will try to auto adjust to the light and if the source of the lighting is behind you, then the camera will adjust to the glare. The potential auto adjustment of the webcam can make the presenter appear to be blurred or dark. Dark video (or a presenter who doesn't appear to care about/know to care about their lighting on camera) could negatively impact viewer perceptions of presenter credibility and social presence.

Windows can be tricky. Natural light is the preferred light source as it is balanced and makes you look your best. Try to position yourself with the window in front of you, or consider closing drapes or covering the window if it is creating too much glare in your video image. If natural light is not an option, then using a lamp or LED ring light is preferred. Diffused light is key, this will give you the soft video lighting you need with minimal shadows (Lopez, 2022).

Audio: Headsets & Microphones

Using a headset with a built-in microphone, preferably with noise canceling capabilities, during the presentation can provide a clear and consistent sound. Use of a headset and microphone helps to block out background noise, not only for the audience but for the speaker as well. Most general purpose built-in microphones in computers pick up many sounds in the background. For example, kids screaming, keyboard clacking, mouse clicking, fire truck or police sirens, or the occasional dog barking can likely all be picked up in most laptop microphones. External USB, table-top microphones designed for web conferencing and conference room environments could also be great options for quality audio.

If a headset or microphone is not available, presenting in a smaller room or office could provide better sound quality (Koon, 2021). In addition, smaller rooms help to reduce the “echo” sound from speaking in a larger room. Additionally, a room with rugs, cushioned furniture, bookcases, and other objects will tend to have ‘warmer’ acoustic properties and sound better in a meeting. Also, be careful with the placement of your computer speakers and your microphone, if they are too close together then this could cause distracting audio feedback. When in doubt, test your setup with someone who can let you know how your microphone sounds. In general your audio will sound best when you are comfortably close to your microphone (typically 3 to 4 feet).

If the Internet connection is strong, preferably wired, using voice over Internet protocol (VoIP), or Zoom's "Join with Computer Audio" is a good (actually the preferred) solution. If the Internet connection is slow, or unreliable, your best backup option would be to use a telephone to dial-in (though a phone may not sound as good as your computer's voice over Internet protocol audio). In summary:

- ☐ Try to present from a location with minimal noise and distractions,
- ☐ Consider a noise canceling headset with a built in microphone for noisy environments,
- ☐ USB microphones designed for small conference room environments can be effective,
- ☐ Stay close and speak into to your microphone,
- ☐ Use your phone to dial into the conference if you experience bandwidth related audio issues,
- ☐ Avoid excessive typing or mouse clicks during your presentation,
- ☐ As always, mute your microphone when not in use,

The Visual Background

Backgrounds are great. They can say something about you and your interests, but they can also serve as a distraction to your audience. Remember, the goal is to keep the focus on you and the information that you are trying to convey, and so try to limit distractions in your physical background. The choice of presentation backgrounds are very personal though consider for example:

- ☐ A simple house plant or a vase with flowers to add depth,
- ☐ A painting on the wall to add some visual interest,
- ☐ Light colored walls,
- ☐ Maybe include your framed degrees to add to your credibility,
- ☐ Or use a blurred or virtual background,
    - ☐ This could also be a good option if you would like some consistency in the backgrounds of your presenters and moderators.

- ☐ Consider trying to limit the following items:
  - ☐ Distracting books, toys, or other objects,
  - ☐ Personal pictures,
  - ☐ Posters, unless these objects send an intended message,

It is important to consider the message in your background, similar to clothing selection, consider what you want your background to say? Will having your home library behind you support your credibility? Would flowers and movie posters be more fun and engaging?

Or you could simply use Zoom's ability to blur your physical background or use a virtual background, both are great options if you have any concerns over the unprofessional appearance of your physical background. Though please note that when using a virtual or blurred background, when the presenters move, they can become blurred which would be a distraction to the audience. Virtual backgrounds are helpful and presenters may feel less self conscious about their surrounding and more comfortable during their presentation (Duhart et al., 2020).

