The Impact of Textual Display Strategies on Learning from Electronic Presentations

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ABSTRACT

An increasing number of students are learning in classrooms that employ electronic presentations designed in PowerPoint and other similar software programs. The design of the slides in such electronic presentations has an impact upon student learning, and ample recommendations are made within the literature as to specific strategies that serve as presumed best practices for the design of those slides that will best facilitate learning. While most of such recommended strategies are well supported by cognitive theory – they are considered to positively impact learning by contributing to decreased cognitive load, leveraged dual coding, and facilitated active processing, for example – many of them are not supported by empirical evidence that they do in fact enhance learning. Some of the recommended best practice strategies unsupported by empirical evidence include the use of progressive disclosure, dimming, and highlighting of text instead of full disclosure of text. Through the development and use of four separate electronic presentations, each of which was designed to employ one of these specific strategies (full disclosure, progressive disclosure, dimming, and highlighting), this study examined the impact of such strategies on student learning. The findings of this study indicate that significant differences are not evident in learning among the four different strategies. As such, this initial foray into the examination of the effectiveness of these four strategies indicates that any of the four strategies may be used with equal impact in the design of electronic presentations by instructors who want to help foster student learning.

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GENERAL AUDIENCE ABSTRACT

An increasing number of students are learning in classrooms that employ electronic presentations designed in PowerPoint and other similar software programs. The design of the slides in such electronic presentations has an impact upon student learning, and ample recommendations are made within the literature as to specific strategies that serve as presumed best practices for the design of those slides that will best facilitate learning. While most of such recommended strategies are well supported by cognitive theory, many of them are not supported by empirical evidence that they do in fact enhance learning. Some of the recommended best practice strategies unsupported by empirical evidence include the use of progressive disclosure, dimming, and highlighting of text instead of full disclosure of text. Through the development and use of four separate electronic presentations, each of which was designed to employ one of these specific strategies (full disclosure, progressive disclosure, dimming, and highlighting), this study examined the impact of such strategies on student learning. The findings of this study indicate that significant differences are not evident in learning among the four different strategies. As such, this initial foray into the examination of the effectiveness of these four strategies indicates that any of the four strategies may be used with equal impact in the design of electronic presentations by instructors who want to help foster student learning

Dedication

To my mother, Marion Edytha Demers, whose love and spirit I carry with me everywhere I go.

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Table of Contents

Chapter 1: Introduction and Need for the Study

Introduction

The use of electronic technology in the classroom has become the norm over the last couple of decades (Hill, Arford, Lubitow, & Smollin, 2012). Among other electronic platforms, instructors are using course management systems, screen capture software, and electronic presentation software (such as Microsoft PowerPoint) as the process of teaching and learning has come to include more digital artifacts that are housed in online environments and disseminated in different ways in the classroom. Institutions of higher education have both led and sustained that charge, devoting ample money and other resources to acquiring such technology and making it available to faculty, as well as updating instructional spaces to be able to accommodate its use with students (Young, 2004).

For any given technology, it is not *whether* that technology is used in the classroom that impacts student learning, but rather *how* that technology is used for instructional purposes (Clark, 1983). In the case of PowerPoint and other electronic presentation software (e.g., Prezi, Google Slides), then, attention must be paid to how such software is used in the classroom if it is indeed going to positively lend itself to the facilitation of student learning. This focus further necessitates that attention must also be paid to what aspects of electronic presentation slide design positively impact learning.

Problem Statement

The ubiquitousness of electronic presentation software in the classroom has led to the identification and wide dissemination of numerous presumed best practice recommendations for the design of electronic presentation slides for instructional purposes. A majority of such presumed best practices recommended in the literature are supported by cognitive theory; they will, it is espoused, facilitate learning by, for example, decreasing cognitive load (e.g., Chandler & Sweller, 1991), leveraging dual coding (e.g., Levasseur and Sawyer, 2006), and/or increasing active processing for learners (e.g., Mayer & Moreno, 2003). At the same time, however, many are not supported by empirical evidence showing that they will facilitate learning as it is theorized they will. This leads to the question: How does the design of electronic presentation slides impact student learning?

Background Information and Need for the Study

Theoretical and empirical knowledge of human learning informs the fields of instructional design and message design; for example, cognitive load (Chandler & Sweller, 1991), dual coding theory (Paivio, 1986), and active learning and processing (Mayer & Moreno, 2005). Unfortunately, this knowledge – particularly empirical knowledge – is not always evident in the literature relative to recommended presumed electronic presentation slide design best practices for the purpose of facilitating learning. One such recommendation is *progressive textual disclosure* – the step-by-step revealing of text content on electronic slides timed with the beginning of its verbal address by a live instructor or in recorded narration. A second recommendation is the subsequent *"dimming" of text* – using a gray or more subtle font color to make a piece of textual content (often in the form of a bulleted line of text) less prominent than other text on the slide, timed with the ending of its verbal address as the narration (live or recorded) of the slide moves away from that content to, often, the next bulleted piece of content. A third recommendation is the *highlighting of text* – the step-by-step "highlighting" of specific text content on electronic slides timed with its verbal address in live or recorded narration. Such highlighting may be achieved through the use of bolded text type, larger font size, and/or brighter (more prominent) font color. Progressive disclosure, dimming, and highlighting are each often recommended as presumed best practices for electronic slide design (e.g., Broderick, 2003; Collins, 2004; Mollerup, 2014), but without any empirical human learning evidence to support their recommended use.

One exception is Mahar, Yaylacicegi, and Janicki (2009), who studied student learning differences across two treatments, one of which used progressive disclosure of all content, which in this case included text, bullets, and images; and the other of which used full disclosure of those same three types of design elements. As opposed to progressive disclosure, full disclosure of content involved complete disclosure of all of a slide's content at one time; there were no differences in the timing of the revelation of a slide's distinct bulleted text items or images, and there was no movement of any content onto the screen; each slide was static in nature. (When the slide appeared on the screen, all of the content that would ever be visible on that slide was visible, and all of it remained visible during the narration of the entire slide.) In Mahar et al. (2009), there were also no differences, for any of the full disclosure slides, in text attributes such as font size or color; all of a slide's bulleted textual content was presented in the same size and color, and was thus equally visually prominent on the slide. Findings were that students exposed to the static full disclosure slides learned *more* than did those exposed to slides with progressive disclosure (Mahar et al., 2009).

Mahar et al. (2009), however, conflated text and graphics in their study examining the impacts of progressive disclosure on student learning, using both design elements (text and graphics) on the same slide but not distinguishing the impact of each one (and its progressive or full disclosure) upon learning. This conflation leaves the question of what would be the impact of the progressive disclosure of either text or graphics alone. The purpose of this current study was to begin to examine this question, addressing slides with text only and investigating therein the differences in student learning relative to four various strategies of textual display: specifically, the aforementioned full disclosure, progressive disclosure, dimming, and highlighting. Through this examination, this study thus provides empirical evidence relative to the best practice recommendations of using progressive disclosure of text, dimming, and highlighting in lieu of full disclosure of text.

In an instructional environment with content delivered via a narrated electronic presentation – specifically, a sequence of PowerPoint slides and voice narration – this study examined differences in student learning relative to these four different textual display treatments.

Relevant Terminology

Terminology relevant to this study is identified and defined within this section.

Electronic Presentation

A slideshow – a series of slides created in Microsoft PowerPoint or a similar software program (such as Prezi or Google Slides) – that combines "sequences of words and pictures that help tell a story or help support a speech or public presentation of information" (Rouse, 2011, para. 1). More specifically, slideshows may include any combination of text, images, graphs, videos, and/or any other forms of media. The four electronic presentations used within this study were created in Microsoft PowerPoint and each integrates PowerPoint slides including visual textual content (i.e., words and phrases) with auditory content in the form of a recorded narration.

Textual Display

The act of disclosing, showing, or revealing instructional content in the form of text (i.e., typed words) on a slide in an electronic presentation. Textual display is achieved in various ways related to the size, color, and font style of the text, as well as the timing of the text's revelation on, and duration of visibility on, a given slide. The four textual display treatments within this study include full disclosure, progressive disclosure, dimming, and highlighting.

Message Design

The design of individual messages – "information conveyed . . . in a single context on one occasion" (Pettersson, 2012, p. 94) – between the person sending the information and the person receiving the information. Primary components of such messages include visuals, words, and forms, and the tools their design employs include graphic design, sound, pictures, text, and other symbols (Pettersson, 2009, 2012).

Instructional Message Design

The design of individual messages specifically "for the purpose of modifying the psychomotor, cognitive, or affective behavior of one or more persons" (Fleming & Levie, 1993, p. x) through "a deliberate process of analysis and synthesis that begins with an instructional problem and concludes with a concrete plan or blueprint for a solution" (Fleming & Levie, 1993, p. x).

Cognitive Load Theory

A theory in cognitive psychology grounded in the idea that the amount of information that learners' working memory can process at a given time is limited (Chandler & Sweller, 1991). Cognitive load theory has been "designed to provide guidelines intended to assist in the presentation of information in a manner that encourages learner activities that optimize intellectual performance" (Sweller, Merrienboer, & Paas, 1998, p. 257).

Dual Coding Theory

A theory in cognitive psychology that two separate human systems are responsible for the processing of visual and auditory information (Paivio, 1986). Essentially, when visual information is misaligned with verbal information presented at the same time (that is, when content presented visually is not the same as content simultaneously presented auditorily), they compete for limited cognitive resources. When visual and verbal information are aligned, however, the dual representations do not require additional cognitive resources and are integrated into a more coherent whole.

Cognitive Theory of Multimedia Learning

A theory in cognitive psychology that rests upon three assumptions impacting human learning relative to multimedia: (a) the dual-channel assumption (dual coding theory), that separate channels are used for processing visual and auditory information; (b) the limited-capacity assumption (cognitive load theory), that the amount of information that may be processed by each of those two channels at one given time is limited; and (c) the active-processing assumption, that meaningful learning requires active processing participation on the part of the learner (Mayer, 2001; Mayer, 2002; Mayer & Moreno, 2003).

Cueing

A strategy used in the design of multimedia for instructional purposes that involves manipulation of "visuospatial characteristics of instructional materials in order to help learners in selecting relevant information" (De Koning et al., p. 114). Two specific types of cueing are relevant to this study: "stimulus-driven attention shifts" (Franconeri & Simons, 2003, p. 999), relating to the onset of motion of content onto a screen that captures learners' attention (Abrams & Christ, 2003; Franconeri & Simons, 2003); and typographical signaling (Mautone & Mayer, 2001), potentially involving the coloring, italicization, or bolding of text to "directly focus attention to the relevant words, making the words, and the content they describe, visually distinguishable from other text" (Mautone & Mayer, 2001, p. 378).

Step Size

The average number of words visible on a slide in an electronic presentation at one given time to the learner (Holland, 1965). Step size varies between electronic presentations, as it is dependent upon the textual display and disclosure strategies employed within the design of each presentation.

Amplification of Text

The deliberate use of specific textual features to "attract and direct [learners'] attention to specific screen parts or text" (Rieber, 1994, p. 191) in an electronic presentation. Amplification of text may be achieved in numerous ways, including but not limited to the use of bolded typefaces, varying text colors and brightness, and different font sizes (Park & Hannafin, 1993; Rieber, 1994).

Display Time

The amount of time a given piece of content (e.g., a bulleted line of text) is visible on the screen to the learner in an electronic presentation (Avons & Phillips, 1990; Ross & Moeller, 1996). Display time varies between electronic presentations, as it is dependent upon the textual display strategies employed within the design of each presentation.

Animation of Text

The movement of content onto or away from the screen in an electronic presentation (as text enters or exits a slide), or changes to the qualities of the text such as its color, font size, or positioning on the slide (Mayer, 2005).

Synchronized Multiple-Channel Communication

The temporal synchronization of auditory and visual information relative to the same content within an electronic presentation (Moore, Burton, & Myers, 1996). Synchronized multiple-channel communication is used in the design of some, but not all, electronic presentations in the study.

Research Questions

This study examined the following broad research question, as well as the specific narrower research questions listed and enumerated below: What is the impact on student learning of various textual display treatments in electronic presentations? Within this study, the dependent variable was student learning, as measured by participant scores on an assessment. The independent variable was textual display format, and it included four levels: full disclosure, progressive disclosure, dimming, and highlighting.

Specific research questions included:

1. Is there a difference in learning from electronic presentations involving full disclosure vs. progressive disclosure of text?
2. Is there a difference in learning from electronic presentations involving full disclosure vs. dimming of text?
3. Is there a difference in learning from electronic presentations involving full disclosure vs. highlighting of text?
4. Is there a difference in learning from electronic presentations involving progressive disclosure vs. dimming of text?
5. Is there a difference in learning from electronic presentations involving progressive disclosure vs. highlighting of text?

6. Is there a difference in learning from electronic presentations involving dimming of text vs. highlighting of text?

Significance of the Study

Instructors use electronic presentation software (including PowerPoint) frequently, and the percentage of instructors who use electronic presentations in the classroom increases among junior-level faculty such as graduate teaching assistants and assistant professors relative to more senior-level faculty such as associate and full professors (Hill et al., 2012). Despite frequently reporting having experienced learning with electronic presentations as students themselves, faculty primarily identify that they learned to use the software in the role of instructor on their own, without specific support from their institutions or colleagues (Hertz, Woerkum, & Kerkhof, 2015). As such, how their slides may best be designed to facilitate learning in their classrooms is left for them either to discern on their own, by conducting searches for recommended presumed best practices, or to not explore at all. For those who search for advice, in mainstream literature there exist numerous presumed best practice recommendations relative to the design of electronic slides for instructional purposes. While these recommendations are in most cases well grounded in cognitive theory, they tend to not be based upon empirical evidence and are, in at least one case (i.e., progressive disclosure), made in light of contradictory empirical evidence. This study thus serves to provide previously lacking empirical evidence relative to three such best practice recommendations often made within the literature: to use progressive disclosure, dimming, and highlighting of presentation text instead of full disclosure of textual content.

Chapter 2: Review of the Literature

Introduction

Since its release to the general public in 1990, electronic presentation software (such as Microsoft PowerPoint) as a supplement to lecture has become one of the most used instructional tools in college teaching. Indeed, 75% of college-level instructors identified themselves as using PowerPoint for instructional purposes at least a moderate amount of time (Hill et al., 2012). Students report having come to expect its use in their classrooms, as well as preferring that it be used therein (e.g., Beets & Lobingier, 2001); and instructors report an awareness of such preferences and expectations (Hertz et al., 2015), as well as a desire to meet such expectations (Hill et al., 2012). However, students who report a preference for PowerPoint in the classroom have also largely been found to experience no increases in learning when PowerPoint is used in comparison to when other content delivery methods such as lecture are used (e.g., Susskind, 2008). Clark (1983) declared that the impact of any particular medium on student learning is dependent upon *how* that medium is used in the classroom, rather than upon the mere fact that it *is* used in the classroom. As such, how PowerPoint and other electronic presentation software are used in the classroom matters relative to student learning, and how electronic presentation slides should be designed to facilitate learning requires specific investigation. An exploration of this topic necessarily involves examining elements of message design and principles of cognitive psychology.

After a brief identification of what is meant by the term “electronic presentations” for the purposes of this dissertation, this chapter includes an introduction to how message design has been formally defined, and how it is defined relative to the purpose of instruction. It further provides an introduction to key cognitive psychology principles at the heart of electronic presentation slide design, as well as to the strategy of cueing, which is often used in the design of electronic presentations to leverage benefits relative to learning that have been linked to those cognitive psychology principles.

Electronic Presentations

Electronic presentation software is designed to help users – typically developers of presentations or the presenters themselves – “create sequences of words and pictures that help tell a story or help support a speech or public presentation of information” (Rouse, 2011, para. 1). As a whole, Levasseur and Sawyer (2006) identified such software as having “become a pervasive communication medium” (p. 101). Since its initial release in 1990, Microsoft’s PowerPoint has emerged as one of the most often used electronic presentation software products (Microsoft PowerPoint, n.d.). A testament to its popularity and rampant use is the idea that “today, watching a business presentation without accompanying PowerPoint slides is like watching a film without sound” (Levasseur & Sawyer, 2006, p. 101). Although it was first used primarily within the business sector, postsecondary educational institution classrooms have joined the ranks of corporate boardrooms; over time, PowerPoint “has become entrenched in the academy. From accounting to geology, it is now a common feature of academic instruction” (Hill et al., 2012, p. 242). The research documented in this chapter broadly considered electronic presentations. While the research did not singularly focus on PowerPoint, much of the published literature targets PowerPoint and its use in teaching and learning because of its prevalence in the classroom; indeed, Kinchin (2006) identified it as the tool of choice among lecturers for visually supporting their classroom content delivery.

Institutions have made it easy for that choice to be made by their faculty with their own response to the increase in technology available for use in education. Indeed, they have invested significant amounts of monetary funds in the development of "smart classrooms" (Young, 2004) that house assets and resources supporting the instructional use of various types of technology. Such classrooms facilitate instructors' use of PowerPoint and other electronic presentation software, providing projectors and screens and/or boards onto which presentations may be projected. Further, the application of technology as a whole – including electronic presentation software – within education now exceeds the use of more traditional instructional methods (Abdelrahman, Attaran, & Hai-Leng, 2013).

Message Design

In general, message design concerns the design of individual messages – "information conveyed . . . in a single context on one occasion" (Pettersson, 2012, p. 94) – between the person sending the information and the person receiving the information. Primary components of such messages include visuals, words, and forms, and the tools their design employs include graphic design, sound, pictures, text, and other symbols (Pettersson, 2009, 2012). Fleming and Levie (1993) identified that when such messages are designed "for the purpose of modifying the psychomotor, cognitive, or affective behavior of one or more persons" (p. x) through "a deliberate process of analysis and synthesis that begins with an instructional problem and concludes with a concrete plan or blueprint for a solution" (p. x), the process and focus therein are one of *instructional* message design. Instructional message design may be considered the "specification and manipulation of media for the purpose of supporting learning" (Spector, Merrill, Elen, & Bishop, 2014, p. 959) that occurs both prior to and during instruction, regardless of the type of media employed. Indeed, Larson and Lockee (2014) interpreted instructional message design broadly to "include all forms of information presentation, from the spoken word to virtual worlds – all possible types of educational communication" (p. 304), while Lohr (2008) called instructional message design "the art and science" (p. 29) of that communication's format for the purpose of instruction. Instructional message design, then, is an intentional process of presenting information – in various forms, including text and images – in a way that facilitates learning for those receiving the information.

A final point of focus is on that intentional nature of instructional message design. Pivotal is the idea that relative to instruction, "message design and delivery is not an afterthought. It's something you think about from the very moment you begin an instructional project" (Larson & Lockee, 2014, p. 203). Within the role of message design relative to instructional strategy as "planning for the physical part of the presentation part of an instructional strategy" (Seels, 1996, p. 691), then, instructors' good intentions must be paired with message design principles and learning principles in the creation of electronic slide presentations that facilitate learning. Such learning principles include, but are not limited to, the cognitive principles surrounding the facilitation of attention, perception, processing, and memory that Pettersson (2012) identifies as fundamental to the design of materials for the purpose of teaching and learning. In discussing subprinciples related to perception, for example, Will (1993) noted that although learner attention is generally drawn to contrast, "great care should be given to the structural properties of messages that affect perceptual organization . . . [including] the relative placement, size, and dominance of objects in the visual field, and the way the eye is 'led' over [instructional content] by various techniques of composition" (p. 56). Cueing – a strategy discussed throughout this document – is one method that may be used to help "lead" the eyes of learners to specific instructional content by drawing their attention to that content at a particular time. In discussing subprinciples related to memory, Hannafin and Hooper (1993) state that learners are likely to better remember text that has been logically organized. Chunking (Lidwell, Holden, & Butler,

2003) – another strategy mentioned throughout this document – is but one way of logically organizing the instructional content included in a presentation.

For the purposes of this dissertation, the physical aspect of the presentation mentioned above by Seels (1996) is the visual electronic presentation itself, designed to be projected to learners in conjunction with narration in the form of a spoken presentation from the instructor or a recorded narrative.