Your Camera

Equally as important as the background is the position of the camera. Nothing is worse than a camera that is positioned so that the audience is looking up the nose of a speaker or at the presenter's forehead. Almost just as entertaining as exploring sinus cavities are camera shots of the tops of heads, a tiny person in a corner of their video, half a face, or ghostly silhouettes (also see "Lighting Considerations" a few pages ago). The camera on the laptop or stand-alone camera should be positioned so that it is pointed at or just very slightly above eye level. Even slight deviations from eye level can impact the perceived credibility of the presenter (Ramlatchan & Watson, 2020).

To test how you are positioned on the screen, you can open Zoom, Photo Booth, or another application that uses your camera (Loosvelt, 2020). This will ensure that the camera is positioned correctly, and it will also show any objects that could possibly be distracting. Additionally, make sure you as the speaker are positioned so that the camera is capturing just your shoulders and up. That way the audience can see your eyes and facial expressions. Often the built-in cameras on laptops do not lend themselves well to eye-level camera positions, though propping your laptop to make it sit higher can help. External USB cameras that mount on the top of your laptop, or on top of your workstation monitors, or on its own tabletop tripod could also facilitate better eye-level camera placement. In terms of good instructional message design, being able to communicate with nonverbal cues and facial expressions is one of the key affordances of online web conferencing, these advantages can be maximized with good camera setup. In summary:

- ☐ Keeping your camera eye-level is critical and conveys your credibility and enhances social presence,
- ☐ Plan for a medium shot of yourself, not too close, not too far,
- ☐ Try to keep yourself centered on camera,
- ☐ Preview your video in Zoom before unmuting your video, to confirm that you are portraying yourself the way you would like to be seen.

In the “Settings” menu in your Zoom application, under the “Video” settings, also select “HD” for your camera settings and “Auto” for adjust for low light. These settings will give Zoom a comfortable range of auto-adjustment to changing camera conditions.

Clothing & Jewelry

Clothing is also an important consideration during a Zoom webinar**.** For instance, you don’t want to wear a turtleneck that blends in with your wallpaper and makes you look like a floating head. Stick to monochromatic colors if you really want to wear them (Page, 2020). Clothing items that are acceptable for in-person meetings don’t always translate to the virtual world which can become a distraction to the audience. In terms of message design the presenter should consider the audience and the tone that they want to create during the presentation. For instance, formal business attire to portray subject matter expertise? Business casual to communicate business informality? Or casual dress to communicate fun and engagement? But whatever you decide, please do not make the mistake of not wearing pants.

- ☐ Formal, business casual, or casual dress?
- ☐ Shiny jewelry can cause reflections and noise,
- ☐ In general, with on-camera clothing and jewelry options you still want to avoid distracting your audience from your message.

Also consider your jewelry options, even the shine from an Apple Watch can give the green screen functionality in Zoom issues when processing your virtual background. Jewelry that jingles or otherwise makes noise when you are moving can be picked up in your microphone and can also be distracting.

Importance of Host, Co-hosts, & Alternative Hosts

As other participants, such as conference facilitators, moderators, or other technical staff join the conference, the Zoom host can make them co-hosts. As a co-host, other staff can now also monitor and provide operational and technical support along with the host. An additional colleague or technical person responsible for the computer allows the speaker to focus on delivering the presentation. The co-host or alternative host can also help moderate questions, manage the recordings, or troubleshoot any technical issues. The technical Zoom host can also add other staff and team members as alternative hosts when the meetings and events are originally scheduled in Zoom. Thus, if the original host becomes unexpectedly unavailable (sudden Internet loss, power loss, laptop issues, flat tire on way into office, etc.) then the alternative host can start the event in the host's place. It is always helpful to have business continuity options.

There will be some audience members who will also have technical issues. They may not be able to hear the audio, see the speaker or see the presentation. The tech person can help determine if it is one person or if it is an issue impacting the whole audience and need to stop the presentation. Technical staff serving as the meeting host will typically connect early, confirm the settings of the conference, help test audio, video, and content with presenters and help troubleshoot any issues before the presentation starts. Having a second computer logged in as an audience member will allow the tech staff to see what the audience sees. This is valuable for getting ahead of the issues the audience might be experiencing.

Zoom has an impressive speech to text engine that creates a live transcript for viewers who can benefit from the auto-generated captions. However, this feature of Zoom is very susceptible to diverse accents and audio quality. The result could be a live transcription that reads like bad text messaging. Until the technology catches up, true ADA closed captions that are 98%+ accurate for our learners with specialized needs requires an external service provider who will log into your event and offer live transcription services (some options include https://verbit.ai, https://captionmax.com, & https://www.ai-media.tv).

- ☐ Co-hosts and alternative hosts can help support the host and provide business continuity when unforeseen issues arise:
  - ☐ The host should assign co-hosts during the event,
  - ☐ The host should also assign alternative hosts when events are scheduled,
- ☐ The host sets up the initial configuration of the event, and continues to monitor the event for any technical issues.
- ☐ Live captions:
  - ☐ The host activates Zoom's auto speech-to-text captioning feature,
  - ☐ The host can also schedule and coordinate external ADA captioning services,
- ☐ Technical support staff should have another set of laptops to log into the event as general participants, to help monitor and confirm the participant experience during the event.

Presentation Design & Pace of Presentation

A number of Powerpoint tips, tricks, and techniques can be used to improve our instructional messages. The design and the pace of the presentation plays an important role in keeping the audience's attention. Our viewers learn best when extraneous, distracting material is not included (Mayer, 2014). Thus, if the design is flawed, it can be a distraction, pulling the audience away from its intended purpose. Numerous animations or transitions can also easily be disorienting and annoying. Static bullet points and graphics can summarize information, but hard to read font sizes, bright colors, and too many extraneous graphics will be a distraction. In addition, a slide with a lot of text will also serve to unnecessarily increase intrinsic load. The audience will then tend to focus on (and try to make sense of) the text and may no longer have cognitive resources to focus on the speaker. Mayer's multimedia design principles also teach us that humans learn better from words and pictures than just words alone (Mayer, 2014). Presentation designers should integrate images with words but should be sure that the image helps to enhance or clarify the information. It can also be helpful to have someone preview your slides/presentation, a second set of eyes will have a different perspective than yours will.

Always perform a dress rehearsal and record yourself giving the presentation. Doing so allows you to gauge your pace, adjust the microphone, adjust the camera, listen/see if there are any external noises or distractions in your location, and determine if the presentation has any design flaws. This practice and rehearsal is especially important when your presentation has a time limit. Time yourself when practicing to ensure that you stay well within your given limit, and leave some time at the end for an audience question and answer session. Also be sure before your presentation to close any applications that you are not using so that you do not inadvertently share them during your session.

Equally important to the design of the presentation is the amount of information that is presented. When possible, the material should be designed so that it reduces the amount of extraneous load. Heavy extraneous load leads to the audience missing the important information that is trying to be conveyed. Presenters should also consider the needs of the audience. For instance, viewers on mobile devices would benefit from having the font sizes in presentation slides a little larger than what would be used in a face-to-face presentation on a conference room projector. Other Powerpoint best practices should be followed in addition to appropriate font sizes such as font selection, light fonts on dark backgrounds, or dark fonts on light backgrounds. Please be sure to test any embedded video, audio, or other multimedia components of your presentation early before your presentation session (and remember to select Zoom's 'Share Sound' & 'Optimize for Video' options when Sharing). Instructional message design using PowerPoint can be quickly summarized as:

- ☐ Manage the cognitive load of your audience by dividing the content in your slides into manageable 'chunks',
- ☐ Use appropriate, professional fonts (Times New Roman, Helvetica, or other easily readable fonts), and font sizes,
  - ☐ Do not over saturate your slides with walls of text.
- ☐ Use light color fonts on dark backgrounds, or dark colored fonts on light backgrounds,
- ☐ Eliminate unnecessary distractions from your slides,
- ☐ Embedding multimedia (audio, video, animation) can help foster engagement and motivation in your presentation,
  - ☐ Be sure to test the multimedia in your presentation before your presentation to improve your audience's perception of your credibility.