Key Cognitive Psychology Principles

General message design has been described as a field of knowledge fed from "more than fifty established disciplines, subject matters, and areas of research" (Pettersson, 2009, p. 39), including the behavioral and cognitive psychology disciplines. Lohr addressed the extension of this interdisciplinary nature to instructional message design, identifying instructional message design as "applying a variety of theories (perception, learning, communication and systems) to the design and evaluation of instructional media" (as cited in Wang & Shen, 2012, p. 561.) Instructional message design's roots in such theories speak to the fact that "when a message is intended to be instructional, great care must go into planning for the content and form that will attract attention and facilitate perception, comprehension, and retention" (Seels, 1996, p. 689). As such, several learning and cognition principles are prevalent within the literature surrounding both instructional message design and the design of electronic presentations for instructional purposes.

Indeed, the challenge in designing any instructional content is "to build lessons in ways that are compatible with human learning processes. To be effective, instructional strategies must support these processes. That is, they must foster the psychological events necessary for learning" (Clark & Mayer, 2016, p. 24). Key cognitive principles and theories – relative to what we have come to know about how humans learn – relevant to the subsequent discussion in this chapter are explained below, including cognitive load theory, dual coding theory, and a cognitive theory of multimedia learning. Therein, connections are also made to some instructional design strategies that are supported by those theories.

Cognitive load theory. One of the most commonly encountered theories in the literature relative to the design of electronic presentations for teaching and learning is cognitive load theory. Cognitive load "reflects the cognitive and working memory resources required to complete a given task" (Terry, Doolittle, Scheer, & McNeill, 2004, p. 90), and cognitive load theory is grounded in the idea that the amount of information that learners' working memory can process at a given time is limited (Chandler & Sweller, 1991). Given such limitations, consideration of cognitive load in instructional message design – including the design of electronic presentations – impacts learners' experience. Cognitive load theory has, in fact, "been designed to provide guidelines intended to assist in the presentation of information in a manner that encourages learner activities that optimize intellectual performance" (Sweller et al., 1998, p. 257).

Cognitive load is sensitive to demands that are intrinsic, which is the load inherent in the completion of a given learning task and tied to its complexity and the content included therein; extraneous, which is the load created by unnecessary and competing noise tied to the method and design of an instructional presentation that serves as a detriment to learning; and germane, which is the load necessary to the development of more effective strategies for task completion over time and that which facilitates long-term learning (Sweller, 2010). As such, materials designed for the purpose of instruction are considered to place three specific types of cognitive load on the learner: *intrinsic cognitive load*, *germane (or effective) cognitive load*, and *extraneous (or* *ineffective) cognitive load* (Paas, Renkl, & Sweller, 2003). These three individual types of cognitive load "may be summed to obtain a *total cognitive load* . . . the total cognitive and working memory resources necessary to complete a given task" (Terry et al., 2004, p. 92). Intrinsic load may not be manipulated – it may be neither increased nor decreased – by decisions relative to the design of instructional materials. Extraneous load, however, may be so manipulated via decisions about the initial design and subsequent presentation of instructional materials; and its resulting increase or decrease inversely impacts germane load, such that when extraneous load is reduced, germane load is increased, thereby allowing for more cognitive processing (Terry et al., 2004).

Electronic presentations, then, can be strategically designed to increase germane load through the reduction of extraneous load (Leacock & Nesbit, 2007) by, for example, placing "images, spoken language and printed words in appropriate combinations to maximize the instructional effectiveness" (Wang & Shen, 2012, p. 563) of the presentations. A learner experiences cognitive overload when cognitive processing demands exceed available cognitive capacity (Mayer & Moreno, 2003). Since PowerPoint has begun to play such a significant role in classroom teaching and learning, the term "PowerPoint overload" has emerged, and has been described in part by Yilmazel-Sahin (2009) as the result of subjecting learners to PowerPoint slides that "are overloaded with information in such a way that students feel overwhelmed and unable to cope" (p. 363).

Specific strategies to help presentation designers mitigate cognitive overload are offered in the literature. Mayer and Moreno (2003), for example, suggest synchronizing the presentation of visual and auditory information that correspond to each other. This strategy helps to minimize cognitive load by decreasing the demands placed upon working memory. Other instructional design strategies also help to ensure appropriate, manageable cognitive load. Chunking text, or meaningfully "combining many units of information into a limited number of units or chunks" (Lidwell et al., 2003, p. 40), is one such strategy that minimizes the amount of information in working memory at a given time. Similarly, focusing on minimizing the amount of text that is presented during instruction also serves to decrease cognitive load. Using keywords and phrases in lieu of full sentences in a visual presentation that is accompanied by an auditory narrative expanding on those keywords and phrases is a specific example of how this strategy may be achieved.

Dual coding theory. Another of the most commonly encountered theories in the literature on instructional message design and the specific design of electronic presentations for instructional purposes is dual coding theory, the primary tenet of which is that two separate systems are responsible for the processing of visual and auditory information (Paivio, 1986). Essentially, when visual information is misaligned with verbal information presented at the same time (that is, when content presented visually is not the same as content simultaneously presented auditorily), they compete for limited cognitive resources. When visual and verbal information are aligned, however, the dual representations do not require additional cognitive resources and are integrated into a more coherent whole. Capitalizing on the interconnectedness of these two visual and verbal systems, synchronizing coordinated verbal and visual information in presentation design – rather than presenting them individually – enhances learning (Najjar, 1998; Williams, 1998) and improves recall (Hannafin & Hooper, 1993). Presenting verbal information that is not aligned well with visual information, on the other hand, impedes the learning process and increases cognitive load (Larson & Lockee, 2014).

Numerous instructional design strategies may be employed in the design of electronic presentation slides to leverage dual coding effectively. One such strategy, cueing (see De Koning, Tabbers, Rikers, & Paas, 2009), can draw the attention of the learner to a specific part of the visual instructional content, helping to ensure that what learners are experiencing visually (seeing) and auditorily (hearing) at the same time are aligned. Such cueing may be achieved through various methods within the design of electronic presentations. Movement of text via animations is one such method. Using a different text color or font size is another, and this may be achieved by using a brighter text color or bigger font size to draw attention to the text being discussed in the slide narration. Additionally, previously discussed text may be made less prominent on a slide by using a less-bright font color, again helping draw attention to the currently prioritized content. Once learners' attention is focused on the visual information corresponding to the auditory information, dual coding is leveraged and a more meaningful, coherent understanding is possible.

Cognitive theory of multimedia learning. Dual coding theory joins cognitive load theory and working memory theory (Baddeley, 1992) in playing a substantial role in the cognitive theory of multimedia learning identified by Mayer & Moreno (2005). Learning with the aid of electronic presentations is considered to be multimedia learning, a phenomenon described by Mayer (2002) as occurring "when a learner builds a mental representation from words and pictures that have been presented" (p. 85). The media offering such words and pictures vary widely, including both printed and electronic text and images, as well as videos and virtual experiences simulating reality (Mayer, 2002). The cognitive theory of multimedia learning rests upon three assumptions: (a) the dual-channel assumption (dual coding theory), that separate channels are used for processing visual and auditory information; (b) the limited-capacity assumption (cognitive load theory), that the amount of information that may be processed by each of those two channels at one given time is limited; and (c) the active-processing assumption, that meaningful learning requires active processing participation on the part of the learner (Mayer, 2001; Mayer, 2002; Mayer & Moreno, 2003). Several principles of multimedia design – including the coherence principle and signaling principle – were identified in Mayer (2008, 2002) to be instrumental in reducing extraneous cognitive processing, thereby potentially leveraging dual coding, reducing cognitive load, and increasing active processing, each of which contributes to more learning.

Coherence principle. In the design of electronic slides for instruction, the use of specific instructional design strategies may be instrumental in facilitating active processing – and learning – among learners. Focusing on minimizing the amount of text presented visually, for example, can contribute to improved active processing opportunities for learners (Mayer & Moreno, 2005). Using keywords and phrases on a slide in lieu of full sentences is one strategy that minimizes the amount of visually-presented text and helps learners to synthesize what they are hearing with what they are seeing on the screen, thereby making meaning on their own. This particular strategy is well aligned with what Mayer (2008, 2002) referred to as the *coherence principle*, one of numerous principles of multimedia design that lend themselves to facilitated cognitive processing and, thus, learning.

Signaling principle. Further focusing on emphasizing essential instructional content within instructional materials can also contribute to improved active processing opportunities for learners (Mayer, 2008). At any particular moment, for example, the information on a slide that is being discussed by a live speaker or in recorded narration is likely to be considered the most essential information at that time. Emphasizing that information in some way is a method of signaling to learners its relative importance over other content also visible on the slide. How this is accomplished may vary (e.g., movement of text, bolded font, larger font size, brighter font colors), but in all cases the strategy is well aligned with what Mayer (2008, 2002) referred to as the *signaling principle* that lends itself to facilitated cognitive processing and learning.

Summary. In designing instructional messages for distribution in classrooms via electronic presentations, it is thus critical to consider the impacts of such design on students' learning experience. Purposefully focusing on design strategies (such as cueing and chunking) and design elements (such as the amount of text visible at any given time) that will help decrease cognitive load and take advantage of dual coding can help maximize the amount of meaningful processing and learning that occur.

Cueing

In the design of multimedia for instructional purposes, cueing is a strategy defined as "the manipulation of visuospatial characteristics of instructional materials in order to help learners in selecting relevant information" (De Koning et al., p. 114). This particular strategy, also called selection cueing, is employed with the intent to attract the attention of learners to specific important components of content included within the materials; and selection cueing thereby neither presents information additional to the instructional content already presented nor changes that content (De Koning et al., 2009). Two specific types of cueing are relevant to this study. The first, which Franconeri and Simons (2003) called "stimulus-driven attention shifts" (p. 999), relates to the onset of motion of content onto a screen. Such onset of motion of instructional elements (including text) has been shown to capture the attention of learners as they view a slide (Abrams & Christ, 2003; Franconeri & Simons, 2003). This sudden appearance of textual content provides salience through its contrast with the static content elsewhere on a given slide (Jamet, 2014).

The second type of cueing is also sometimes referred to as signaling (Mautone & Mayer, 2001; Meyer, 1975) or more specifically, typographical signaling (Mautone & Mayer, 2001). Such typographical signals may include the coloring, italicization, or bolding of text to "directly focus attention to the relevant words, making the words, and the content they describe, visually distinguishable from other text. This not not only labels the concept as important, but it also makes it more memorable" (Mautone & Mayer, 2001, p. 378). This type of signaling, or cueing, may also be achieved through the highlighting of specific text of interest at a given time (Meyer, 1975).

Both of these multimedia attentional cueing strategies (selection cueing and typographical signaling) have been found to lessen the amount of time learners focus their attention on less-relevant information on a slide, and to be instrumental in the synchronization of visual and auditory instructional content for learners. This synchronization then helps to leverage dual coding and has the potential to better facilitate learning of the cued content (Jamet, 2014). It further helps to decrease cognitive load, which also has the potential to better facilitate learning of the cued content.

Relevant Research

The Use of Electronic Presentations for Instruction

The literature includes numerous and varied findings relative to the design of electronic presentations used for instructional purposes. This section is organized using those topics, which include general electronic presentation software and technology classroom use; student performance; student perceptions and preferences; and instructor perceptions, preferences, and experience as subheadings.

General electronic presentation software and technology classroom use. Several studies provided a glimpse into how, and how frequently, electronic presentations are used in the college classroom, primarily from the perspective of students but also from that of instructors. Hill et al. (2012) reported findings from the student perspective that indicated both frequent and sustained classroom PowerPoint use: while 67% of student participants identified that they had experienced PowerPoint use in the classroom for instructional purposes, they also identified that that same 67% experienced PowerPoint in an estimated 95% of their class meetings. Hill et al. (2012) further found that 75% of instructor participants in their study identified that they used PowerPoint for instructional purposes at least moderately. The frequency with which they used PowerPoint, however, was found to differ by rank, decreasing as instructional experience increased. The percentages of participants who self-reported using PowerPoint either in every class meeting or frequently for graduate teaching assistants, assistant professors, associate professors, and full professors were 69%, 50%, 60%, and 20%, respectively. Additionally, 63% of full professors identified that they never used PowerPoint in class, while 0% of the graduate teaching assistants said the same (Hill et al., 2012).

Differences in PowerPoint use were also found according to academic discipline by Shuell and Farber (2001), who focused on the use of all technologies for instructional purposes in the classroom. Instructors of graduate library sciences courses and of undergraduate social sciences courses were found to use more forms of technology in general, while instructors of graduate education courses were found to use fewer forms, for example. Further, PowerPoint was the form of instructional technology most frequently used in the classroom (Shuell & Farber, 2001). Students – thus found to have been exposed frequently to PowerPoint in the classroom – have also been shown to have generally positive attitudes toward the use of electronic presentations (particularly in PowerPoint) for instruction. In Acikalin (2011), for example, 89% of student participants reported such positive attitudes; and in Shuell and Farber (2001), a majority reported the same. Shuell and Farber (2001) found no significant difference in student attitudes toward electronic presentations in the classroom by class year or level; and Stolte, Richard, Rahman, and Kidd (2011) found no significant difference by age, professional experience, and undergraduate degree status in the comfort level of students with regard to electronic presentations in the classroom.

Student performance. Numerous studies have investigated the impact of instructional electronic presentations on subsequent student performance, typically on in-class quizzes and exams. Common were media comparison studies, which compared the performance of students exposed to instruction via electronic presentation to that of students exposed to instruction via another delivery method such as traditional lecture (e.g. Kunkel, 2004; Savoy, Proctor, & Salvendy, 2009; Susskind, 2005) or overhead transparencies (e.g. Simons, Andres, & Peterson, 2000; Szabo & Hastings, 2000). The outcomes of media comparison studies have been largely recognized as not useful, based on the fact that the primary question they are designed to answer (i.e., do particular media inherently increase student learning) are not valid. Such questions both introduce abundant confounding via numerous uncontrolled variables and lack sound theoretical basis. Predictably, a majority of the media comparison studies found in the literature reported no significant difference in student performance when electronic presentations were used in the classroom (e.g., Apperson, Laws, & Scepansky, 2006; Susskind, 2008; Szabo & Hastings, 2000). Such findings are aligned with those of Clark (1983), who concluded after a review of media comparison study meta-analyses that “media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition . . . only the content of the vehicle can influence achievement” (p. 445). Since it is *how* media is used that matters, rather than the fact that it is used, Clark (1983) suggested that media comparison studies no longer be conducted, as the aforementioned confounding variables are not easily mitigated.

Also common was the inspection of student performance subsequent to exposure to electronic presentations incorporating specific features. Larson (2004), for example, studied the impact of differences in features such as typefaces, background and text colors, and background complexity on student short-term recall. Findings therein were no significant difference in performance relative to PowerPoint instruction using different typeface (Helvetica and Times New Roman, in this case) or different type (positive, with light-colored background and dark-colored text; and reverse, with dark-colored background and light-colored text.) A significant difference was found, however, in performance relative to PowerPoint slides with differing background complexity: visually complex backgrounds were associated with a decrease in performance.

Several studies focused on the use of images in electronic presentations. Bartsch and Cobern (2003), for instance, studied the importance of the relevance of images to instructional content, comparing student performance after exposure to electronic presentation slides with only text and no images, with text and unrelated images, and with text and related images. Findings were that performance was significantly better for students exposed to either text-only slides or slides with text and related images as compared to those exposed to slides with text and unrelated images. Such findings are well aligned with Clark and Lyons (2010), who espoused that “all graphics are not equally effective” (p. x); indeed, excessive use of decorative images used solely for aesthetic or entertainment purposes may interfere with the “essential mental learning processes needed to promote learning” (p. 16). When learning from slides that included images unrelated to the text, Bartsch and Cobern (2003) surmised, their participants may have been confused by the misalignment of the text and images and thus distracted from the instructional content. Further, unrelated images may have interfered with dual coding (Bartsch & Cobern, 2003). It is this kind of interference that is encompassed within the coherence principle of multimedia learning. The coherence principle warns against the use of images and other material unrelated to the instructional content, as “adding interesting but irrelevant material can interfere with the learner’s process of structure by distraction, . . . disruption, . . . or diversion” (Mayer, 2002, p. 115-116).

In a separate study, Bartsch and Cobern (2003) focused on the use of relevant images, comparing the performance both after individual class meetings and at the end of the semester of students exposed to “basic” slides with only text and “expanded” slides with text, related images, and sound unrelated to the content. Findings were mixed for the two timeframes: while no significant difference was found in performance at the end of the semester, students exposed to basic, text-only slides performed significantly better after each class meeting than did students exposed to the “expanded” slides.

A study considering the effectiveness of notes accompanying PowerPoint slides, relative to note-less slides and transparencies, resulted in similar findings: students with exposure to PowerPoint – with or without notes – performed significantly better than did those exposed to transparencies (Szabo & Hastings, 2000). Lowry (1999) found student performance after instruction with PowerPoint to be superior to that after instruction with transparencies as well:

scores were consistently significantly better for the entirety of the two years during which performance was measured. Considering traditional chalkboard instructional delivery in addition to delivery via overhead transparencies and PowerPoint slides, Beets and Lobingier (2001) found in general no significant difference in performance between the three participant student groups. What was significant, however, was the increase in performance when students were learning via their preferred mode of the three (i.e., chalkboard, overhead transparencies, or PowerPoint slides.) Students who preferred classes in which PowerPoint presentations were used to those in which chalkboards or transparencies were used, for example, were found to perform better when they were taught with PowerPoint presentations.

In summary, a majority of the media comparison studies examining outcomes in environments with instructional content delivered via electronic presentations and in environments with instructional content delivered via other platforms, such as lectures without technology or overhead transparencies, predictably found no significant difference in student learning. Studies examining student learning in the presence of various specific electronic presentation design features found no significant difference in student learning relative to different type faces (e.g., Helvetica and Times New Roman) and font types (e.g., positive and reverse.) They did find significant differences in student learning, however, relative to slide complexity (less complex slides yielded more learning) and the use of images (images not related to instructional content impede learning.)

Student perceptions and preferences. Evident within the literature are studies designed to identify perceptions and preferences of college students – at both the undergraduate and graduate level – with regard to the use of electronic presentations within the instructional environment. Such preferences relate to specific instructional delivery methods (e.g., lecture or electronic presentations), and such perceptions relate to instructor quality, benefits and drawbacks of electronic presentations, and how electronic presentations should be used in the classroom.

Lecture methods. Students were frequently asked to compare experiences in classrooms delivering content through lecture without electronic technology to those in classrooms delivering content through electronic presentations. Both Bartsch and Cobern (2003) and Kunkel (2004) reported findings of no significant difference in the preferences of students for instruction with traditional lecture and electronic presentations. While Lowry (1999) and Szabo and Hastings (2000) reported that students preferred electronic presentations to overhead transparencies and traditional lecture, respectively, Szabo and Hastings (2000) also reported students' preference to have electronic presentations in future classes, based on their perceptions that such presentations are better than traditional lecture for getting their attention and maintaining interest, providing structure and organization, and improving motivation to attend class. Similar to Szabo and Hastings (2000), Shuell and Farber (2001) also sought student perceptions comparing the use of electronic presentations and overhead transparencies in the classroom. Therein, it was found that 84% of student participants preferred electronic presentations to transparencies, and 75% perceived such electronic presentations as making lectures more interesting and increasing student attention in class. Savoy et al. (2009) further identified students' preferences for electronic presentations in helping them to identify important content, as well as their lamentation that those same electronic presentations tend to stifle classroom discussion.

Instructor quality. Student perceptions relative to instructor quality were also studied in environments with instructional electronic presentations. Both Apperson et al. (2006) and Nouri and Shahid (2005) reported higher perceived instructor quality when electronic presentations were used in the classroom. Nouri and Shahid (2005) specifically found significant differences in students' perceptions of how much better prepared instructors were, and how much easier it was to understand their class lectures, when they used electronic presentations. No significant difference was found, however, in the perceived effectiveness, time efficiency, overall performance, and entertainment value of the instructor when electronic presentations were used for instruction.

Benefits and drawbacks of electronic presentations. Evident throughout the literature is that students were given ample opportunity to share with researchers their perceptions relative to electronic presentations in the form of what they liked and did not like about their use in class, particularly based on comparisons to their experiences in classrooms with traditional lecture and/or overhead transparencies. The most commonly reported perceived advantage of electronic presentations was improved organization and structure (e.g. Abdelrahman et al., 2013; Acikalin, 2011; Susskind, 2005), which was perceived to make following the lecture and taking notes therein easier. Also perceived as contributing to better note-taking were increased clarity of course content (e.g. Apperson et al., 2006; Lowry, 1999) and a better emphasis on main points (e.g. Acikalin, 2011; Hill et al., 2012; Susskind, 2005). Such improvements were additionally considered by students to impact their academic time outside the classroom. Indeed, Acikalin (2011), Hill et al. (2012), and Susskind (2008) found that students considered electronic presentations to further improve the quality of their individual studying. Also commonly reported was that electronic presentations were more interesting to students (e.g. Abdelrahman et al., 2013; Acikalin, 2011; Brock & Joglekar, 2011), thereby helping to capture and maintain their attention. Abdelrahman et al. (2013) further found, however, that such interest tended to fade over time for students as the novelty of the software diminished.