Audience Attention

In a live presentation, the presenter receives immediate feedback from the audience. Looking over the audience, the presenter can easily tell if they are engaged, heads nodding, eyes focused, and attendees following along. In a Zoom presentation, the audience must view it on their computer which is a distraction. The audience may have other tabs or websites open, may be checking email, or could be working in other applications. The online presenter must work harder to keep the audience's attention. Some instructional message design suggestions to improve audience attention include**:**

- ☐ Welcome your attendees and use your voice to draw attention to the slide,

- ☐ Point out or ask questions about a picture or figure,
- ☐ Make the titles on the slides more descriptive,
- ☐ Frequent movement of slides – you do not want the audience getting bored, if one slide required you to speak for a long time, consider having multiple slides for it.
- ☐ Include multimedia (video, audio, animation) to gain attention, act as an introduction, or describe objects and concepts that move and change over time.
- ☐ Do not include Powerpoint's 'bells and whistles' or noises and animations that do not add to your presentation and could distract or annoy your audience.

If a slide requires the speaker to speak for more than a few minutes, to keep the audience's attention, stop sharing the presentation. This will put the speaker back in full screen mode and help to keep the audience engaged. Including polls, using the built-in whiteboard, planning for breaks in long presentations, and designing places in your presentation to ask questions and engage your audience are other techniques presenters can use to keep their audience's attention.

Best Practices for Professional Conferences and Events

Planning for a professional conference is challenging enough, now add to that online presenters and audiences, and now that conference becomes much more complicated much more quickly. However, the most successful events are those where the conference facilitators and planning teams have paid the greatest attention to detail. While this guide focuses on many of the technical aspects of virtual events, consider Alicia Riley's *The Virtual Event Planner* for a strategic and detailed approach to event planning, including a Run of Show block scheduling technique (Riley, 2021). A systemic task analysis, good project management, and a well organized schedule are essential when elaborate online, virtual events.

For complex events consider having a moderator, question screeners or co-moderators, and a technical host along with the presenters or panelists. In terms of cognitive load, it is tough for a single person to be the content presenter, provide technical support, screen and reply to questions in the chat, and keep the entire conference on track. This workload becomes even harder to manage as the conference audience becomes larger. Having operational support available to presenters in complex events helps alleviate this workload and allows presenters to focus on content, dialog, and discussion and not on event logistics or technology.

To help our events go well it helps to divide the workload and reduce overall workload on our team. For instance, the facilitator in the context of this guide is the conference owner, the client of the technical host, and the overall event organizer. The technical host creates and schedules the meetings, gets those links to our web developers or whoever is organizing the conference launch page. On the day of the event the host logs in early to the meeting or webinar to test audio, video, presentation content, and connectivity before moderators and presenters arrive. A moderator guides and helps the presenters and is often a key member of the overall conference administrator team. While they do not focus on the technical aspects of the meeting, they are involved in the subject matter of the content, introduce the presenters at the beginning of the session, and guide the question and answer activities. In large events it could be difficult for the moderator to focus on guiding the discussion and also monitoring the Zoom chat, the Zoom Q&A, prioritizing questions, and passing questions onto the presenters. In this case it is helpful to have co-moderators or question screeners who can help.

Pre-planning & First Steps

Among the first steps in organizing a professional event or conference is determining the level of online access that presenters and participants will have. Organizing a professional conference is not an easy task. Along with arranging and scheduling presenters, finding a keynote speaker, managing catering, and coordinating needs at the venue, when you add the online virtual component you add another layer or technology complexity. However, the added benefit of extending access to your event to an online audience is the increased outreach, engagement, and involvement of participants who would otherwise not be able to attend. Zoom meetings and webinars can originate from physical conference venues with the inclusion of audio and video systems and reliable Internet connections. This strategy would allow for both a local physical audience as well as an online audience. Preplanning becomes especially important when the setup for these events include multiple cameras, multiple speakers/microphone systems, on location lighting kits, audio mixer systems, and laptops or workstations to connect to and from the Zoom conferences. Or the conference could be completely virtual without a physical venue, and potentially avoid the added cost of facility renting and catering. Confirm that presenters are okay being recorded, depending on your audience there could be more viewers of the anytime, anyplace recording then there were when the event was live. Also consider advanced planning, the sooner you are able to plan and organize the event then the sooner you can begin advertising the event and increasing awareness, registration, and participation.

It is important to note that back to back sessions may require your team setting up one session while another is still in progress. For instance, if our conference keynote starts at 9 am then our technical hosts are probably connecting at 8 am, and moderators, question screeners, presenters, and panelists are connecting between 8:30 and 8:45 am. If multiple concurrent meeting sessions start at 10 am, that means the technical hosts for those are connecting around 9 am to prepare for their new set of moderators, question screeners, presenters, and panelists who are connecting between 9:30 and 9:45 am. To accomplish this smoothly may require a choreography of multiple Zoom licenses and multiple teams of staff who are working multiple simultaneous sessions throughout the conference.

- [ ] Start your pre-planning early, and confirm at least the basics of your conference schedule, this will enable you to announce and advertise your event early to increase registration and attendance.