The primary disadvantage of electronic presentations reported by students was that they allowed fewer discussions and interactions in class meetings (e.g. Abdelrahman et al., 2013; Brock & Joglekar, 2011; Hill et al., 2012). While Susskind (2005) found that students considered class meetings with electronic presentation use to thus be less spontaneous and the instructors less personable, Hill et al. (2012) found that students' question-asking behavior was actually inhibited in that environment. Not only did students ask fewer questions, but they also reported only asking questions when prompted (Hill et al., 2012).

How electronic presentations should be used in the classroom. Based on students' experiences in the classroom with electronic presentations, the literature included suggestions from students of how electronic presentations should – and should not – be used for instructional purposes. One category of preferences was the use of specific types of electronic presentation features. The most common preferences herein surrounded the idea of visualization. While numerous studies found that students preferred a more intentional broad focus on helping students visualize content (e.g. Hill et al, 2012; Szabo & Hastings, 2000), other studies (e.g. Acikalin, 2011; Apperson et al., 2008) specifically recommended the use of targeted images and video clips. Apperson et al. (2008) also reported student preferences that if sound were to be used in conjunction with such images, such sound should be relevant to the image content. While students reported a desire for visuals and sound in presented slides, they also expressed a warning that slides should not be overloaded with too much of any kind of information at once (Apperson et al., 2008; Yilmazel-Sahin, 2009), specifically citing bullets as an item to avoid using in excess (Abdelrahman et al., 2013). These suggestions each relate to the reduction of cognitive load and the leveraging of dual coding, both of which contribute to improved processing and increased learning. Including only images or sound relevant to the instructional content, for example, facilitates dual-channel integration, while a reduction of bulleted text decreases cognitive load.

A second category of preferences related to how instructors design and build, and later present, their slides. In building the slides, for example, students recommended that instructors present content in outline form (e.g. Hill et al., 2012; Yilmazel-Sahin, 2009). In designing those outlines, Acikalin (2011) and Apperson et al. (2008) reported advice that key words and phrases be used in lieu of full sentences. Students were also wary of instructors merely copying their textbook directly into the presentation slides (Yilmazel-Sahin, 2009) and using all capital letters within any given slide (Apperson et al., 2008). Students further suggested that instructors should incorporate into their presentations both prepared discussion topics and time for student questions (Hill et al., 2012; Yilmazel-Sahin, 2009). Finally, students had several recommendations with regard to instructors' actual in-class presentations. One such recommendation was that instructors reveal the information on their slides as they address it in their speech (Apperson et al., 2008; Szabo & Hastings, 2000). Other recommendations were that instructors not simply read their slides verbatim (Acikalin, 2011; Hill et al., 2012), and that they not move too quickly through their slides as students are taking notes and processing the content (Apperson et al., 2008; Yilmazel-Sahin, 2009).

Summary. In summary, a majority of studies examining differences in learning within instructional environments using electronic presentations, traditional lecture, and overhead transparencies, students were found to prefer electronic presentations to other delivery methods. Further, students reported perceiving instructors who used electronic presentations to be more prepared and of higher quality than those instructors who did not use electronic presentations. The affordances of electronic presentations that students perceived positively include increased structure, clarity, and emphasis on main points, all of which were perceived to contribute to an improved ability to study; as well as an increased ability to capture and hold their attention. At the same time, students lamented that in the presence of electronic presentations, classroom discussions and questioning are stifled.

Instructor perceptions, preferences, and experiences. Researchers were also interested in the experiences and perceptions of college-level instructors with regard to the use of electronic presentations for instructional purposes. More prevalent in the literature is reporting of what instructors like about using electronic presentations in the classroom, as well as why instructors use, or do not use, them. Brock and Joglekar (2011) found, for example, that information management instructors primarily appreciate electronic presentations' ability to incorporate visual elements to support and increase student learning. While findings in Hertz et al. (2015) similarly pointed to instructors' perceptions of the ability of electronic presentation software to generally be used to support student learning and memory, they further identified that such presentations can be used to entertain students, to direct attention away from the instructor, and to conform to student expectations. Hertz et al. (2015) conversely reported findings of perceived disadvantages of electronic presentations as reported by instructors. Such drawbacks included that too much text is used in such presentations, that narratives can end up fragmented, that the presentations may lack passion as instructors merely read from their slides, and that instructors may lose contact with their students during the presentations as each student "too frequently looks at the pictures on the projection, or is busy copying the text from the slides" (Hertz et al., 2015, p. 283).

Hill et al. (2012) found that instructors had similar perceptions to those mentioned above: that electronic presentation use for instructional purposes could constrain teaching and/or limit interactions with and between students in the classroom. Indeed, the reasons instructors who preferred not to use electronic presentations cited for that preference were that they perceived such presentations to discourage discussion and require passive learning (Hill et al., 2012). Instructors who did use electronic presentations, on the other hand, did so for numerous varying reasons, including improved clarity for students, improvements in teaching performance, and the availability of slide printouts as study materials for students to use after class (Hill et al., 2012). Among those instructors who reported using electronic presentations, 100% of them used the software for the purpose of projecting lecture notes and accompanying charts and explanations; 54% used it to show video clips; and 41% incorporated discussion questions into their slides (Hill et al., 2012).

In identifying the relationship between their use of electronic presentations and their pedagogy, instructors noted the critical role such presentations play in improving their organization and lecture pacing, and decreasing their performance anxiety (Hill et al., 2012). Hertz et al. (2015) reported similar findings, with instructors using electronic presentation features (e.g., images and text) deliberately to more thoroughly explain content and support the instructor. They also used such features to create a pleasant classroom atmosphere and to provide bridging slides (with images that may or may not be unrelated to content) between segments or chunks of information (Hertz et al., 2015). The aforementioned performance anxiety reported in Hill et al. (2012) was found to be lessened with the use of electronic slides both because of the increase in organization and because of an adherence to what instructors perceived to be the expectations of their students. To that end, Hill et al. (2012) found that 65% of instructors believed their students expect and/or like PowerPoint to be used in the classroom, and 70% believed their students think that PowerPoint makes class easier with more simplified information to learn.

Separate from those perceived student expectations are the perceptions of instructors as to the inherent capabilities of electronic presentations used for instructional purposes to enhance learning. In Hertz et al. (2015), instructors who do use electronic presentations were asked to consider how their instructional practices would change if they were to instead begin to teach without those presentations. Instructors responded that they would, without the use of electronic presentations, provide more examples in class, focus more specifically on some subjects than they typically do when using electronic presentations, engage in more improvisation while teaching, use more variety in both their speech patterns and speaking volume, and practice the delivery of their lectures more before class (Hertz et al., 2015). Indeed, the organization instructors report as a welcome affordance of electronic presentations seems to impact their instructional experience in a multitude of ways.

In summary, instructors were found to appreciate the ability to use visual elements, to entertain their students, and to detract attention from themselves with the use of electronic presentations in the classroom. Like their students, they also lamented limited discussions, and a loss of contact, with their classes when they use electronic presentations. Despite those issues, however, they also reported using electronic presentations because they perceive them to afford improved clarity, the use of video clips and images, and handouts that may be easily printed for students.

Best Practice Recommendations for Instructional Electronic Presentation Slide Design

Within the literature, a wealth of practices are recommended for designing effective electronic presentations, particularly those in PowerPoint, for instructional purposes. In an analysis of the literature, themes emerged in the form of specific familiar categories of design elements (e.g., text and color) into which such recommendations could be classified. Side-by-side comparisons of recommendations within each category revealed both advice that was reiterated by several sources, as well as advice that was not commonly shared. Although it was rare, some recommendations outright contradicted each other. More often, however, recommendations that were similar (though not identical) to each other emanated from diverse sources.

Specific recommendations by category. The following is an identification of the most frequently cited recommendations, as they could be considered to contribute to a set of presumed best practices grounded in theory and in the literature. More general recommendations taking a more holistic view of electronic presentation design are discussed first, followed by specific aspects of slide design (e.g., text, images.) A short at-a-glance summary is provided for this narrative in Table 1.

General design. A majority of published sources have made general recommendations with regard to the design of electronic presentations for instructional purposes that do not fall neatly into the specific categories described in subsequent sections. Three general recommendations were made most frequently. The first recommendation of those top three is, as will also subsequently be discussed with regard to text, revealing visual slide content as it is addressed in the instructor's speech to align what learners are seeing with what they are hearing at the same time. The second recommendation of those top three is to include only content that is relevant to instructional objectives and content, explained by Johns (1995) as follows: “used well, [slides] should attract and hold attention and they should help understanding and retention. When they are used badly, they can have the reverse effect . . . the lecture is [then] an inefficient tool” (p. 121). The final of the top three recommendations is to minimize the amount of all content – regardless of type (e.g., text, images) – per slide. Only Stein (2006) further posited that including too little content per slide should be avoided. Tarpley and Tarpley (2008) explained the dilemma instructors face in preparing content-rich slides with a minimum amount of design elements in saying that “electronic presentations require readability as well as worthwhile content . . . The often overwhelming amount of data tempts the educator to crowd slides with graphs, illustrations, or tiny print and then to announce, ‘I know you can’t read this, but . . . ’” (p. 129).

Related to the idea of minimization is the often-cited recommendation to also limit the content of each individual slide to only one concept or idea, in order to minimize cognitive load (e.g., Broderick, 2003). To further decrease cognitive load for leaners, numerous sources (e.g., Collins, 2004; Reimold & Reimold, 2003) recommend using blank slides between content slides, for use when the instructor is no longer directly addressing the text and/or images that were on the screen. This strategy also serves to decrease distractions for the learners, as “any image which is retained on a screen after its use may focus the [learners] on the image and not on the speaker” (Crosby, 1994, p. 6). This recommendation aligns with another reiterated one, in that it acknowledges that discussion and/or explanation will occur outside of the content inserted into slides: to design presentations to “be used as an aid to highlight important points but not as an entire lecture” (Priya, 2012, p. 2). The recommendation to employ blank slides also relates to the repeated recommendation that white space be used well in each slide. This recommendation was stated succinctly by Kushner (1995) with the recommendation to "Let the screens breathe" (p. 192).

Text. A majority of the reviewed publications specifically made recommendations with regard to the use of text and its features. Such recommendations were determined to fall into three subcategories, addressing text font, the amount of text used, and general text guidelines. The most common recommendations with regard to text font addressed minimum font sizes that should be employed such that the presentation audience (the learners) could read the text on the screen. The most frequently recommended minimum font size was 24 (e.g., Collins, 2004; Crosby, 1994; King, Johnson, & Rupnow, 2001), and particular minimum size recommendations varied somewhat, ranging from 18 (Reimold & Reimold, 2003) to 30 (Berk, 2012) for primary body text. Only one recommendation was made for the minimum font size of title text: Crosby (1994) suggested a size of at least 36. Specific font families (e.g., Times New Roman or Arial) were not recommended within any of the literature, but the generic family of sans serif fonts was recommended by numerous sources (e.g., Barone & Tucker, 2002; Tarpley & Tarpley, 2008) over serif fonts, and serif fonts were not recommended over sans serif fonts at all. Further, a combination of capital and lower-case letters emerged as a general recommendation: Lohr (2008) and others advised that text not be in all capital letters, while Kushner (1995) and others further advised against the use of all lowercase letters.

The most common recommendations with regard to the amount of text used in electronic presentations addressed the maximum number of text elements included on an individual slide; indeed, multiple sources (e.g., Crosby, 1994; Priya, 2012) cited specific maximum numbers of words per line and lines per slide. Particular concern was noted in thereby minimizing the amount of text visible on a given slide, solving the problem identified by Berk (2012) as presenting “dead words on the screen” (p. 2): an overabundance of text and bullets. The most frequently cited maximums were six words per line and six lines per slide, for a total of 36 words per slide (Collins, 2004; Pettersson, 2010; Priya, 2012). Collins (2004) included with that recommendation the perspective that “the fewer words per slide, the better” (p. 1179). Particular maximums varied somewhat, ranging from four to eight words per line and four to eight lines per slide (e.g., Kushner, 1995), for a total of 16 to 64 words per slide. Brock and Joglekar (2011) provided the sole recommendation relative to the number of bullets per slide; three was their suggested maximum.

The most common recommendations with regard to other, more general text-related design considerations addressed the use of full sentences, the use of capital and lower-case lettering, and the planned timing of the revelation of design content such as text and images. Many sources (e.g., Broderick, 2003; Young, 2004) advised presenters against using full sentences, and others (e.g., Prasad, Roy, & Smith, 2000; Stein, 2006) more explicitly advised that presenters use keywords or phrases in lieu of full sentences. Barone and Tucker (2002) described the problem that such use of keywords mitigates as follows: “long phrases or sentences cause clutter and visual overload” (p. 107), thereby potentially overwhelming learners. Numerous sources (e.g., Johns, 1995; Mayer & Moreno, 2003; Yilmazel-Sahin, 2009) further recommended that presenters refrain from merely reading their slides to their learners in the classroom, thereby simply narrating the text. Johns (1995) considered it the most egregious waste of learners’ time to subject them to listening to words read verbatim from the slides they can see and read on their own, making it “insulting to [learners] who have given up valuable time” (p. 122) to be present. Also common was the recommendation that slide text be designed to be revealed to the learners as it is being spoken about either by the instructor or in a recorded narration (e.g., Williams, 1998). A more specific recommendation sometimes followed: that content already discussed but still shown on a slide be "dimmed" as the instructor proceeds through the slide (e.g., Broderick, 2003).

A similar recommendation was made relative to the entrance animation of text on slides (e.g., Barone & Tucker, 2002). Herein, the reiterated messages were that such animation should be meaningful, minimal, and not distracting to learners. Prasad et al. (2000) identified the existence of a "fine line between using animations to get good effect and to being perceived by [learners] as too much of a showman or show-woman" (p. 196).

Images. Numerous recommendations have been made with regard to the use of images in the design of electronic presentations. While the advice from Brock and Joglekar (2011) is simply that images should be used, Collins (2004) warned that "a poor image can be worse than no image, and poor-quality images should not be used" (p. 1182). Other authors provided more detailed recommendations as to exactly how images should be used. A majority of those authors addressing images at all, for example, stated that if any images are used in a presentation, it is imperative that they be relevant to instructional content and objectives (e.g., Arredondo, 2000; Clark & Lyons, 2010; Clark & Mayer, 2016; Mayer & Moreno, 2005). Pointed recommendations elaborated that images considered purely decorative – "the most frequently used type of instructional [visuals]" (Lohr, 2008, p. 4) – are not appropriate for inclusion (e.g., Prasad, et al., 2000), with Lohr (2008) warning against the use of "edu-junk" and "eye candy" (p. 29) in the form of such decorative images.

Often prioritized in the literature was the temporal synchronization of images and the text to which they relate. As Najjar (1998) described, this synchronization "may help learners to use dual (verbal + pictorial) coding . . . to increase cognitive interconnections between the two forms of studied information and to prior knowledge" (p. 313). A common reminder from Collins (2004) and others was to ensure that all images used in electronic presentations are large enough to be visible and comprehended by learners in the audience, and Felkey and Anderson-Harper (2000) and Leech (2004) agreed that images should not be distracting to learners. Similarly focusing on minimizing distractions, two sources who addressed slide background design (Barone & Tucker, 2002; Prasad et al., 2000) recommended using a solid background, without any images incorporated into it. Three other sources (e.g., Berk, 2012; Larson, 2004) were somewhat more lenient, recommending that if images are used in the background, they should be both simple and subtle in design.

Color. Various specific recommendations have been made in the literature with regard to the use of color in the design of electronic presentations. The most common recommendation is to ensure good contrast, throughout the presentation, between background color and the colors of all text and images (e.g., Berk, 2012). The second-most common recommendation was to use color consistently throughout an entire presentation (e.g., King et al., 2001). Another reiterated best practice included minimizing the number of colors used on an individual slide (e.g., Carter, 1999); some authors such as Collins (2004) specifically recommended limiting this number to four. Conflicting advice was found with regard to the polarity of prepared slides. While Pettersson (2010) singularly recommended that a light-colored background be used with dark text – positive polarity – Barone and Tucker (2002) and others recommended negative polarity: the use of a dark background with light text. Negative polarity would, according to Berk (2012), avoid the afore-mentioned issue of presenting "dead words on the screen" (p. 2). Two sources recommended that instructors consider the psychology of colors in designing their slides, since "colors can evoke moods, feelings, or ideas" (Reimold & Reimold, 2003, p. 91), while two others (e.g., Leacock & Nesbit, 2007) advised more generally that any colors used should not be distracting to the learners.

Sound, video, and transitions. Many specific recommendations have been made in the literature with regard to the use of sound. Such recommendations were determined to fall into two distinct subcategories, addressing all sound in general and addressing music as a specific type of sound. Upon further inspection, there were no commonalities found among the recommendations that focused specifically on sound in the form of music. One of the most commonly mentioned recommendations regarding all sound, however, was that it be meaningful – that is, connected to and reinforcing of instructional content (e.g., Collins, 2004). Meaningful sound in an electronic presentation, posited Prasad et al. (2000), "can be effective as a means of attracting [learners'] attention to perhaps one crucial point . . ., to emphasize humorous content, or to signal the beginning or end of the presentation" (p. 196). Interestingly, while Prasad et al. (2000) advocated for using sound precisely to gain attention, Williams (1998) and others admonished the use of sound solely for the purpose of getting learners' attention.

Additional common recommendations were that sound be used minimally (e.g., Priya, 2012) and that it not be distracting to learners (e.g., Felkey & Anderson-Harper, 2000). A smaller number of sources addressed the use of video clips within slides and transitions between slides. The one commonality that emerged among those addressing the use of video clips was the recommendation that any video clip used in a presentation not be distracting to learners (e.g., Felkey & Anderson-Harper, 2000). Commonalities that emerged among those addressing the use of transitions were that such transitions be meaningful, minimal, and consistent throughout the presentation.

Summary of best practice recommendations. Clear within the literature is an identification that the design of electronic presentation slides for instruction matters. A summarization of the best practice recommendations made throughout the literature relative to the effective design of electronic presentation slides is depicted in Table 1.

Table 1

Presumed Best Practices Recommendations Summary

Text
Font
Minimum size: 36 point for titles, 18-30 point for body text
Sans serif font type
Combination of capital and lower-case letters
Amount
Maximum of 4-8 words per line and 4-8 lines per slide
General Guidelines
Keywords and phrases instead of full sentences
Do not merely read each slide
Reveal text as it is addressed in speech
Dim text when the discussion proceeds to subsequent content
Animation of text should be meaningful, minimal, and not distracting
Images
Relevant to instructional content/objectives; not distracting
Synchronize with text to which relate
Large and clear enough to be perceived
Color
High contrast between background and design elements
Consistent throughout presentation
Minimal number per slide
Not distracting
Sound, Video, and Transitions
Relevant to instructional content/objectives; not distracting
Minimal
General Guidelines
Reveal content as it is addressed in speech
All content should be relevant to instructional content/objectives
Minimal amount of content per slide
One concept/idea per slide

The content of Table 1 supports the declaration of Larson and Lockee (2014) that "bad message design can often ruin or obscure an instructional message" (p. 216); in short, design matters.

The Need for Additional Research

Despite the frequency with which the best practice recommendations for the design of electronic presentations for instructional purposes in Table 1 are made, only some are grounded in empirical research. Many others are not; and although they are presented relative to cognitive theory, rooted in recognizance of learning principles such as cognitive load, dual coding, and the cognitive theory of multimedia learning, they are not based well on cognitive theory. Empirical evidence also has not been compiled to show their impact on student learning. With the rampant use of electronic presentations in the classroom, this is problematic as instructors seek advice relative to how to design their classroom slides to better facilitate student learning. In the case of the often-recommended best practice of presenting visual content as it is addressed auditorily, for example, research addressing this best practice is confined to a single study, which demonstrated that this particular practice actually impedes learning. This strategy and two others are discussed herein.