Registration Systems and Conference Launch Pages

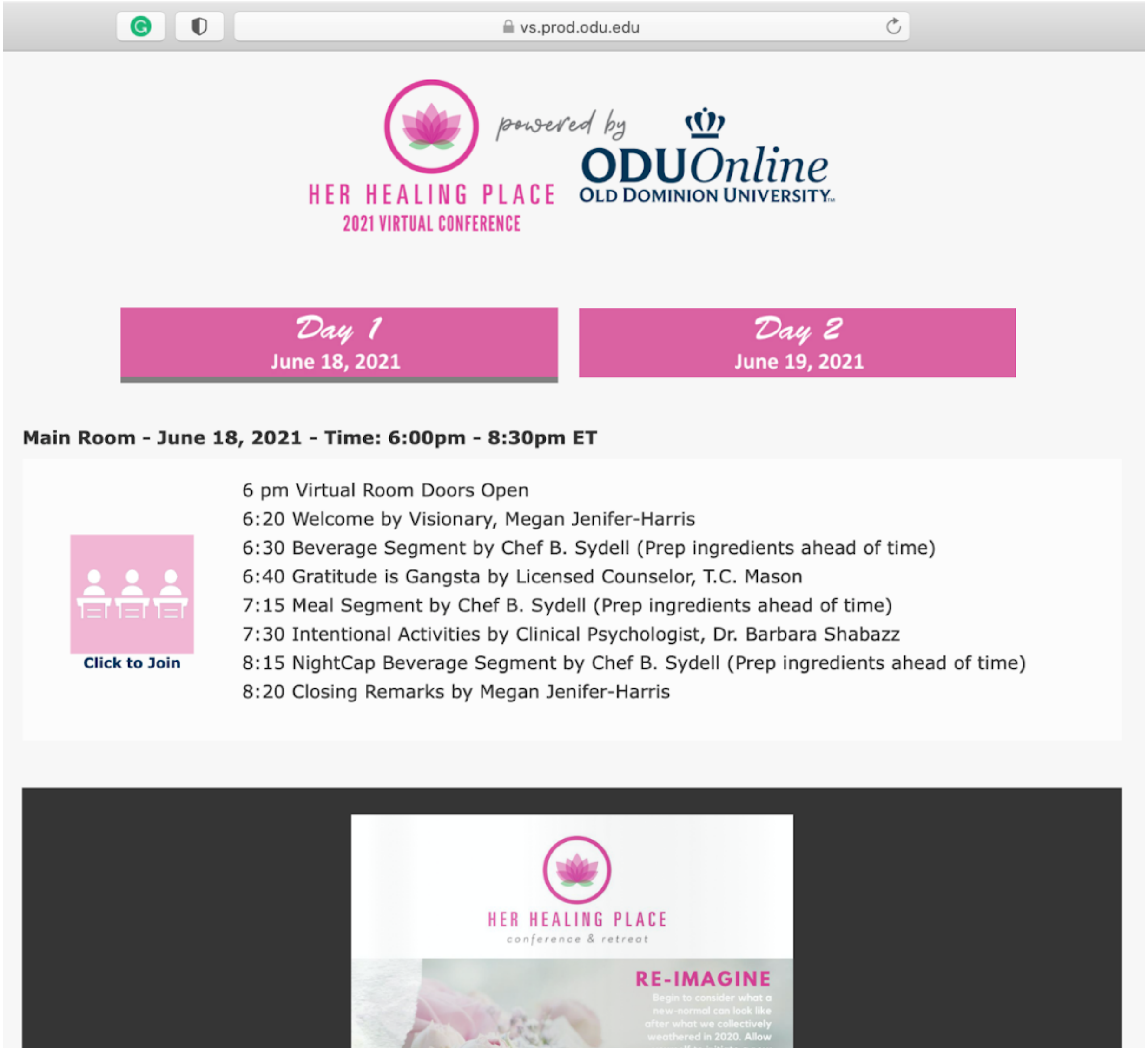
From an instructional message design perspective we want our participants to be able to register as easily as possible and to also be able to find the sessions that they want to attend during the day of the event as easily as possible. There are a number of greate online services where you can organize your event and create a registration system for your attendees such as www.cvent.com, www.eventbrite.com, https://www.webex.com/events.html, and events.zoom.us. The costs of these systems will vary and are typically based on the number of participants in your event. Some platforms will have native integration with the web conferencing system of your choice, or will at least allow you to paste and include the links to pre-arranged conference meetings or webinars. If you have access to a web designer or web developer you could also have your own custom registration systems and launch pages created. The registration process should be minimalist, only collect the demographic and contact information that you need, let attendees register for all or just the sessions that they are interested in, and easily collect payment information if you are charging for this event. Once registered, the system should automatically send the participant the link to the conference launch page.

The conference launch page is the site that participants see when they log into your event. Event attendees should easily be able to find the conference sessions they want to participate in. While it is important for attendees to see descriptions of the sessions, find the names of presenters, and potentially read brief biographies of speakers, care should be taken to not overload and confuse attendees. Access to any technical support services should be available, and recordings should be available from here when the event is complete.

- ☐ Design an easy registration system that will automatically send event login information to newly registered attendees.

Figure 1 illustrates a recent example, where a concerted effort to reduce extraneous load and present a clean, easy to understand conference interface.

Figure 1
Custom Conference Launch Page Example



Note. This example takes an effective, simplistic approach, conference attendees can switch between conference days, and see the schedule of events on each day from the same page. There are no Zoom links for them to remember, participants can scroll down for a digital booklet that describes the conference speakers and conference sessions, and the Zoom links behind the pink 'click to join' button can be changed by web design staff as needed. Not visible in this screenshot are links to vendor rooms and contact information for technical support (used with permission: https://vs.prod.odu.edu/events/her_healing_place/).

Testing and Rehearsals

The affordances of technology enables communication, but our communication systems are deceptively complex and a multitude of things can go wrong - which is why testing is so important. Setup and schedule time before the event for your technical team to connect with your keynote speaker, presenters, and panelists to ensure:

- ☐ A reliable Internet connection from the exact location where they will be connecting on the day of the event,
- ☐ Please ensure that they are connected to this test from the exact device that they will be using on the day of the event,
- ☐ Test their audio, video, and presentation content, especially any multimedia in their presentations, and
- ☐ Test how they receive your audio and video.

For complex events it would be helpful to have a rehearsal that goes beyond just technology testing. A rehearsal session before the actual event would be especially helpful to confirm that session moderators, question screeners, and technical hosts are all sure what each other are responsible for on the day of the event. Practicing the question and answer session, where question screeners pick the best questions to either answer themselves or pass them onto the moderator to ask of the presenters via private chat, will help the team become comfortable with event logistics.

The Day of the Event

Goal of the pre-planning, testing, and rehearsing is so that the day of the event goes as smoothly as possible. While these items have been discussed earlier in the chapter, here they are presented in convenient checklist format as the day of the event is when these need to happen:

Technical Hosts:

- ☐ Connect early (typically 60 to 30 minutes early depending on event complexity),

    - ☐ It can often be helpful to also connect with another device to serve as an attendee or another presenters,

- ☐ Confirm audio and video, especially if a presenting from a venue where cameras systems and audio systems had to be setup,
- ☐ Confirm conference settings such as:
    - ☐ Breakout rooms enabled (if they will be used)
    - ☐ Speaker View (based on preferences of the facilitator or moderator),
    - ☐ Spotlight Presenters Video (and whoever has a speaking role),
    - ☐ Enable mute of all participants upon entry,
    - ☐ Allow presenters to share screens, but disable participants can share screen,
    - ☐ Enable Waiting Room (allows presenters to setup and practice without attendees seeing them),
    - ☐ Turn on Zoom "Live Transcript" & "Enable Auto-Transcription".
- ☐ When the presenters connect, test their audio, video, and presentations,
    - ☐ If the presenters have multimedia (Audio, video, and/or animations) in their presentations ask them to select Zoom's "Share Sound" & "Optimize for Video" when Sharing.
- ☐ Be prepared to help the presenters, moderators, question screeners with any last minute technical issues,
- ☐ Start the conference once the presenters and moderators are ready,
    - ☐ By ending the Zoom Meeting's "Waiting Room", or
    - ☐ By starting the Zoom Webinar and ending the Practice Session.
- ☐ Double check that the Meeting or Event is being recorded,
- ☐ Also be prepared to monitor the ongoing session, the chat, and the Q&A for any participants having any issues,

provide help as best you can, and refer those participants to technical support as needed,

- ☐ Mute participants (attendees and presenters/moderators) audio and video, as needed (e.g. when they forget and leave themselves unmuted),
- ☐ Remove unprofessional participants, as needed.
- ☐ Communicate with moderators, question screeners, and other panelists/presenters via the private chat, as needed.

For Moderators and Co-moderators:

- ☐ Connect early (typically 10-15 minutes early) and check-in with the technical host,
- ☐ Wait for the presenters and panelists to connect and confirm that any last minute needs are met,
- ☐ Ask the presenter to share their presentation, especially the opening slide.
- ☐ A few minutes before the event start time,
    - ☐ Confirm that the presenters are ready, and
    - ☐ Confirm with the technical host that they can now let participants in from the Zoom Meeting's Waiting Room, or starting the Zoom Webinar.
- ☐ As you start the event,
    - ☐ Turn on your camera,
    - ☐ Unmute your audio,
    - ☐ Introduce the presenters to the audience,
    - ☐ Turn the session over to the presenters,
    - ☐ Turn off your camera and mute your microphone until needed again.
- ☐ Monitor the chat and Q&A during the presentation and answer or ask questions from participants to the presenters as needed,
    - ☐ Also be on the lookout for private chats from question screeners.
- ☐ To keep the session on time it may be necessary to gently interrupt the presenters to alert them of their remaining time.