Progressive Disclosure

One of the most commonly made recommendations relative to the general design of electronic presentation slides for the purpose of instruction is to reveal visual slide content as it is addressed auditorily during the classroom presentation (e.g., Collins, 2004; Levasseur & Sawyer, 2006). This strategy requires either the sequential animation of slide content onto a given slide or the use of numerous sequential slides disclosing information progressively: "building" a slide incrementally, bullet by bullet (Broderick, 2003). Although little of the more current literature used this terminology, this strategy was formerly termed *progressive disclosure* (e.g., Best, 1968;

Ellington, 1987), as the disclosure of slide content occurs progressively rather than all at once. From here forward, this particular term (progressive disclosure) will be used.

History of progressive disclosure. Progressive disclosure is a term that dates back to educational technologies that preceded PowerPoint, such as overhead transparency slides (e.g., Ellington, 1987) and 50-mm slides (e.g., *Effective 50mm*. 1964). With overhead slides, progressive disclosure was achieved with the placement of a sheet of paper on top of a transparency slide – thereby obscuring the content underneath it – that was subsequently physically moved by the instructor down the slide to reveal content sequentially, rather than all at one time. This was recommended for instructional purposes to help with "concentrating the mind of the learner on whatever item or section is being discussed at the time and maintaining interest by keeping him or her in suspense over what is going to be revealed next" (Ellington, 1987, p. 12). Progressive disclosure is recommended for overhead transparency use in publications both old and new (e.g., Best, 1968; Wyman, 2013), but such recommendations are not accompanied by citations of empirical support.

Recommendations for using progressive disclosure. The recommendation that progressive disclosure be used in the design of electronic presentation slides for instructional purposes is frequently made, both relative to the disclosure of text and to the disclosure of all design elements, including images and other content. Largely, such recommendations are made simply based upon students' reported classroom preferences (e.g., Apperson et al., 2008) or upon some undisclosed criteria that may include personal experience in the role of either a learner or a presenter (e.g., Kushner, 1995). Such recommendations are also often accompanied by explanations of what progressive disclosure can offer with regard to cognitive psychology; namely, that it can help direct student attention through cueing and/or decrease cognitive load (e.g., Berk, 2012; Johns, 1995). Specifically, cognitive load may be decreased with progressive disclosure through the chunking of instructional content, as well as the revelation of smaller amounts of text at a time.

Despite the fact that this strategy is so frequently recommended, however, only one study has examined its impact on student learning. Mahar, Yaylacicegi, and Janicki (2009) studied student learning differences between two treatments, one of which used progressive disclosure of text, bullets, and images and the other of which used static, full disclosure of those same design elements in narrated PowerPoint presentations that combined PowerPoint slides with a voiceover narration. Each treatment presentation was 17.5 minutes long, and the progressive disclosure treatment presentation included an average of 3.4 animations per slide. Content was related to management information systems.

Information not divulged in the article includes (a) the range and average amounts of text (in the number of words per bullet or per slide) that was shown on the slides, and whether that text was in the form of keywords and phrases or full sentences; (b) the font size(s) of any text shown; (c) the sizes of any images included in the slides; (d) the average and range of numbers of images included per slide; and (d) whether included images were related to the instructional content. Such design decisions (i.e., amounts of text and images, use of keywords and phrases, and font and image sizes) themselves may have a potential impact on student learning. Using too much text in general on a given slide, for example, has been shown to potentially increase cognitive load and work against the leveraging of dual coding, thereby diminishing learning (Berk, 2012). Including text on a given slide in the form of full sentences instead of keywords or key phrases has been further found to potentially increase cognitive load and thereby negatively impact learning (Berk, 2012; Young, 2004). Using a font size that is too small to allow learners to be able to perceive textual content well, or even at all – or including images on a slide that are too small to be perceived well or at all – has been found to be detrimental to learning as well (Berk, 2012; Brock & Joglekar, 2011). The more images that are included in one particular slide, the smaller each must be in order for both to fit; so the number of images potentially plays a part in how much learning occurs from the viewing of an electronic presentation. Including images that are unrelated to the instructional content has also been found to be detrimental to learning (Felkey & Anderson-Harper, 2000; Young, 2004). Without information about the design choices Mahar et al. (2009) made relative to these variables impacting the presentation of each slide, it is impossible to know if such choices impacted learning as measured within their study.

In Mahar et al. (2009), 93 undergraduate management and information systems (MIS) students enrolled in the same course with one instructor participated in the study, and all participants completed two assessments. The first assessment was an anonymous pre-test administered five weeks prior to exposure to the study treatments' electronic presentations, and was designed to assess participants' prior knowledge and establish a baseline thereto. The second assessment was a post-test, with items identical to those on the pre-test, that was administered immediately after participants were exposed to the study presentations. All nine assessment items were multiple-choice questions that each had four answer choices and that were based on recognition in the assessment of students' acquisition of declarative knowledge. Recognition-based assessment is considered a more superficial form of processing depth than is assessment based on recall, application, or transfer (Anderson, 2005; Craik & Lockhart, 1972). Participants were not required to provide an answer to each question; instead, they could leave one or multiple items blank, in which case the researchers counted such item(s) as answered incorrectly.

Student learning was measured in this study through the comparison of average participant scores on the pre-test and the post-test (Mahar et al., 2009). Participants completed the pre-test anonymously, such that any given individual participant's pre-test score was not identifiable. As such, a given individual's pre-test score was further not able to be compared to that participant's subsequent post-test score for the purpose of measuring individual participant growth. For this reason, growth as measured within this study instead makes two comparisons to the same gross pre-test average score: of the average of all 93 participants' pre-test scores to (1) the average post-test score of the full disclosure group with around 46 participants, and (2) the average post-test score of the progressive disclosure group. True growth of individual participants was not measured. Further, the comparative calculations unnecessarily considered the gross pre-test average score; simply comparing the two treatments' post-test scores would have yielded the same difference between groups, since the same gross pre-test average score was used in both cases. (The difference between y-x and z-x is simply the different between y and z; x is irrelevant.)

Findings were that students exposed to the full disclosure slides learned statistically significantly more than did those exposed to slides with progressive disclosure (Mahar et al., 2009). The researchers explained such findings by focusing on "the temporal constraints of animations" (p. 588) in the progressive disclosure slides. Further, they definitively stated that the full disclosure group "had better recall of graphics and text on the slides due to prolonged exposure to the information" (p. 588), and that the progressive disclosure group's slides "[led] to excessive processing demands and limited exposure time" (p. 588).

Berk (2011) cited and discussed these findings from Mahar et al. (2009); then one year later, the same author alternatively recommended using progressive disclosure "to maintain focus" (Berk, 2012, p. 5). This leaves the question of whether other authors recommending the use of progressive disclosure for enhanced learning are similarly ignoring Mahar et al. (2009). Further, in their study, Mahar et al. (2009) conflated text and graphics in progressive disclosure, using both design elements on the same slide but not distinguishing the impact of each one – and its progressive disclosure – on learning. The impact discovered within their study could have resulted from the progressive disclosure of the text and not the images, or of the images and not the text. Questions thus exist within the literature and call for further research as to the impact of progressive disclosure of text on student learning.

Dimming

A common recommendation for the design of electronic presentation slides is that dimming be used to accompany progressive disclosure of text (e.g., Broderick, 2003). When both practices are used within a slide, text is first revealed as it is addressed by the instructor (progressive disclosure); thereafter, it is subsequently "dimmed" or "grayed out" when the instructor moves on to the next item of content on the slide (dimming.) Dimming is typically facilitated by the use of gray font color, such that the dimmed text is not removed from the slide or blacked out completely; rather, it remains on the slide but is not as prominent as the text that was disclosed next. Dimming is recommended as a strategy to permit "the audience to absorb the information one step at a time" (Collins, 2004, p. 1181) and to ensure "that the focus [of audience attention] is on the current line of text" (Broderick, 2003, p. 1049).

Those who recommend dimming (e.g., Broderick, 2003) posit that it will, in theory, decrease cognitive load and/or leverage dual coding. Dimming may serve to facilitate learners' meaningful chunking of instructional content into more easily processed pieces, enhances attentional cueing already facilitated by progressive disclosure, and helps ensure that the amount of text a learner is asked to process at once is minimized. As with progressive disclosure, there is no empirical evidence that dimming does in fact contribute to improved student learning. Another gap thus exists within the literature with regard to this particular best practice and its actual impact on learning.

Highlighting

Highlighting is a third strategy recommended in the design of PowerPoint slides for instructional purposes. This particular strategy may be used with or without progressive disclosure, and in all cases is facilitated by making the bullet of text currently being discussed in the narration more prominent than other text on the slide: larger (with an increased font size), bolded (with a bold font type), and/or differently colored than the text that is visible on the slide but not currently being addressed in the narration (in a bright yellow or red font color, for example.) Cooper and Yoder-Wise (2003) and Reimold and Reimold (2003) specifically recommend highlighting for the same reason that progressive disclosure and dimming are often recommended: to help draw students' attention to the current focus of the narration. This attentional cueing is likely to decrease cognitive load for learners (De Koning et al., 2009). Further, highlighting may serve to facilitate learners' meaningful chunking of instructional content, and will help ensure that the amount of text on which learners are led to focus at once is minimized.

Summary

All three of these specific strategies – progressive disclosure, dimming, and highlighting – are recommended throughout the literature to be used in the design of electronic slides to facilitate learning in lieu of full disclosure. Indeed, they are claimed to focus student attention, thereby potentially decreasing cognitive load, leveraging dual coding, and increasing active processing, which should in turn facilitate learning. Gaps exist within the literature, however, in examining whether the strategies actually do in fact lend themselves to positive impacts upon student learning. This study was designed to examine each of these strategies and thereby add empirical evidence to the literature with regard to their impact on learning.

Chapter 3: Method

The purpose of this study was to examine differences in student learning relative to textual display approaches in the design of electronic presentations. Findings from this study will contribute to the literature relative to how student learning is impacted by the design of electronic presentations, with empirical evidence currently lacking within that literature. Findings will further provide educational practitioners with immediately usable recommendations supported both by cognitive theory and by empirical evidence. This chapter details the methodology that was applied in order to answer the research questions identified for this study.

Research Questions

This study examined the following broad research question, as well as the specific narrower research questions listed and enumerated below: What is the impact on student learning of various textual display treatments in electronic presentations? Specific research questions included:

1. Is there a difference in learning from electronic presentations involving full disclosure vs. progressive disclosure of text?
2. Is there a difference in learning from electronic presentations involving full disclosure vs. dimming of text?
3. Is there a difference in learning from electronic presentations involving full disclosure vs. highlighting of text?
4. Is there a difference in learning from electronic presentations involving progressive disclosure vs. dimming of text?

5. Is there a difference in learning from electronic presentations involving progressive disclosure vs. highlighting of text?
6. Is there a difference in learning from electronic presentations involving dimming of text vs. highlighting of text?

Research Design

This experimental study was designed to examine potential differences in student learning from electronic presentations relative to variations in textual display, such as the amount of text disclosed at a given time and the use of specific physical attributes of text to focus learner attention. While the study focused similarly to Mahar et al. (2009) on differences in student learning relative to various content display treatments, this study was not a replication of Mahar et al. (2009). Different choices were purposefully made relative to the design of this particular study and to the design of its materials, instrumentation, and data collection procedures, each of which will be explained within this chapter. One such choice was to include four, rather than two, treatment groups, each with its own electronic presentation format. Such treatments were identified as full disclosure, progressive disclosure, dimming, and highlighting. Among those four treatments, any given pair of electronic presentations (e.g., full disclosure and progressive disclosure, full disclosure and highlighting) offers specific similarities and differences in their design. Such differences provide further nuances not considerable in the comparison of only two treatments. (See Materials section.)

Another such choice was to randomly assign study participants into the four treatment groups. This decision was made for the purpose of controlling for various potentially confounding issues that are mentioned throughout this chapter, such as participants' prior knowledge relative to the electronic presentation content. Collected data was to first be analyzed via a one-way analysis of variance (ANOVA) to identify whether any significant differences exist among the data in the four treatments. If the one-way ANOVA had yielded significance, Tukey post hoc tests would have been conducted in order to identify where the pair-wise significant difference(s) were located. Such Tukey post hoc tests would have been used to maintain a family-wide $\alpha = 0.05$.

Participants

Participants included 256 non-minor aged undergraduate students (128 males, 128 females, one student who identified with a gender of “other”, and one student who did not answer the question about gender) at a large public university in the southeast United States with a mean age of 19.3 years (1.46 standard deviation.) Participants included 57 Asian, 9 black/African-American, 13 Hispanic, and 169 white/Caucasian students; as well as 5 students who identified their ethnicity as “other” and 5 students who did not answer the question about ethnicity. Participants further included 113 freshmen, 83 sophomores, 29 juniors, 28 seniors, and 5 students who did not answer the question about school year.

All participants were recruited from a large, online 1000-level introductory geography course with enrolled students representing numerous colleges and academic departments across campus as well as all undergraduate class years (freshmen through seniors.) Recruiting took place electronically. The course instructor invited students to participate in the study with an e-mail distributed to all students enrolled in the course via the learning management system. This message was accompanied by an informational IRB-approved recruiting script and an IRB-approved recruiting flyer prepared by the researcher to explain the study and what participation would entail, and it provided a link to an electronic sign-up form housed online within the university’s Qualtrics survey platform. Students enrolled in the course were not required to participate in the study; they had a menu of options from which they could choose how they earned regular course credit, and participation in this study was but one of such options. As such, all of those students who did participate received regular course credit from their instructor for participating and were randomly assigned to one of the four treatment groups.

Study Materials

This study used four distinct sets of electronic presentation slides developed in Microsoft PowerPoint and narrated in Adobe Captivate for the delivery of instructional content to participants. One separate version of the electronic presentation was developed for each of the four text design treatments: full disclosure, progressive disclosure, dimming, and highlighting. These narrated electronic presentations were used in lieu of live, in-person classroom content delivery by one or more instructors in order to decrease the potential for confounding relative to differences in live delivery experiences, ensuring that content was delivered in a consistent manner to all participants, regardless of the treatment group to which they were assigned. All four presentations used the same recorded narration (the script for which is included in Appendix A) to ensure the same auditory experience for all participants: all participants, regardless of the treatment group to which they were assigned, heard the exact same audio narration. All four presentations also provided the same textual content on the same number of slides designed within PowerPoint. As such, all participants, regardless of the treatment group to which they were assigned, saw the exact same words in the same presentation slides at some point during the narration.

Treatment descriptions. The differences between the four presentations, then, lay in the way the text was displayed: its movement onto and the timing of its disclosure in a slide (relative to the animation of such text), the duration of its appearance in the slide (display time), and/or specific attributes of the textual content that provide amplification of that text, such as font size, font color, or text type (e.g., bolded vs. non-bolded).

Treatment 1: Full disclosure. Each slide in the full disclosure treatment presentation, for example, included no animation or other movement; all of the textual content included on each slide was visible immediately and throughout that slide's entire narration, and there were no changes in the size, color, or type (e.g. bold) of the text; none of the text on a given slide was amplified at any time during the slide's narration.

Treatment 2: Progressive disclosure. In the progressive disclosure treatment presentation, on the other hand, each bullet of textual information was animated to appear on the screen as it was initially addressed in the narration, at its first verbal mention. As such, the textual content that was discussed in the narration at any given time was the text that had most recently appeared on the slide, and previously-discussed bulleted content was not removed from the slide or dimmed after it had been discussed. By the time the final bullet of textual content appeared in the slide, then, all of the slide's content was visible at once.

Treatment 3: Dimming. In the dimming treatment presentation, progressive disclosure was used to animate each piece or bullet of text content onto the slide as it was addressed in the narration, at its first verbal mention. That same textual content was subsequently "dimmed" as the narration later moved on to the next piece of bulleted textual content. In this case, dimmed text was not removed from the slide but, rather, appeared in a gray color that was not as prominent – that is, did not contrast as much with the black slide background – as the white text that was most recently disclosed via progressive disclosure.

Treatment 4: Highlighting. Finally, in the highlighting treatment presentation, all of a slide's textual content was immediately visible on the slide and remained visible as it was narrated – as was the case with the full disclosure treatment presentation. As a bullet of textual content was discussed in the narration, however, that text was made more prominent than the rest of the text on the slide: it was a bigger font size, bolded type, and bright yellow in color. As such, the textual content being discussed in the narration at any given time was the most prominent, salient text on the slide.

Images of the narrated electronic slides for the full disclosure treatment are included in Appendix B, and an image of one full disclosure treatment slide and images of its corresponding slides from the other three treatments (progressive disclosure, dimming, and highlighting) are included in Appendix C, to show differences. Appendix E includes a table that names the design characteristics evident within the slides of each treatment group presentation and that identifies similarities and differences in such design characteristics in all possible pairs of treatments.

Treatment design characteristic comparisons. Similarities and differences exist between all of the four treatments in the specific design characteristics that were used within each of the narrated electronic presentations‘ slides to accomplish each treatment’s strategy (e.g., full disclosure, progressive disclosure.) These design characteristics include step size, text attributes allowing for amplification of text (specifically bolded typeface, text color, and font size), display time, animation of text, and multimodal synchronicity. Paired comparisons of these design characteristics for all six pairs of treatments may be found in Appendix E, and they are both elaborated upon and summarized within this section.

Step size. Step size is a characteristic of content represented in instructional multimedia that has historically been represented several distinct ways in the literature (Lockee, Moore, & Burton, 2004). One common representation of step size is as the amount of content visible on the screen at one given time (Holland, 1965). This may be represented by, for example, the average number of words per bulleted line in an electronic presentation, or the average number of total words per slide. For the purpose of comparing step size used within each of the four treatments in the case of this study, step size is being identified herein as the average number of words visible on a slide at one given time to the learner.

In the case of slides included in both the full disclosure and highlighting treatment presentations, then, the step size was the average total number of words included on a slide – all bulleted words. This was the case since no text was animated onto any of those treatments' slides; all words on the slide appeared at once and were visible throughout that slide's narration. In the case of slides included in both the progressive disclosure and dimming treatment presentations, on the other hand, the step size varied throughout the narration of a given slide as bulleted textual content was progressively revealed on the slide as it was discussed in the narration. As an example, consider a slide that includes two bulleted lines of content, with eight and four words per bullet for the first and second bullets, respectively. In a presentation using full disclosure or highlighting of text, step size would be 12 words for that slide. In a presentation using progressive disclosure or dimming of text, however, step size would be eight words during the narration of the first bullet and 12 words during the narration of the second bullet; and the average step size of that slide would be 10, the average of eight and 12. Within this study, the average step size used in both the progressive disclosure and dimming treatment presentations (7.5 words) was thus smaller than the average step size used in both the full disclosure and highlighting treatment presentations (11.4 words).

The impact of step size on learning has been examined in numerous studies (e.g., Gropper, 1966; Shap, 1961). Findings have been that as step size was decreased, learning significantly increased (Shap, 1961). The strategy of purposefully reducing step size is aligned somewhat with the coherence principle of multimedia design, which Mayer (2008) identified as one way to facilitate more learning. The coherence principle recommends minimizing the number of extraneous visible words; and when an electronic presentation slide with more than one line (bullet) of text is narrated, all text except that which is being narrated at a given time may be considered extraneous. Thus, the fewer extraneous words visible on an electronic presentation slide at one time, the smaller the step size will necessarily be relative to that particular slide and its content.

Amplification of text. Distribution of emphasis is a characteristic relative to the intentional design of the display of instructional content in order to help "the most important information [on a given slide, for example] 'jump out' at the user, while having less important information remain unobtrusive, yet supportive . . . effectively [redirecting] a student's attention to the most relevant and salient information" (Rieber, 1994, p. 190) in the slide. Using a distribution of emphasis in the design of an individual electronic presentation slide is a form of attentional cueing, reducing the likelihood that the learner will be distracted from the most important information at any given time. One specific category of distribution of emphasis is cosmetic-based amplification of textual content, which in the case of electronic presentation slide design is the deliberate use of specific textual features to "attract and direct [learners'] attention to specific screen parts or text" (Rieber, 1994, p. 191). Cosmetic-based amplification may be achieved in numerous ways, including but not limited to the use of bolded typefaces, varying text colors and brightness, and different font sizes (Park & Hannafin, 1993; Rieber, 1994). By purposefully introducing cosmetic-based amplification to the text included in electronic presentation slides in these and other ways, then, the opportunity for dual coding to be better leveraged is enhanced, as learners' attention may be directed to visual content that is well aligned with verbal content: while other text may be visible on a specific slide, the bulleted text currently being narrated may be emphasized during its narration.

In this study, amplification of text was used in two of the treatments, dimming and highlighting, though in different ways. Such amplification strategies were employed to emphasize the textual content currently being narrated at any given time and to thereby cue the learners' attention to that particular content. In the case of the dimming treatment presentation, all bulleted content was displayed in the same non-bold typeface and with the same font size. There were differences, however, in the color and brightness of the text as the narration proceeded through the content of each slide. As each bulleted line of content was introduced and discussed within the narration, for example, that line of text was displayed in a white color, in sharp contrast to the medium-blue slide background color. As the narration moved away from a bulleted line of content, however, that line of text was then displayed in a medium-gray color with less contrast to the slide background color. As such, the most prominent or visible content at any given time was that content which was being discussed in the narration. This was done in an attempt to coordinate the learner's visual focus at a given moment to align with the verbal information in the narration.

In the case of the highlighting treatment presentation, more distribution of emphasis strategies were employed to draw learners' attention to the content being discussed at any given moment. Although all textual content included in a slide was visible during the entirety of the slide's narration, three strategies were used for attentional or typographical cueing (Hartley, 1987) purposes. As each bulleted line of content was introduced and discussed within the narration, that specific line of text was displayed in a bolded typeface, in a vivid yellow color, and in a large 60-point font. At the same time, all other bulleted text on the slide (that was not the focus of the narration at that time) was displayed in a non-bold typeface, in a white color, and in a smaller 48-point font. These strategies were employed in an attempt to coordinate the learner's visual focus at any given moment to align with the auditory information in the narration.

In this study, amplification of text was not used in the other two treatments, full disclosure and progressive disclosure. In the presentations for both of these treatments, all bulleted content was displayed in the same non-bold typeface, in the same white color, and with the same font size.

Display time. Display time represents the amount of time a given piece of content (e.g., a bulleted line of text) is visible on the screen to the learner (Avons & Phillips, 1990; Ross & Moeller, 1996). In this study, display time for each bullet or line of text included within the presentation slides varied somewhat across the four treatments. In the case of the full disclosure and highlighting treatment presentations, for example, all of the bulleted text included within a specific slide was visible for the entire duration of that slide's narration. As such, all bulleted lines included in a given slide had the same exact display time for those two treatments. In the case of the progressive disclosure and dimming treatment presentations, on the other hand, each bullet of text on a specific slide was visible for a unique amount of time dependent upon when it was discussed in the narration. As such, the first bullet of text on any given slide had a longer display time (i.e., the duration of the narration of the entire slide) than did the last bullet of text on the same slide (i.e., the duration of the narration of only that bullet.) As such, the average display time for the bulleted lines of text was longer within the full disclosure and highlighting treatment presentations, and shorter within the progressive disclosure and dimming treatment presentations.

Animation of text. Animation of electronic presentation textual content is the movement of content onto or away from the screen (as text enters or exits a slide), or changes to the qualities of the text such as its color, font size, or positioning on the slide (Mayer, 2005). Within this study, no animation of content was used in the full disclosure treatment presentation. Animation was used, however, in various ways in the progressive disclosure, dimming, and highlighting treatment presentations. Such animation strategies were employed to emphasize the textual content currently being narrated at any given time and to thereby cue the learners' attention to that particular content.

In the progressive disclosure and dimming treatment presentations, animation was used to provide timed disclosure of textual content. Therein, each bulleted line of text was moved (i.e., animated) onto the screen one at a time. The entrance of any given bulleted line was timed to coincide with the moment the narration began to discuss that line's text content, cueing learners to focus visually on what they would be hearing at that time. The dimming treatment presentation further used animation to provide timed deemphasis of textual content. Therein, the font color of each bulleted line of text (except for the final line on any given slide) was changed from a bright white to a dull gray, giving the effect of that line being grayed out or "dimmed". This dimming animation was timed to coincide with the moment the narration moved away from that line of text to the subsequent line of text on the same slide, and thus occurred simultaneously with the timed disclosure animation of that subsequent bulleted line onto the slide. The dimming animation had the potential to thus further cue learners to focus visually on what they were hearing at that given time.

In the highlighting treatment presentation, animation was used to provide timed emphasis on textual content as the narration discussed each bulleted line in sequence. Therein, each bulleted line of text was emphasized in three ways (with a larger font size, bolded font, and brighter yellow color, in contrast to the white font color used for text in other lines.) The timing of these emphasis animations coincided with the moment the narration began to discuss that line's content, cueing learners to focus visually on what they would be hearing at that time. As the narration later moved away from that particular line to the subsequent one on the slide, another timed animation was used to deemphasize the text no longer being discussed in the narration. Deemphasis was achieved in three ways as well: with a smaller font size, non-bolded font, and a white font color. Deemphasis of one bulleted line was timed to occur simultaneously with the emphasis of the subsequent bulleted line. With the combination of the timed emphasis and timed deemphasis animations, the most prominent chunk of content on a slide at any given time was the one being discussed in the narration.

Synchronized multiple-channel communication. In multimedia instruction, modalities are defined as the sensory receptors or systems through which learners take in information (Moreno & Mayer, 2007; Penney, 1989). Examples of such sensory modalities include auditory, relative to what learners are hearing, and visual, relative to what they are seeing during instruction. Multiple-channel communication is communication in which stimuli is presented through multiple sensory channels (Moore et al., 1996). In this study, participants were presented with synchronized content delivered via multiple-channel communication, specifically in the form of auditory (spoken) narration and visual (textual) content. As such, the content herein was received in a multimodal, multiple-channel, fashion.

In three of the four treatments (i.e., progressive disclosure, dimming, and highlighting), the presentations included multiple-channel content delivery (content received via auditory and visual channels) that was synchronized, offering temporal contiguity of related auditory and visual content components. In the presentations for each of these three treatments, animation and/or amplification of text was employed to coordinate what participants were seeing (i.e., a specific bulleted line of text) with what they were hearing (i.e., the narration about that bulleted line of text) at the exact same time. In the case of the progressive disclosure and dimming treatment presentations, for example, each bulleted line of text was animated onto the slide at the same time as the narration began to discuss its content. In the case of the highlighting treatment presentation, each bulleted line of text was highlighted – amplified – at the same time as the narration began to discuss its content. In the case of the full disclosure treatment presentation, on the other hand, all bulleted lines of text were visible during the narration of the entire slide. As such, there was no temporal contiguity aligning each individual visual line of text with its narrated, auditory explanation.

Development and validation. The narrated electronic presentations were designed by the researcher specifically for this study, and each of the 15-minute presentations included 39 total slides with an average of four bullets per slide, 13.3 words per content slide, and a 2,137-word narration. The progressive disclosure, dimming, and highlighting treatment presentations that used animations to introduce textual content onto the screen or to change textual attributes to provide cueing each used an average of 2.5 animations per animated slide (e.g., animating a bullet and its content onto the screen, animating content by increasing its size and color). The content included in the presentations was an introduction to the United States Coast Guard Academy (USCGA), and the content was collected from numerous websites, such as the USCGA official site (http://www.uscga.edu) and its Wikipedia page (https://en.wikipedia.org/wiki/United_States_Coast_Guard_Academy), as well as other knowledgeable sites (e.g., https://media.defense.gov/2017/Jun/25/2001768429/-1/-1/0/USCGA_HISTORY_FINAL.PDF.)

The content was organized into meaningful chunks, and the script was written, by the researcher to allow the narration to flow meaningfully and smoothly from one main idea to another. Some of the main ideas included within the script include introductory information (e.g., USCGA location and purpose), USCGA history, athletics at the USCGA, and academics at the USCGA. The initial draft of the 15-minute script was sent to three subject matter experts, including a U.S. Coast Guard officer, a third-class (junior) USCGA cadet, and a member of Virginia Tech's Corps of Cadets, for verification of the accuracy of the information included therein for content validity. Feedback correcting the script information was used in modifying the script accordingly, and feedback suggesting changes based on preference was considered and used in making changes to the script when such changes were deemed to enhance the script. One change was made, for example, when feedback indicated that USCGA cadets spend six weeks – rather than the five originally reported in the script – aboard the USCGA's training vessel in the summer following their first academic year. Another change was made in how that vessel was named in the script: "Unites States Coast Guard Cutter" was added immediately before its name of *Eagle.* To assure readability by the targeted participants, the modified script was then sent to three Virginia Tech undergraduate students who read through the script to identify any portions that were confusing or that did not make sense. Feedback therefrom was considered and used in making changes to the script when such changes were deemed to enhance the script. One such change was the inclusion of the fact that the USCGA is a four-year institution, which was not initially stated in the script. Another was removing the acronym STEM from the description of the USCGA's majors; feedback thereto was that some participants may not be familiar with the term.

All of the four treatments' electronic presentations included visual content solely in the form of text; no images were used on any of the slides. The purpose for this part of the design was to focus on the impact of variations in the display of text only. Including images in addition to the text may have introduced conflation of such images with the included text, thereby confounding the results. Each individual slide was one of two types: a header slide or a content slide. Ten header slides were used to introduce a new idea of content (e.g., USCGA history, athletics at the USCGA, or academics at the USCGA), and were shown as the narration began to describe that idea. Header slides included one or two words describing that idea, with centered text in an Avenir 110-point font that was white in color on a medium-blue background.
A total of 28 content slides followed such header slides with a left-justified title at the top of each slide, and left-justified textual information related to that particular idea using bulleted text below the title. One of the content slides relative to athletics at the USCGA, for example, included the three levels of athletic competition in which cadets engage at the USCGA. (See Figure 1 for an example of a header slide.)

Figure 1. Header slide example. This figure illustrates the formatting of header slides.

In all four treatments' presentations, all content slides were designed with a black background, and the title at the top of each content slide used Avenir 66-point font in the same medium-blue color that comprised the header slides' background. In the full disclosure and progressive disclosure treatment presentations, all body (bulleted) text used an Avenir 48-point font that was white in color (see Figures 2a and 2b.) In the dimming treatment presentation, all body text used the same Avenir 48-point font. The color of each bullet of text was white while that bullet was narrated, and it changed to a medium gray as the narration proceeded to the subsequent bullet and as that subsequent bullet appeared on the slide (see Figure 2c.) In the highlighting treatment presentation, "highlighted" body text used a bolded Avenir 60-point font that was a vivid yellow in color, and non-"highlighted" body text used the same white-colored Avenir 48-point font as was used throughout the full disclosure, progressive disclosure, and dimming treatment presentations (see Figure 2d.) Images of some of the slides from each of the four presentations are included in Appendices B and C.

Figure 2a. Content slide example: full disclosure. This figure illustrates a content slide in the full disclosure treatment presentation.

Figure 2b. Content slide example: progressive disclosure. This figure illustrates a content slide in the progressive disclosure treatment presentation.

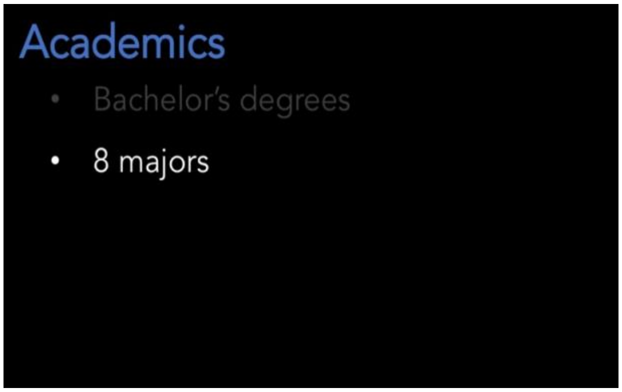

Figure 2c. Content slide example: dimming. This figure illustrates a content slide in the dimming treatment presentation.

Figure 2d. Content slide example: highlighting. This figure illustrates a content slide in the highlighting treatment presentation.

All slides – header and content – included text in the form of keywords and phrases. No full sentences were used on any of the slides in any of the electronic presentations. This was a deliberate choice for the purpose of adhering to the coherence principle of multimedia design (Mayer & Moreno, 2005) supported by Mayer's (2002) cognitive theory of multimedia learning. This particular principle advocates for minimizing the amount of extraneous words used in a multimedia presentation because "students learn better from a coherent summary which highlights the relevant words . . . than from a longer version of the summary" (Mayer & Moreno, 2005, p. 4).

Assessment Instrument

One assessment instrument for use with all four treatments was developed within Qualtrics and is available in Appendix D. The instrument was designed by the researcher specifically for this study to assess student learning of declarative (factual) knowledge of the United States Coast Guard Academy as a result of watching and listening to the electronic presentations. The assessment included 15 multiple-choice recognition-based questions, each with four answer choices. Recognition-based assessment is considered a more superficial form of processing depth than is assessment based on recall, application, or transfer (see Anderson, 2005; Craik & Lockhart, 1972).

The assessment instrument was administered once to each participant after their engagement with the narrated electronic presentations. It was not administered as a pre-test prior to students' participation in the study, in an effort to not prematurely introduce study participants to the presentations' content, which could confound the results of the study. Potentially confounding variations in participants' prior knowledge were controlled for by random assignment of all participants into one of the four treatment groups.

The assessment was shown all on one page within Qualtrics, such that participants could see all of the questions at once and did not need to click through numerous pages to complete the assessment. All questions were required to be answered before the assessment could be submitted within Qualtrics; participants were thus not permitted to leave items unanswered. Included at the end of the instrument, on a page separate from and subsequent to the assessment items, was a questionnaire designed to collect demographic information including each participant's gender, age, ethnicity, and year in school. Participants were given the option of responding to each of these demographic items, or instead choosing not to provide a response to any or all of them.

Procedures

Participants signed up electronically to participate in this study via an online Qualtrics form designated for this purpose. On the form, each participant provided their first and last name and their e-mail address, and selected their first choice of a date and time on and at which they would meet to participate in the study. They were then sent a follow-up e-mail directly from the researcher thanking them for their willingness to participate, confirming the date and time they would be participating, and providing the location where they would participate in the study. The e-mail also provided directions to the study location, both the building and the specific room. Further, it reminded them that they would meet with the researcher only once, for no more than 30 minutes. Finally, the e-mail introduced them to the consent form, which was included in PDF format as an attachment. Participants were asked to download the consent form for their own records, and to read through the consent form before meeting with the researcher to participate in the study. They were invited to ask any questions they had regarding the consent form and/or the consent process by contacting the researcher directly via e-mail or phone call, and were notified that they would have the opportunity to sign the consent form when they arrived to participate in the study and to ask any final questions in person before signing.

In groups of no more than ten, participants met with the researcher in a classroom on campus. Prior to their arrival to the study room, participants were randomly assigned to one of the four treatment groups. When they arrived to the study room, they were asked to sign a paper sign-in sheet to indicate their attendance. Each seat that was used in the study was numbered, and had a laptop (either Apple or Dell) and a set of headphones ready for participants to use. Each participant was asked to sit at an assigned seat number, based on the treatment group to which they were assigned. Each laptop was running (from a thumb drive) an HTML file appropriate to the participant's treatment, and the screen showed a brief message asking participants to wait for instruction before proceeding.

Once the scheduled start time was reached, the researcher read a script to the participants, welcoming them, thanking them for their time, and providing instructions. The instructions concluded with an invitation for participants to turn their attention to a printed copy of the consent form in front of them on the table, and to ask any questions they had about consent before signing the last page of the form. Once all questions were answered, participants gave their consent by signing the forms, and all forms were collected. The researcher then asked one final time for any further questions from the participants about the study.

After all participant questions were answered, participants were then asked to put on their headphones and then to click the "Begin" button on their screens. This click took them to a screen on which the 15-minute instructional electronic presentation appropriate to each participant's treatment group began playing automatically. While watching and listening to the presentation, participants did not have any "player controls" available with which to manipulate the presentation; they were unable to stop, pause, or rewind the presentation. They were also instructed not to take any notes while watching the presentation. At the end of the presentation, participants were instructed by the narration to scroll down the computer screen and click on "Continue." Doing so linked them directly to the assessment within Qualtrics. Participants then completed both the 15-item assessment and the demographic questionnaire, submitting their responses electronically. Once all participants completed these tasks, the researcher read a final script thanking them again for their time, and dismissed them from the room. Their participation in the study was at that point complete.

Pilot Testing

Several months before the research study was conducted, pilot testing was conducted in order to evaluate study and instrument feasibility and time expectations, to improve the study's design, and to identify which four narrated electronic presentations would be used in the study. Prior to the pilot testing, narrated electronic presentations of two different lengths (10.5 minutes and 15 minutes) were produced. Two scripts were finalized for those presentations; the 10.5-minute script was a pared-down version of the 15-minute script, with some sections of information removed (in entire meaningful chunks, so as to not disrupt the flow and meaning of the narration) but nothing additional added. Four electronic presentations were made at each length – one per treatment (full disclosure, progressive disclosure, dimming, and highlighting) – for a total of eight presentations.

Pilot testing participants included undergraduate students and new graduate students (who earned their undergraduate degrees two months prior) on campus during the summer session. All years of undergraduate students (freshmen through seniors) were represented. Participants were recruited from various summer courses and programs across campus. One course instructor awarded two points of extra credit to pilot participants; non-participants in that course were allowed to complete an alternative assignment for the same amount of extra credit. A second instructor gave students the choice to participate or to complete an alternative assignment for regular course credit. All other instructors, facilitators, and mentors did not offer extra credit, and participants from these groups were entered into two drawings for $20 gift cards to Starbucks. Some pilot participants were recruited by their instructors and facilitators via e-mail with a text script written by the researcher and an attached recruiting flyer created by the researcher, while other participants were recruited by the researcher during in-person visits to their classrooms with a brief narrative (oral) description of the pilot testing and distribution of the recruiting flyers. Pilot testing procedures mimicked planned study procedures. Participants first signed up for a participation date and time online via Qualtrics. All testing took place in classrooms on campus, where each participant signed in and was directed to a specific laptop and set of headphones (based upon prior randomized assignment to one of the treatment groups), was read the welcoming script, watched the electronic presentation associated with the treatment to which he or she was randomly assigned and completed the assessment, and was dismissed. Students participated in pilot testing in groups of one to seven students at a time.

Fifty-five (55) total students participated in the pilot testing. Initial pilot testing focused on the 10.5-minute treatments, and 22 participants (13 females, nine males; average age 19.7) were randomly assigned to one of the four treatments. Following exposure to the assigned treatment electronic presentation, each participant then completed the content assessment composed of 15 multiple choice questions. The mean score of the 22 participants was 12.3 with a standard deviation of 1.85. The focus then turned to the 15-minute treatments. The 15-minute assessment was revised prior to pilot testing, based upon what was learned from pilot-testing the

10.5-minute materials: three questions that all students had answered correctly were replaced or revised. The 33 participants (28 females, five males; average age 21.3) pilot testing the 15-minute electronic presentations were also randomly assigned to treatment groups, and following exposure to the assigned treatment, each participant then completed the content assessment composed of 15 multiple choice questions. The mean score of those 33 participants was 11.7 with a standard deviation of 1.79. A summary of pilot testing participant data is provided in Table 2, organized by treatment length (i.e., 10.5-minute and 15-minute.)

Table 2

Pilot Testing Participant Data by Treatment Presentation Length

Treatment Presentation Length	M	SD	Male	Female	n
10.5 minutes	12.3	1.85	9	13	22
15 minutes	11.7	1.79	5	28	33

In examining results of the 10.5-minute and 15-minute electronic presentation participants, both presentation lengths and their associated assessments functioned well. Additionally, participants' performance relative to the 10.5-minute and 15-minute presentations were statistically similar: $t(53) = 1.20$, Cohen's $d = 0.32$, $p = 0.23$. Given the appropriate functioning of each presentation and the statistically similar performances of each group of participants, there was no structural reason to choose one set of treatments over the other. It was considered that the 15-minute treatments may contribute to greater cognitive load than the 10.5-minute treatments based on the 15-minute presentations' increased length (11 additional slides over 4.5 additional minutes) and increased amount of content (590 additional words in the script) relative to the 10.5-minute presentations. It was further considered that this higher cognitive load may become more evident in a study with a larger number of participants. For these reasons, the 15-minute presentations were selected for use in this research study.

Data Collection

All data captured by the assessment instrument was electronic in nature, and included participants' responses to the 15 assessment and demographic questionnaire items. Such data was collected and stored within the Qualtrics website where only the researcher had access to the data via a password-protected account. None of this data included any identifying information such as participants' names, e-mail addresses, or student identification numbers. From the Qualtrics website, the data was downloaded into a spreadsheet file and saved onto a password-protected computer (in the possession of the researcher) for analysis.