        - ☐ Typically at the predetermined start of audience Q&A, or
        - ☐ About 5 to 10 minutes from the end of the session.
    - ☐ At the end of the session,
        - ☐ Thank the presenters and attendees, and
        - ☐ Let participants know where to go for the next session.

For Question Screeners or Co-moderators:

- ☐ Connect early (typically 10-15 minutes early) and check-in with the technical host and moderators,
- ☐ Monitor the Zoom chat and answer any questions that arise there,
- ☐ During the presentation, prioritize and send relevant questions to the moderator via the private chat functionality in Zoom (the moderator can then verbally answer these questions or pass the questions onto the presenters).
- ☐ Keep your camera off and microphone muted during the presentation, unless you need to step in to help the moderator.

Recordings and Attendance Reports

After the event is complete you will ideally want to capitalize and build on the event's momentum by having the recordings of your event's sessions ready as soon as reasonable. This way attendees who missed sessions have access to the content while it is still fresh and relevant. Some video editing may be required to remove any presenters practicing, extraneous moderator and presenter discussion, or dead time from the beginning of the recording. We typically want the playback of the file to start a few seconds before the moderator starts to introduce the presenter to give the most professional appearance. Large, day-long files where multiple sessions were recorded onto a single file may need to be segmented into the individual presentations. These final files can then be added to a content distribution service provider (e.g. Youtube, Vimeo, Kaltura, etc.). Some registration and event hosting platforms (e.g. Webex Events, Zoom Events, others) will let you host the recordings from the same online location where participants accessed the links of the live sessions. Offering the recordings from the same conference launch page reduces confusion and is much more convenient for viewers. Also consider presenting the recording such that viewers can see both the video of the presenters as well as the visuals of the presenter's content or slides. In summary, after the event the final steps are to:

- ☐ Edit the recordings,
- ☐ Post the recordings and inform participants of their availability,
- ☐ Send final attendance reports to the conference organizers,
- ☐ Gather feedback and lessons learned from the event, and apply those lessons on the next project.

After the event it will also be helpful to send to the conference facilitators and organizers the event attendance reports. This data is important, can tell organizers which sessions were well attended, give an indicator of overall event success, and help with planning for future events. Be sure to ask the events organizers how the event went from their perspective, and for ways the event could have gone better. Sending feedback surveys to participants is also a great way to collect data and can let organizers know the effectiveness of the event.

Conclusions

While Zoom is used as our example, the best practices presented in this guide can be applied to Cisco Webex, Google Hangouts, Microsoft Teams, or any of the newly emerging web conferencing technologies. These are only some of the ways one can prepare to host a Zoom conference and deliver an effective presentation. Technical problems are going to happen; computers will crash, applications will freeze, and Internet connections will fail at the most inopportune time. Following these best practices will not eliminate any of these problems from happening, but they do give you a higher probability for success. Viewers of a Zoom conference presentation are susceptible to many distractions. Following these best practices will also help to keep the audience engaged and focused on the message being delivered. For instance, keeping your camera eye-level, having a great looking background, having your light source in front of you, and having a good quality microphone system will help ensure a professional looking presentation.

Being able to participate in a relevant, professional development conference and engaging with colleagues from home without having to travel is an attractive option. However, the key to successful events is organization and preplanning. Preparing and organizing your technical support, moderators, question screeners, presenters, and panelists will go a long way towards a successful and effective online event. Face-to-face event organizers were making themselves available online even before COVID increased the general adoption and diffusion of web conferencing technologies like Zoom. Having a virtual hybrid registration option can increase your audience size during the event, continue audience engagement after the event with viewers of the recordings, and enhance the overall outreach of your conference. While the specifics of your events will dictate the custom setup of your seminar, workshop, or conference, we present what works well in our experience and hope that these instructional message design insights help your event be successful!

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