Data Analysis

Collected data was numerical in nature, and represented scores on the assessment. The assessment was scored by allotting one point for each correct answer, for a maximum individual score of 15 points per participant. Once all assessments were scored, a one-way ANOVA was conducted to determine if any significant differences existed between the four treatments in student performance. If there had indeed been significant differences, a series of Tukey post hoc tests to maintain a family-wide alpha = 0.05 would have been conducted in order to identify where the significant difference(s) across treatments were located.

Chapter 4: Results

This study was designed to examine potential differences in student learning from instructional electronic presentations relative to variations in textual display. Specific textual display treatment methods included full disclosure, progressive disclosure, dimming, and highlighting. Student learning was measured by participant scores on a recognition assessment completed immediately after exposure to an electronic presentation using one of these four display methods, relative to the treatment to which each participant was randomly assigned. Analysis included a one-way ANOVA with the four textual display treatments as levels and with significance identified at $p = 0.05$.

Research Questions

This study examined the following broad research question, as well as the specific narrower research questions listed and enumerated below: What is the impact on student learning of various textual display treatments in electronic presentations? Specific research questions included:

1. Is there a difference in learning from electronic presentations involving full disclosure (treatment 1) vs. progressive disclosure of text (treatment 2)?
2. Is there a difference in learning from electronic presentations involving full disclosure (treatment 1) vs. dimming of text (treatment 3)?
3. Is there a difference in learning from electronic presentations involving full disclosure (treatment 1) vs. highlighting of text (treatment 4)?
4. Is there a difference in learning from electronic presentations involving progressive disclosure (treatment 2) vs. dimming of text (treatment 3)?

5. Is there a difference in learning from electronic presentations involving progressive disclosure (treatment 2) vs. highlighting of text (treatment 4)?
6. Is there a difference in learning from electronic presentations involving dimming of text (treatment 3) vs. highlighting of text (treatment 4)?

Analysis

In examining student learning relative to the four textual display treatments, a one-way ANOVA was conducted to determine if any significant differences existed between the four treatments with regard to student performance on the assessment. Assessment scores were numerical, representing the total number of correct responses to 15 multiple-choice questions. Possible scores were thus whole numbers that ranged from 0 to 15. Mean scores and standard deviations of each of the four treatment groups were calculated and used in this analysis (see Table 3.)

While the sample sizes of the four treatment groups were roughly equal, a Levene's test was calculated in order to verify that the assessment scores of the four treatment groups had equal variances, an assumption of the one-way ANOVA F statistic. Results of the Levene's analysis, $F(3, 254) = 0.427$, $p = 0.73$, indicated that the variances of the four treatment groups were statistically similar and the one-way ANOVA F statistic is appropriate.

The one-way ANOVA revealed no statistically significant differences between the four treatment groups, $F(3, 254) = 0.66$, $p = 0.57$. These results indicate that the same amount of learning occurred across all four treatment groups, regardless of the textual display method that was used within each treatment's electronic presentation. Had any statistically significant differences been revealed, Tukey post hoc tests would have then been conducted in order to identify specifically where the pairwise statistically significant differences were located.

Table 3

Means and Standard Deviations of Treatment Group Assessment Scores

Treatment Group	M	SD	n
Full Disclosure	11.14	2.26	66
Progressive Disclosure	11.29	2.24	66
Dimming	11.33	2.25	63
Highlighting	11.67	2.02	63

Explicit Examination of Study Research Questions

Research question 1 examined the difference in student learning from electronic presentations involving full disclosure and progressive disclosure of textual content. This research question was analyzed through the comparison of learning relative to treatments 1 and 2, the difference between which was found to be statistically non-significant based on the aforementioned ANOVA.

Research question 2 examined the difference in student learning from electronic presentations involving full disclosure of textual content and dimming of text. This research question was analyzed through the comparison of learning relative to treatments 1 and 3, the difference between which was found to be statistically non-significant based on the aforementioned ANOVA.

Research question 3 examined the difference in student learning from electronic presentations involving full disclosure of textual content and highlighting of text. This research question was analyzed through the comparison of learning relative to treatments 1 and 4, the difference between which was found to be statistically non-significant based on the aforementioned ANOVA.

Research question 4 examined the difference in student learning from electronic presentations involving progressive disclosure of textual content and dimming of text. This research question was analyzed through the comparison of learning relative to treatments 2 and 3, the difference between which was found to be statistically non-significant based on the aforementioned ANOVA.

Research question 5 examined the difference in student learning from electronic presentations involving progressive disclosure of textual content and highlighting of text. This research question was analyzed through the comparison of learning relative to treatments 2 and 4, the difference between which was found to be statistically non-significant based on the aforementioned ANOVA.

Research question 6 examined the difference in student learning from electronic presentations involving dimming of text and highlighting of text. This research question was analyzed through the comparison of learning relative to treatments 3 and 4, the difference between which was found to be statistically non-significant based on the aforementioned ANOVA.

Chapter 5: Discussion

As a result of the increasingly widespread use of electronic presentation software (e.g., Microsoft PowerPoint, Google Slides, Prezi) for instructional purposes, numerous recommended presumed best practices for the design of electronic presentation slides to be used in the classroom have been identified and are widely published (e.g., Brock & Joglekar, 2011; Larson, 2004 Priya, 2012). Most of these recommended best practice strategies are supported by cognitive theory, for example cognitive load theory (Chandler & Sweller, 1991), dual coding theory (Paivio, 1986), and active processing (Mayer & Moreno, 2005). Many of these recommended presumed best practices, however, are strategies for which no empirical support exists to show that they will facilitate learning as it is theorized they will. A question this leads to, then, is: How do these recommended presumed best practices for the design of electronic presentation slides impact student learning?

The primary goal of this research study was to explore this question and to seek empirical evidence regarding some of the often-made recommendations regarding textual display in instructional electronic presentations. Specifically, this study examined four particular methods of textual display (i.e., full disclosure, progressive disclosure, dimming, and highlighting) in the design of electronic presentations for instructional purposes, in order to determine whether learning differences occurred relative to those four methods. Participants in the study engaged with the textual displays embedded in one of four electronic presentations that incorporated visual slides created in Microsoft PowerPoint with auditory “voiceover” narration. Participants further completed an assessment with recognition-type items immediately after such engagement, to measure how much they learned from the electronic presentation. The results of this study indicate that differences in student learning, relative to the four treatment methods of textual display in electronic presentations, were not statistically significant.

Instructional Message Design

Fleming and Levie (1993) described instructional message design as the deliberate design of messages in order to modify "the psychomotor, cognitive, or affective behavior of [the learner]" (p. x). A primary goal of instructional message design is the reduction of cognitive load, specifically extraneous cognitive load (Bishop, 2014), which is generally detrimental to learning and potentially impacted (increased or decreased) by the design of instructional presentations – including electronic presentations. Within the literature relative to the design of electronic presentation slides for use in the classroom, progressive disclosure, dimming, and highlighting of textual content are strategies commonly recommended as presumed message design best practices – in lieu of full disclosure of textual content – to help in the facilitation of learning. These particular practices are recommended because they are each perceived to have meaningful impacts on learning through the reduction of cognitive load, leveraging of dual coding, and/or facilitation of active processing. The findings of this study include no evidence that any one of these practices is significantly more impactful than others on student learning from electronic presentations.

Cognitive Psychology Underlying Treatment Display Decisions

The four methods of textual display used in the study treatments – full disclosure, progressive disclosure, dimming, and highlighting – have within them five specific design characteristics, namely amplification of text (e.g., bolding, font size, and text color) (Rieber, 1994), animation of text (i.e., timed disclosure, timed emphasis, or timed deemphasis) (Mayer, 2005), display time (Avon & Phillips, 1990), synchronized multiple-channel communication

(Moore et al., 1996), and step size (Holland, 1965). Each of the four methods of textual display represents a unique combination of these design characteristics (see Appendix E for similarities and differences across treatments), and each one of these five design characteristics has the potential to impact learning by influencing, among other factors, cognitive load, dual coding, and/or active processing.

While the current study yielded non-significant differences across all pairwise comparisons of the four textual display treatments, the study was not designed to specifically examine the singular impact of any of these cognitive psychology principles upon student learning from electronic presentations. Instead, the current study examined these three principles only in various combinations; as such, the efficacy of any of the three individual principles was not examined.

Student and Instructor Perceptions of Electronic Presentation Use in the Classroom

The findings of this study may be tied back to the perceptions reported in the literature of both students and instructors relative to the use of electronic presentations for instructional purposes. A majority of course instructors use electronic presentations frequently and while newer instructors use them in their classrooms more than do more experienced instructors all graduate assistant instructors reported using them (Hill et al., 2012). Electronic presentation use in the classroom only seems to be increasing as time goes by, and those instructors using electronic presentations for instructional purposes report learning how to use them efficiently and effectively through unstructured and unsupported trial and error, if at all (Hertz et al., 2015). The combination of these two situations means that well-defined recommendations of best practices for the design of electronic presentation slides for better facilitation of learning will have an increasingly large audience as time continues to go by. The findings of this study relate to the currently-recommended presumed best practices of using progressive disclosure, dimming, and highlighting of textual content.

Further, students report a preference for electronic presentations for instructional content delivery over other delivery methods such as overhead transparencies or traditional lectures with chalkboards (Lowry, 1999; Shuell & Farber, 2001; Szabo & Hastings, 2000), as well as a desire for electronic presentations to continue to be used in future classes (Szabo & Hastings, 2000). Their instructors perceive that expectation, which in part drives the instructors' continued and/or increased use of electronic presentations in their classes (Hertz et al., 2015). Since students have been found to perform better in classes in which their preferred delivery medium (e.g., electronic presentations, overhead transparencies) is used (Beets & Lobingier, 2001), and electronic presentations are often the preferred medium, the continued use of electronic presentations in the classroom may help to improve student performance.

For instructors wondering how to best design the display of textual content within their presentations, initial data from the current study provides some indication that perhaps any of the four examined methods of textual display (i.e., the four treatments) is as effective in facilitating learning as are the other three. Given that it is *how*, rather than *whether*, electronic presentations are used in the classroom that matters relative to the facilitation of learning, instructors may thus be able to select any of the four treatment methods and then focus more intently on other design decisions such as the amount of content displayed on each slide, or which images for use on slides have the most perceptible details and will best relate to textual content. For instructors who are leery of using progressive textual disclosure in their presentations but whose students recommend the use of progressive disclosure as was reported in Apperson et al. (2008) and Yilmazel-Sahin (2009), these initial findings may support the idea that progressive disclosure is not inhibitive to learning relative to the three other textual display methods, in which case those and other instructors may be able to use progressive disclosure without directly hampering student performance.

Best Practice Recommendations

Within the literature is an abundance of advice for the designers of electronic presentations for instructional purposes. This advice indicates that presentations should be designed using, among other strategies, progressive disclosure (Collins, 2004; Levasseur & Sawyer, 2006; Williams, 1998), dimming with or without progressive disclosure (Broderick, 2003), and/or highlighting with or without progressive disclosure (Cooper & Yoder-Wise, 2003; Reimold & Reimold, 2003) of textual content – rather than full disclosure of textual content – in order to maximize student learning. All three of these strategies are hailed as providing attentional cues to guide the learners' attention, thereby facilitating learning by decreasing cognitive load, facilitating active processing, and/or leveraging dual coding. The use of none of these three strategies, however, is supported by empirical evidence. Indeed, the recommendations that are made on their behalf (e.g., Collins, 2004; Priya, 2012), while made in good faith, arise out of the authors' own experiences as students or instructors and are formed relative to what they know about how people learn.

This current study found that student learning, relative to the three specific strategies of textual display (progressive disclosure, dimming, and highlighting) and to the strategy of full disclosure, in electronic presentations with slides with text only, is not statistically significantly different. Statistically speaking, students learn on average the same amount whether they engage with text-only electronic presentations that use full disclosure, progressive disclosure, dimming, or highlighting. As such, specific recommendations to use one of these strategies instead of any one of the other three are not empirically supported. The use of any of the four strategies in the design of text-only electronic presentations may in fact result in about the same amount of learning.

In a study somewhat similar to this one, Mahar et al. (2009) examined differences in student learning relative to narrated electronic presentations using two treatments (display methods): full disclosure and progressive disclosure. Therein, electronic presentation slides were not limited to text only but instead included a combination of both text and images; and the progressive disclosure treatment presentation included the progressive disclosure of all of those elements to time their revelation on the screen with their discussion within the narration. Findings in Mahar et al. (2009) were that more learning occurred in the full disclosure treatment group than in the progressive disclosure group; the progressive disclosure of text and images, the authors said, inhibited learning. The present study, on the other hand, found that when only text (and no images) were included in narrated electronic presentations, progressive disclosure did not inhibit learning.

The potential application of the results of the Mahar et al. (2009) study is limited, in that the published article did not provide sufficient detail to lend itself to generalization and the determination of potential rationales for the impact of the two examined treatments upon learning. Missing crucial information included how text was represented (e.g., with keywords and phrases or in full sentences) on the slides, the size(s) of all included images and text, whether such images were related to the textual content, and how many images on average were included in each slide. Each of these pieces of information represents a design decision that may have critical impact upon student learning, from the perspectives of perception, cognitive load, and dual coding. When progressive disclosure is used – instead of full disclosure – in the design of an electronic presentation, for example, the learner has less time to read some of the text or to look at and process the images included on the slides, particularly the text and/or images that were disclosed later in the slide's narration. As such, the use of full sentences – which require more time to read than do keywords and phrases, combined with progressive disclosure, could be detrimental to learning. The use of too-small images – which inhibit perception and require more processing time – or a too-large number of images per slide – which may also inhibit perception and require more processing time – combined with progressive disclosure, could be similarly detrimental to learning. The use of text that is of a small font size also has the potential impact of inhibiting perception and requiring more processing time, such that a too-small font size combined with progressive disclosure could diminish learning.

Further confounding is the conflation within Mahar et al. (2009) of text and images, wherein the impacts on learning of the text, of the images, and even of the full disclosure and progressive disclosure treatments themselves were not distinguished. The conclusions of Mahar et al. (2009) should thus be applied to practice cautiously, as the progressive disclosure treatment itself may not have been responsible for the decrease in learning identified relative to the full disclosure treatment group. The use of images, or of images that were unrelated to the textual content, or of images and/or text that was too small to be well perceived, may have been responsible for such identified differences.

Limitations

Some limitations may be identified within the conduct of this study. First, the learning content selected for the electronic presentations with which participants engaged (e.g., facts about the United States Coast Guard Academy) could be related to limited participant interest in the presentation and thus limited motivation to concentrate on the presentation. Second, also potentially limiting participant motivation is the fact that participants all received the same amount of course credit for their participation, regardless of their performance as measured by assessment scores. With their credit not tied to achievement, participants may not have felt as incentivized – been as motivated – to perform as well as possible. Third, the assessment strategy measured recognition memory of a presentation of factual information that was 15 minutes in length. Its sole use of recognition-based items within the assessment of this study is limiting because recognition-type assessment items do not require the recall, or generation, of instructional content. Finally, to what participants specifically attended during the study was not recorded. While interacting with the presentation, for example, their eye movements were not tracked, such that their focus on the presentation's visual content was not verified.

Practical Implications

There are practical implications of this study and its findings for the multitude of instructional professionals (e.g., instructors and instructional designers) who are involved in the design of electronic presentation slides for the purpose of teaching and learning. The primary implication is that in the design of instructional electronic presentations, among the four textual display strategies examined herein (full disclosure, progressive disclosure, dimming, and highlighting), there is not a display strategy that has been statistically shown to either enhance or inhibit learning in comparison to the other three display strategies. As such, this initial foray into the examination of the effectiveness of these four strategies indicates that any of the four strategies may be used with equal impact in the design of electronic presentations by instructors who want to help foster student learning.

A secondary implication is that caution should be applied when reading the scholarly and practice-based literature for recommendations of how to best design electronic presentations with an eye on student learning. In the absence of support in the form of empirical evidence, many of the frequently recommended presumed best practices are heralded as best practices based on their assumed or supposed support from cognitive theory (e.g., decreased cognitive load, leveraged dual coding, and increased active processing). Such claims are easily believable, as they seem intuitively correct; and it is easy to ignore the lack of empirical evidence.

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Appendix A: Module Narration Script

Opening

In this instructional module, you will be learning about the United States Coast Guard Academy. You will watch and listen to a video with information about the Academy, and then you will be asked to answer 15 questions at the end about what you learned.

Introduction

The United States Coast Guard Academy is a four-year undergraduate military college in New London, Connecticut, with about 1,000 students, an average graduating class size of 250, and an average class size of 16 students.

The Coast Guard Academy is one of five federal service academies in the United States that prepares students for service as military officers; the other four include the Naval Academy, Military Academy (also called West Point), Air Force Academy, and Merchant Marine Academy.

As a military college, the purpose of the Coast Guard Academy is to graduate students who will be worthy of serving as commissioned officers in the United States Coast Guard. To help ensure that it fulfills this purpose, the Academy has three objectives that it strives to meet. Specifically, its objectives are to provide for each of its students the following:

- An environment encouraging a high sense of honor, devotion to duty, and respect for others;
- A sound undergraduate education in fields important to the success of the Coast Guard; and
- Athletic, professional, and military training allowing for success in officer positions into which students are placed after graduation.

All students at the Academy are Coast Guard officers in training, and they are called “cadets” just like the members of Virginia Tech’s Corps of Cadets. Also like members of the Corps here at Virginia Tech, cadets at the Coast Guard Academy wear military uniforms while on campus; and they are also required to live on campus all four years.

There are several financial advantages to attending the Coast Guard Academy. Cadets pay no tuition to attend the Academy, for example; the costs of classes, housing, and food are provided by governmental funding. Additionally, cadets earn a monthly stipend during all four years at the Academy. Some of that money is then used to pay for books, uniforms, and other items essential for life on campus; but the remainder of it is theirs to save or spend.

History

The Coast Guard Academy was founded four years after Virginia Tech, in 1876. At that time, the Academy had a total of nine students, was named the Revenue Cutter School of Instruction, was based in Massachusetts, and taught students during a two-year training mission aboard a ship. And although students learned about subjects like math, English, and history while on the ship, it was more like an apprenticeship than the college class environment you are used to.

In 1890, after 13 years of operating on a ship, the Academy moved onto land in Maryland. It wasn't until 1910 that the Academy moved to its current home of New London, Connecticut. Five years later, in 1915, the United States Coast Guard was officially formed by then-President Woodrow Wilson by combining the Revenue Cutter Service with the U.S. Life Saving Service; and the Academy was renamed the Coast Guard Academy.

In 1946, the Academy received, as war reparation from Nazi Germany, a tall ship now called the United States Coast Guard Cutter *Eagle* that became its primary training vessel for all cadets at the Academy. To this day, the *Eagle* retains that role, with cadets getting experience aboard the *Eagle* in the summers during their time at the Academy.

Over time, the Coast Guard Academy changed some of its admissions policies in response to national social changes. In 1962, for example, it became racially integrated. It was not until 1976, however, that women were first admitted as cadets.

Admission
Now that the Coast Guard Academy is fully integrated, applying to the Academy is similar in some ways to applying to civilian colleges like Virginia Tech. Since it is a federal service academy, however, there are some differences. In order to be eligible for admission, applicants must:

- Be United States citizens of sound moral character;
- Be unmarried with no dependents and no financial debt, including car loans and credit card debt;
- Be between the ages of 17 and 22 by the month they enter the Academy; and
- Have a high school diploma or GED.

About 300 cadets are admitted to the Academy each year, representing an average acceptance rate of 10-15%. Regardless of age and prior experience, all cadets start as "freshmen" and must complete all four years at the Academy.

The Academy prioritizes admission for people who are likely to succeed in its unique environment focused squarely on academic, military, and athletic training. Specifically, it seeks applicants with:

- Leadership skills – both a willingness and an ability to lead others;
- A desire to serve the country and humanity at large;
- A commitment to achieve one's own full potential; and
- Physical fitness and athleticism.

When students apply to the Academy, the process is similar to the process for civilian schools like Virginia Tech; they submit an application, transcripts, and SAT scores just like you did. One primary difference is that the Academy also requires applicants to complete a Physical Fitness Examination. The Physical Fitness Exam includes three specific activities:

- Push-ups;
- Sit-ups; and
- A one-and-a-half-mile run.

Once admitted, cadets continue to take the Physical Fitness Exam twice each year, at the beginning of each Fall and Spring semester. If a cadet happens to score below the required minimum twice in one semester, he or she is disenrolled from the Academy.

Athletics

Athletics are an integral part of cadet life at the Coast Guard Academy. In addition to regularly completing the Physical Fitness Exam, every cadet is required to participate in competitive sports; and the Academy offers three ways to compete:

- The first option is also the most competitive: varsity sports. The Academy offers 25 varsity sports that allow cadets to compete against other varsity college teams in the NCAA at the Division III level. 62% of the cadets compete on varsity teams.
- The second option is club sports. Club sports allow cadets to compete against club teams from other colleges and universities.
- The final option is intercompany sports, which are very similar to intramural sports at Virginia Tech in that cadets compete against their peers on campus.

Academics

While athletics are important at the Academy, academics are the primary focus. The Coast Guard Academy offers bachelor's degrees, and students have a choice of eight majors. A majority of these majors are related to science and technology (half, in fact, are in engineering disciplines), and all of them focus on teaching students academic content in the context of what matters in daily Coast Guard operations. The majors offered include:

- Civil engineering,
- Electrical engineering,
- Mechanical engineering,
- Naval architecture and marine engineering,
- Operations research and computer analysis,
- Marine and environmental science,
- Management, and
- Government.

Daily Schedule

Academics are just one part of the rigorous schedule that cadets follow during each Fall and Spring semester. This schedule includes a combination of military training, classes, athletics, and studying.

Cadets begin their day by waking up at 6:00am and eat breakfast at 6:20. Breakfast is followed by military training at 7:00, and morning classes begin at 8:00. Lunch at noon gives the cadets a break between classes; and after lunch, they return to classes at 1:00. The athletic period begins at 4:00, and is followed by dinner at 6:00. After dinner, cadets have a three-hour study period beginning at 7:00. This study period is also the time during which cadets attend campus events and hold club meetings. At 10:00pm, the day ends with the playing of “Taps”.

Free Time

Here at Virginia Tech, you are allowed to leave campus pretty much whenever you want; and you have a decent amount of free time that you can decide what to do with. At the Academy, however, things are different. Cadets may leave Academy grounds generally only on two types of occasions: when they have either “Leave” or “Liberty.”

Leave is essentially a long, school-wide break from campus, such as Thanksgiving break, winter holiday break, and Spring Break.

Liberty is different from Leave; it is individual permission to leave campus for short periods of time. Liberty is earned by individual cadets for following the rules of the Academy, maintaining good grades, and performing well athletically. Typically, Liberty is granted every weekend.

Yearly Progression

Prior to earning liberty and leave, cadets first go through an orientation to the Academy. They arrive to the Academy nearly two months before the Fall semester begins, for what is called “Swab Summer.” At the beginning of Swab Summer, students are officially sworn in as military service men and women serving in the U.S. Coast Guard. Swab Summer lasts eight weeks, and is the Academy’s version of military “boot camp”; the incoming students begin to make their transition from civilian life to military life, and also begin to learn about how important teamwork will be during their time at the Academy and in the Coast Guard after graduation.

During Swab Summer, the incoming students spend one week on the *Eagle* to learn fundamental mariner skills.

At the end of Swab Summer, cadets report to the Academy for their first academic year.

Year One: In their first year, cadets are asked to focus on following and learning. Some of the things they must learn include:

- Information about the Coast Guard itself – their future employer;
- Vocabulary specific to the Coast Guard and other military organizations;
- Career fields of Coast Guard officers – fields in which they will work after graduation; and
- How to function in a military organization, with unique rules and expectations.

At the end of their first year, cadets return to the *Eagle* for six weeks while it is sailing, for their first extended time at sea. They also spend another six weeks on a small operational Coast Guard boat, in apprentice-type roles.

Year Two: In their second year, cadets focus on:

- Serving as role models and mentors for the new class of cadets starting at the Academy;
- Increasing their own self-awareness;
- Beginning to study leadership academically, focusing on the relationship between individual and group behaviors; and
- Developing their own leadership philosophies.

Second-year cadets also select and apply to their majors, and prepare for more formal leadership roles.

At the end of their second year, cadets spend part of the summer leading incoming students during their Swab Summer, acting as drill instructors or “cadre.”

Year Three: In their third year, cadets assume more formal leadership positions and complete their first full year of study in their chosen majors. They also maintain their cadre roles by helping first-year cadets to develop discipline.

Year Four: In their final year, cadets focus more on organizational leadership than on the one-to-one mentoring in which they engaged during their previous two years at the Academy. This is often the first year that many of the cadets assume leadership positions with direct responsibility for others’ performance.

Leadership Development

It may be clear by now that leadership is a significant focus in the life of cadets throughout all of their four years at the Academy; each year brings new and increased opportunities for leading peer cadets on campus. Part of the Academy’s formal leadership model goes by the acronym *LEAD*, which identifies strategies for cadets to follow. Cadets:

- **Learn from authority**, both from faculty and upper-class cadets;
- **Experience through practice**, combining classroom knowledge with action;
- **Analyze with reflection**, asking things like “What went well?” and “What could be done better or differently?”; and
- **Deepen understanding from mentoring**, by sharing knowledge with others like lower-class cadets.

This focus on leadership is designed to help empower each cadet while at the Academy, and to prepare them for their service as Coast Guard officers after graduation.

Post-Graduation

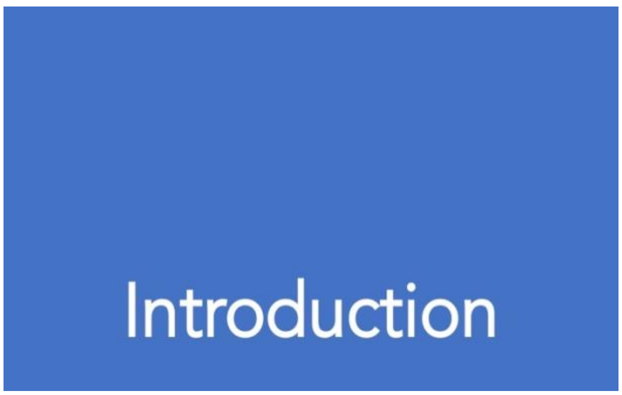
Life after graduation is quite a bit different for cadets from the Coast Guard Academy than for most students from Virginia Tech. First and foremost, every cadet has a job after graduating from the Academy! Every cadet graduates with a bachelor of science degree, as well as a commission as an Ensign (the first and most junior level of military officer) of the U.S. Coast Guard.

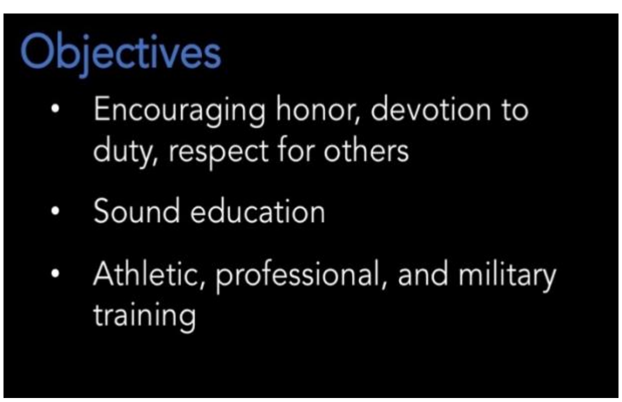
In exchange for the government's investment in their education, housing, and meals at the Academy, cadets are required to serve at least five years in the Coast Guard after graduation. Some graduates serve those five years and then leave the Coast Guard for jobs and lives as civilians. A majority, though – about 85% – remain in the Coast Guard beyond their initial required five years.

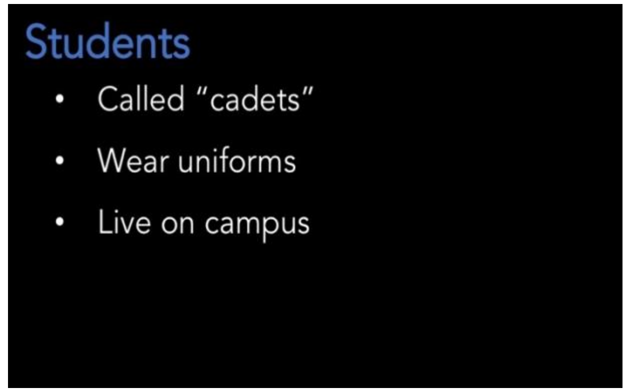
About 80% of graduates take advantage of the opportunity to attend graduate school or flight school while serving those first five years. In return for their graduate or flight school education, these graduates are required to serve additional time in the Coast Guard, beyond the initial five years.

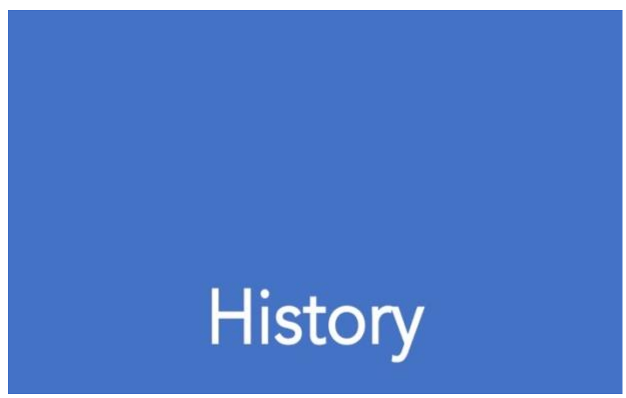
Appendix B: Full Disclosure Treatment Slide Images

Slide images in this appendix are to be read from top to bottom, left column first.

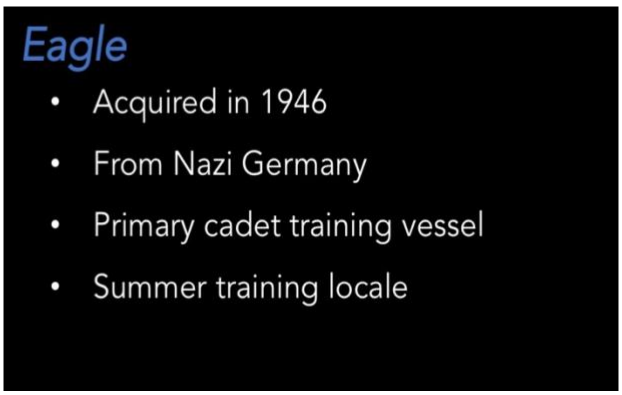


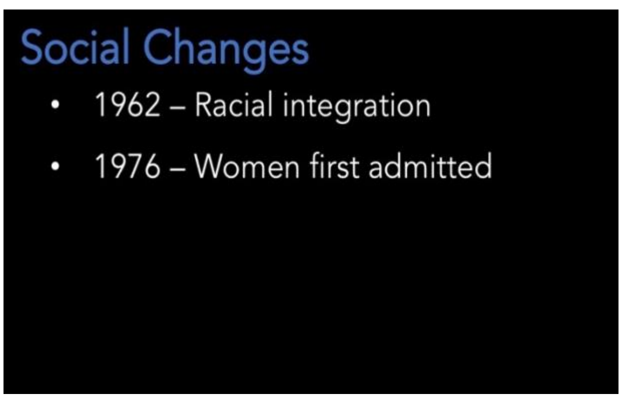


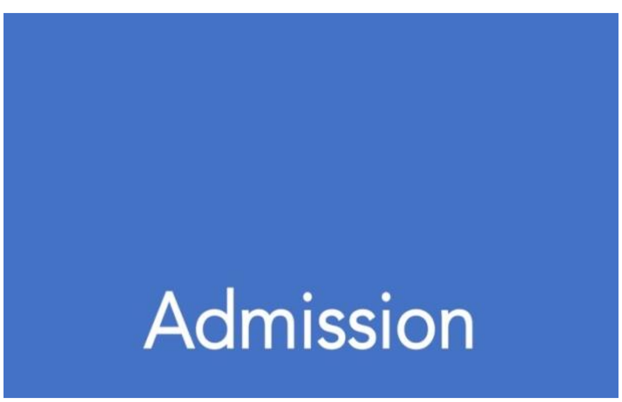


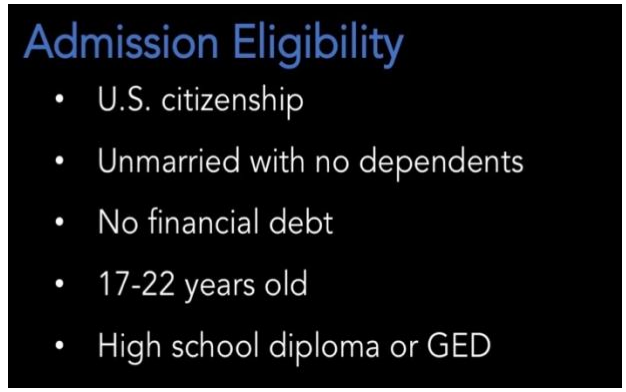


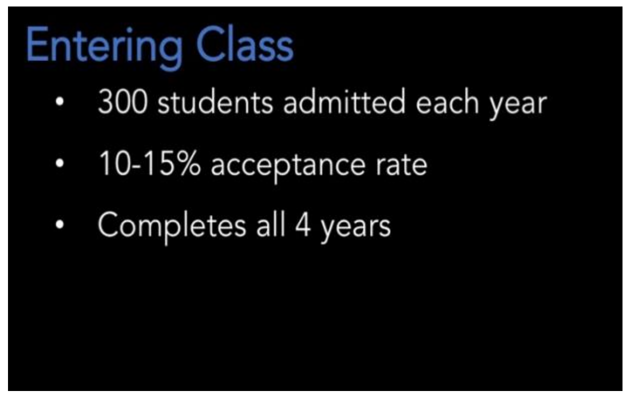

Late 1800s / Early 1900s
1890 - Moved onto land
1910 - New London, CT
1915 - Renamed Coast Guard Academy


Eagle
Acquired in 1946
From Nazi Germany
Primary cadet training vessel
Summer training locale

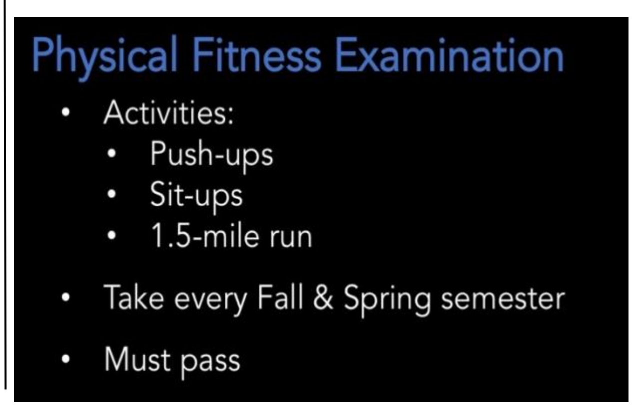

Social Changes
1962 – Racial integration
1976 – Women first admitted


Admission

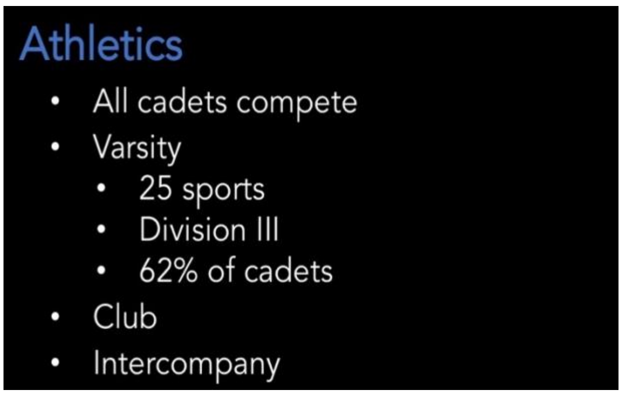

Admission Eligibility
U.S. citizenship
Unmarried with no dependents
No financial debt
17-22 years old
High school diploma or GED


Entering Class
300 students admitted each year
10-15% acceptance rate
Completes all 4 years

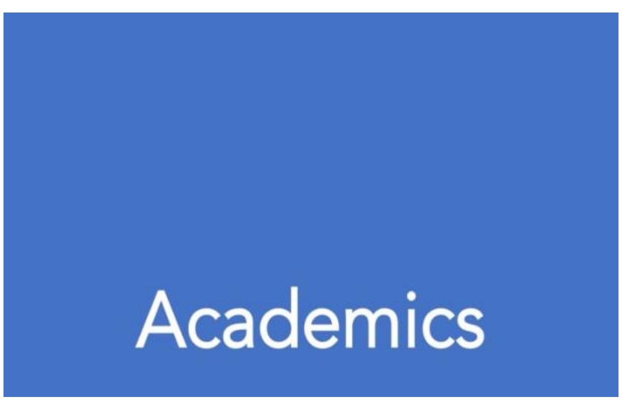

Desired Characteristics
Leadership skills
Desire to serve country & humanity
Commitment to full potential
Physical fitness / athleticism

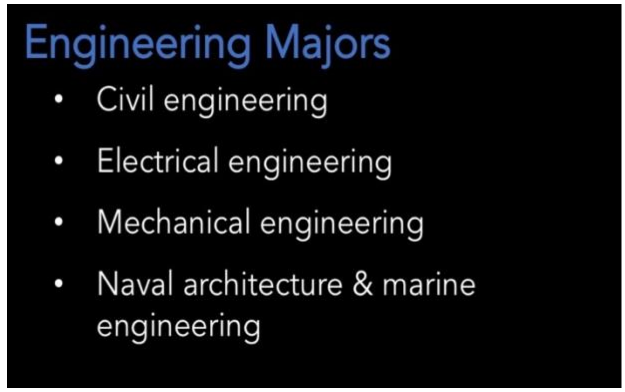

Physical Fitness Examination
Activities:
Push-ups
Sit-ups
1.5-mile run
Take every Fall & Spring semester
Must pass


Athletics

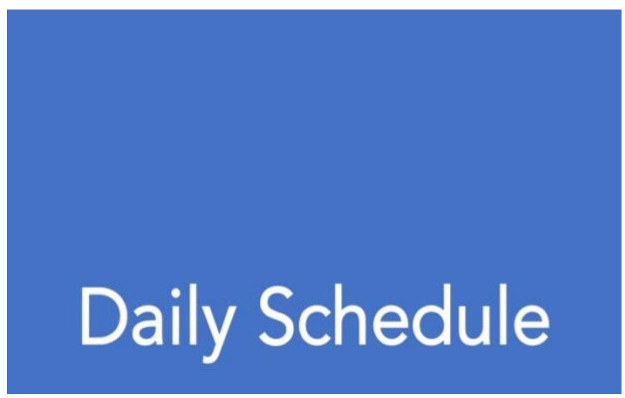

Athletics
• All cadets compete
• Varsity
• 25 sports
• Division III
• 62% of cadets
• Club
• Intercompany


Academics
• Bachelor's degrees
• 8 majors
• Science & technology


Academics


Engineering Majors
• Civil engineering
• Electrical engineering
• Mechanical engineering
• Naval architecture & marine engineering

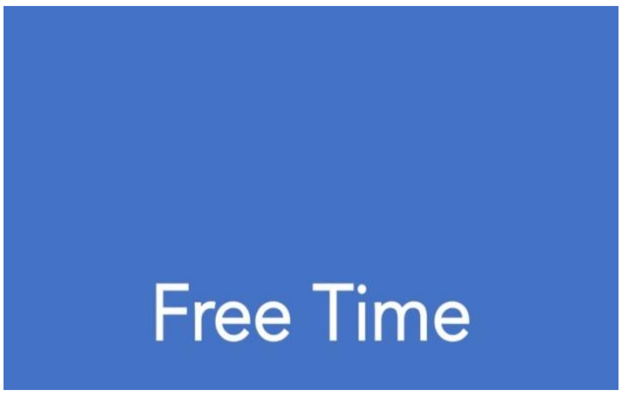

Other Majors
• Operations research & computer analysis
• Marine & environmental science
• Management
• Government

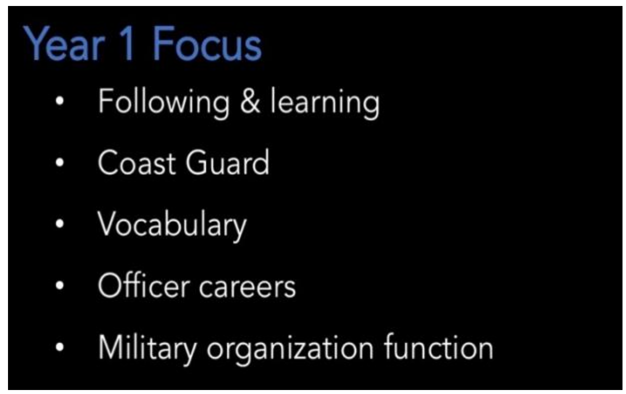

Daily Schedule


Morning Schedule
• 6:00am – Wake up
• 6:20 – Breakfast
• 7:00 – Military training
• 8:00 – Classes
• 12:00pm – Lunch


Afternoon Schedule
1:00pm – Classes
4:00 – Athletics
6:00 – Dinner
7:00 – Study period
10:00 – Taps

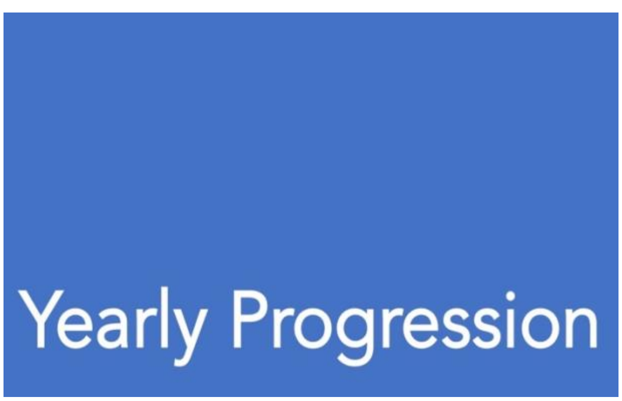

Swab Summer
Swearing-in to Coast Guard
8 weeks
Transition to military life
Teamwork
1 week on Eagle

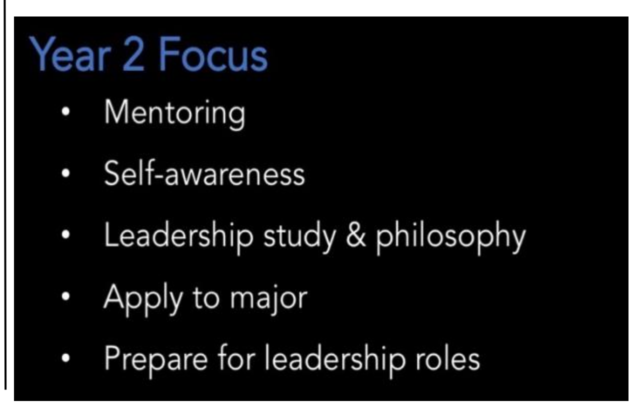

Free Time

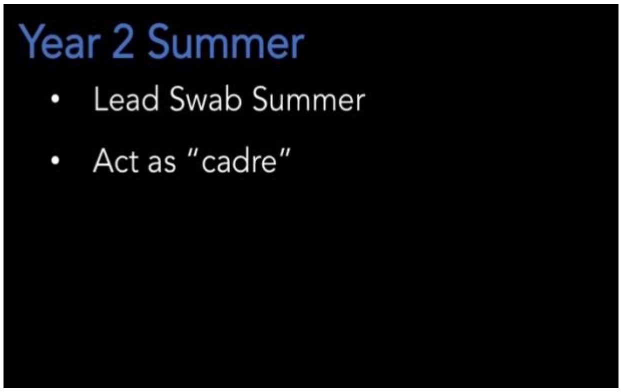

Year 1 Focus
Following & learning
Coast Guard
Vocabulary
Officer careers
Military organization function

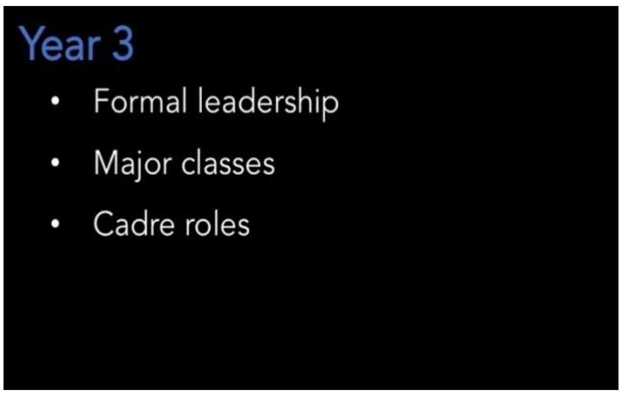

Free Time
Leave
Longer-term
School-wide
Liberty
Individual
Short-term

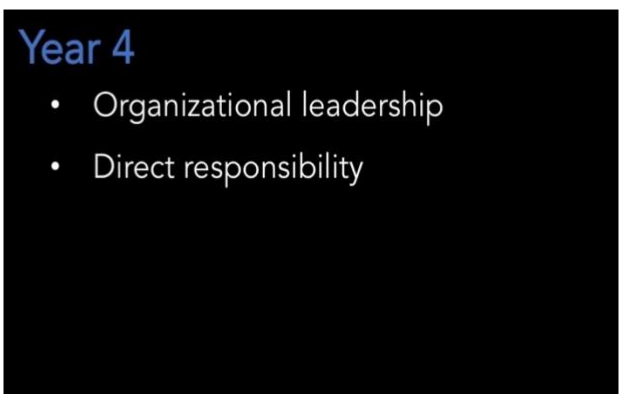

Year 1 Summer
6 weeks on Eagle
6 weeks on Coast Guard boat


Yearly Progression

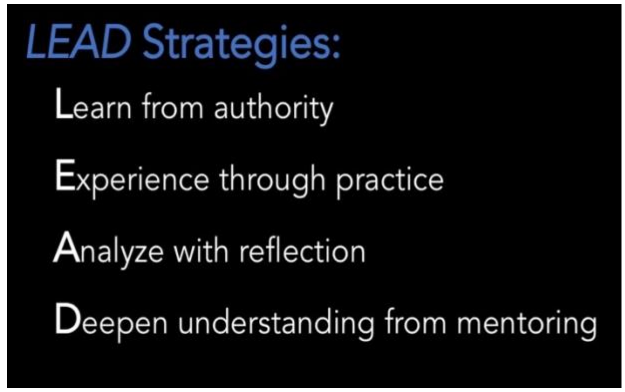

Year 2 Focus
Mentoring
Self-awareness
Leadership study & philosophy
Apply to major
Prepare for leadership roles

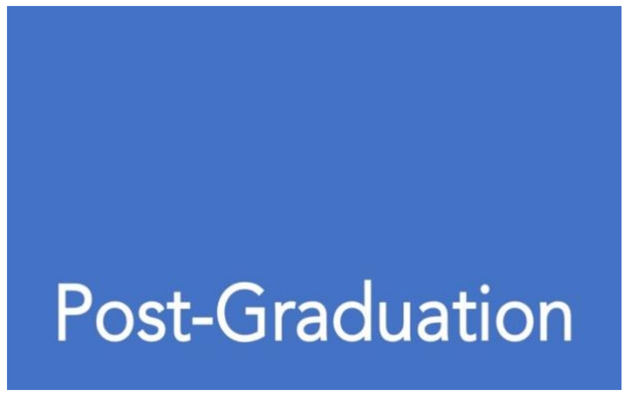

Year 2 Summer
• Lead Swab Summer
• Act as "cadre"


Year 3
• Formal leadership
• Major classes
• Cadre roles


Year 4
• Organizational leadership
• Direct responsibility


Leadership

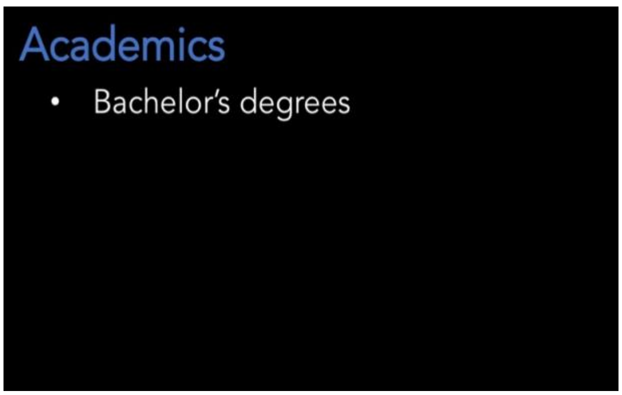

LEAD Strategies:
Learn from authority
Experience through practice
Analyze with reflection
Deepen understanding from mentoring

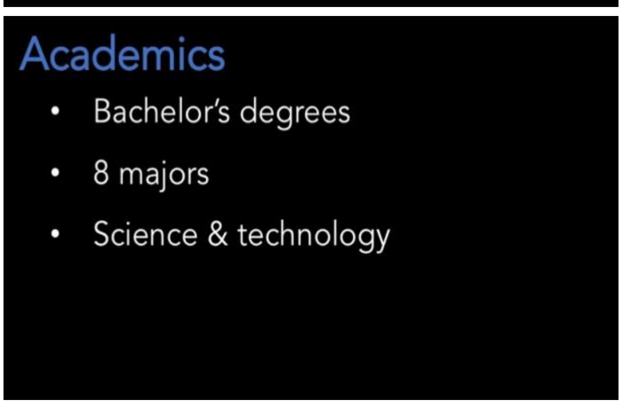

Post-Graduation


Post-Graduation
• Everyone has jobs
• Commissioned as officers
• 5 years obligation
• 85% serve longer
• 80% attend graduate or flight school

Appendix C: Comparison Slide Images for All Four Treatments

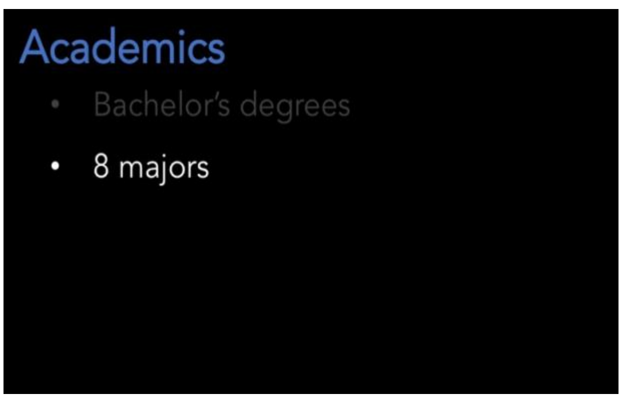
Treatment 1:
Full Disclosure slide

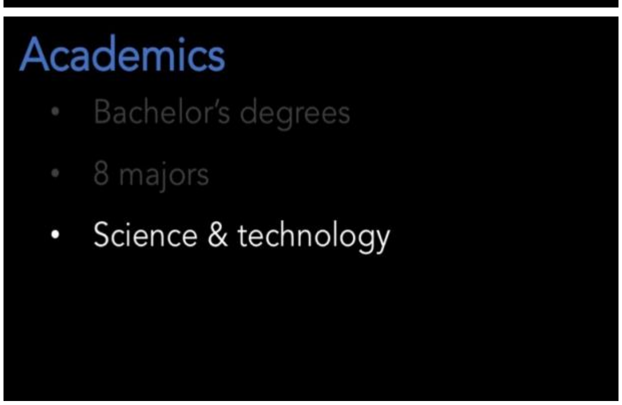




Treatment 2:
Progressive Disclosure slides

Treatment 1:
Full Disclosure slide





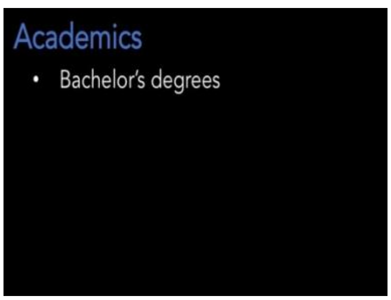
Treatment 3:
Dimming slides

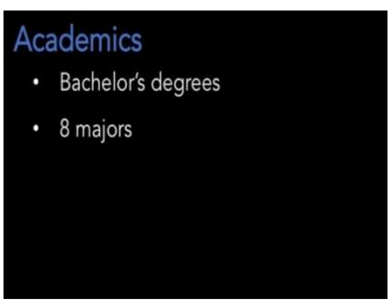
Treatment 1:
Full Disclosure slide

Treatment 4:
Highlighting slides

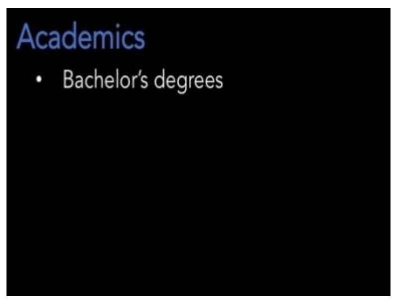
Treatment 1: Full Disclosure

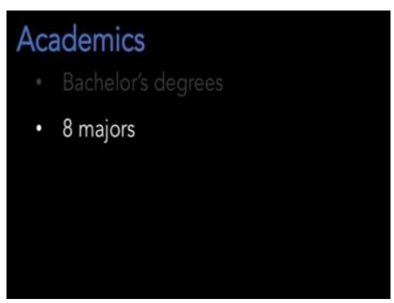
Treatment 2:
Progressive Disclosure

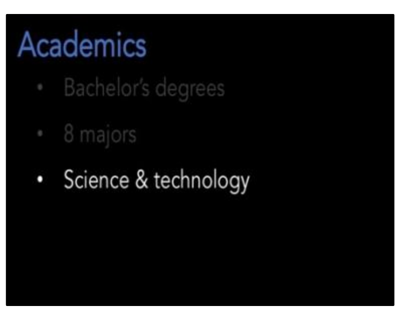




Treatment 3:
Dimming







Treatment 4:
Highlighting

Appendix D: Assessment Instrument

Below are the 15 items included within the assessment. The correct answer to each item is shown in bold font.

1. Which of the following is true about students at the Coast Guard Academy?

   - ○ They are called midshipmen.
   - ○ They may live off-campus after their first year.
   - ○ **They wear uniforms at all times on campus.**
   - ○ They only pay for room and board.

2. Which of the following was true when the Coast Guard Academy was founded in 1876?

   - ○ It was in New London, CT.
   - ○ There were 100 cadets.
   - ○ **It was located aboard a ship.**
   - ○ Cadets took four years of classes.

3. What is the name of the Coast Guard Academy's primary cadet training vessel?

   - ○ The *Cadet*
   - ○ **The *Eagle***
   - ○ *Revenue Cutter*
   - ○ The *Cutter*

4. Which of the following applicants would be eligible for admission to the Coast Guard Academy?

- ○ A 23-year-old community college student
- ○ An 18-year-old without a high school diploma or GED
- ○ A 19-year-old with $1,000 of credit card debt
- ○ **A 22-year-old divorced male**

5. Which of the following are desired characteristics of Coast Guard Academy applicants?

- ○ Superior SAT scores and leadership skills
- ○ **Physical fitness and desire to serve the country**
- ○ Family military history and outstanding high school GPA
- ○ High self-esteem and commitment to fulfill one's potential

6. Which of the following are the elements of the Physical Fitness Examination?

- ○ Pull-ups, push-ups, and a 1.5-mile run
- ○ A 1.5-mile run, a half-mile swim, and sit-ups
- ○ Sit-ups, push-ups, and a shuttle run
- ○ **Push-ups, a 1.5-mile run, and sit-ups**

7. What happens when cadets fail the Physical Fitness Exam twice in the same semester?

- ○ They are not eligible for leave until the following semester.
- ○ They are put on probation for two semesters.
- ○ They are not eligible for liberty until the following semester.
- ○ **They are disenrolled from the Coast Guard Academy.**

8. On which type of sports teams do 62% of Coast Guard Academy cadets compete?

- ◯ Club
- ◯ **Varsity**
- ◯ Intercompany
- ◯ Junior varsity

9. Which of the following majors are offered at the Coast Guard Academy?

- ◯ Aeronautical engineering and Government
- ◯ Oceanography and Management
- ◯ **Management and Electrical engineering**
- ◯ Economics and Civil engineering

10. Which of the following activities occurs in the mornings at the Coast Guard Academy?

- ◯ Athletics
- ◯ Study period
- ◯ Taps
- ◯ **Military training**

11. When do Coast Guard Academy cadets get sworn in as Coast Guard officers?

- ◯ At graduation
- ◯ After their second year
- ◯ **At the beginning of Swab Summer**
- ◯ At the end of Swab Summer

12. Which of the following occurs during Swab Summer?

- ◯ **1 week of training aboard the *Eagle***
- ◯ Transition to civilian life
- ◯ Applying to academic majors
- ◯ 6 weeks on a Coast Guard boat

13. Which of the following do cadets do in their second year at the Coast Guard Academy?

- ◯ **Mentor first-year cadets and apply to majors**
- ◯ Apply to majors and learn about Coast Guard officer careers
- ◯ Learn about Coast Guard officer careers and identify personal leadership philosophies
- ◯ Identify personal leadership philosophies and learn military vocabulary

14. Which of the following is one of the four strategies included in the LEAD acronym?

- ◯ **Learn from authority**
- ◯ Exercise through practice
- ◯ Analyze through mentoring
- ◯ Deepen understanding from reflection

15. Which of the following best describes the development or progression of leadership while at the Coast Guard Academy?

- ◯ Swab leadership, Boat leadership, Military leadership
- ◯ Cadet leadership, Cadre leadership, Officer leadership
- ◯ **Self leadership, Peer leadership, Organizational leadership**
- ◯ Informal leadership, Applied leadership, Formal leadership

Appendix E: Treatment Design Characteristic Comparison Table

	Progressive Disclosure (PD)		Dimming of Text (DoT)		Highlighting of Text (HoT)	
	Similarities	**Differences**	**Similarities**	**Differences**	**Similarities**	**Differences**
Full Disclosure (SD)	Amplification of text - Bolding: None (non-bold) Amplification of text - Text color: None (always the same: white) Amplification of text - Font size: None (same font size)	Animation of text: FD - None PD - Timed disclosure Display time: FD - Same for all text; longer on average PD - Varies by line/bullet; shorter on average Multimodal synchronicity: FD - None PD - By line/bullet Step size: FD - Bigger: 11.4 words PD - Smaller: 7.5 words	Amplification of text - Bolding: None (non-bold) Amplification of text - Font size: None (same font size)	Amplification of text - Text color: FD - None (always the same: white) DoT - Grays out as move on Animation of text: FD - None DoT - Timed disclosure DoT - Timed deemphasis Display time: FD - Same for all text; longer on average DoT - Varies by line/bullet; shorter on average Multimodal synchronicity: FD - None DoT - By line/bullet Step size: FD - Bigger: 11.4 words DoT - Smaller: 7.5 words	Display time: Same for all text; longer on average Step size: Both bigger: 11.4 words	Amplification of text - Bolding: FD - None (always non-bold) HoT - Bolded as discuss Amplification of text - Text color: FD - None (always the same: white) HoT - Brighter as discuss Amplification of text - Font size: FD - None (always same size) HoT - Bigger as discuss Animation of text: FD - None HoT - Timed emphasis HoT - Timed deemphasis Multimodal synchronicity: FD - None HoT - By line/bullet
Progressive Disclosure (PD)			**Similarities** Amplification of text - Bolding: None (non-bold) Amplification of text - Font size: None (same font size) Animation of text: Timed disclosure Display time: Varies by line/bullet; shorter on average Multimodal synchronicity: By line/bullet Step size: Both smaller: 7.5 words	**Differences** Amplification of text - Text color: PD - None (always the same: white) DoT - Grays out as move on Animation of text: DoT - Timed deemphasis	**Similarities** Multimodal synchronicity: By line/bullet	**Differences** Amplification of text - Bolding: PD - None (always non-bold) HoT - Bolded as discuss Amplification of text - Text color: PD - None (always the same: white) HoT - Brighter as discuss Amplification of text - Font size: PD - None (always same font size) HoT - Bigger as discuss Animation of text: PD - Timed disclosure HoT - Timed emphasis HoT - Timed deemphasis Display time: PD - Varies by line/bullet; shorter on average HoT - Same for all text; longer on average Step size: PD - Smaller: 7.5 words HoT - Bigger: 11.4 words
Dimming of Text (DoT)					**Similarities** Amplification of text - Text color: Emphasize current narration Multimodal synchronicity: By line/bullet	**Differences** Amplification of text - Bolding: DoT - None (always non-bold) HoT - Bolded as discuss Amplification of text - Text color: DoT - No change as start/discuss HoT - Brighter as discuss DoT - Grays out as move on HoT - No change in color as move on Amplification of text - Font size: DoT - None (always same size) HoT - Bigger as discuss Animation of text: DoT - Timed disclosure HoT - Timed emphasis DoT - Timed demphasis HoT - Timed deemphasis Display time: DoT - Varies by line/bullet; shorter on average HoT - Same for all text; longer on average Step size: DoT - Smaller: 7.5 words HoT - Bigger: 11.4 words