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Assessing Learning Efficiency In Narrative Simulation Delivered Through Interactive Multimedia

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ASSESSING LEARNING EFFICIENCY IN NARRATIVE SIMULATION DELIVERED THROUGH INTERACTIVE MULTIMEDIA

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Education in the
College of Education
at the University of Kentucky

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ABSTRACT OF DISSERTATION

ASSESSING LEARNING EFFICIENCY IN NARRATIVE SIMULATION DELIVERED THROUGH INTERACTIVE MULTIMEDIA

This study evaluated the effects of Narrative Simulation (NS) on learning and cognitive load. Specifically, it measured the potential differences in observed instructional efficiency when comparing a self-paced expository multimedia lesson to a NS lesson which involves a character-focused story with multiple decision inputs at key points.

This ex post facto design observed 119 participants consisting of preservice teachers from a large public university in the southeastern United States. They were divided into two sequence groups: (a) Expository Lesson Group; and (b) Narrative Simulation group. The Expository group received Expository Lesson One first, then Expository Lesson Two, and then Narrative Simulation. The Narrative Simulation group received Narrative Simulation, Expository One, and then Expository Two.

Upon entering learning management system, participants received the three lessons, each consisting of the following: (a) lesson content, (b) content assessment (c) NASA Task Load Index (TLX), a measure of cognitive load or perceived mental effort.

Statistical analysis reported (a) no statistical differences on perceived cognitive load across lessons (b) no statistical differences in the efficiency score across lessons, (c) no statistical differences on assessment score across Expository One and Two, (d) no statistical differences in the number of attempts needed to achieve a passing score when considering all assessments, (e) statistically significant differences from each group's respective first attempt regarding cognitive load and efficiency, (f) statistically significant differences in the Narrative Simulation assessment score between groups.

KEYWORDS: online learning, learning efficiency, narrative simulation, interactivity, cognitive load theory, multimedia learning

Christopher Shannon Daniel

December 1, 2020
Date

THE EFFECT OF NARRATIVE SIMULATION ON LEARNING EFFICIENCY IN AN ONLINE DISTANCE EDUCATION LESSON

By

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12/1/2020
Date

DEDICATION

To Sara. Grow old along with me! The best is yet to be, the last of life, for which the first was made:

To Colin. See this and know you are always loved, you can do anything you put your mind to, and we live the good life every single day.

The good life gives no warning.
It weathers the climates of despair
and appears, on foot, unrecognized, offering nothing,
and you are there.

-Mark Strand

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CHAPTER ONE: INTRODUCTION

Online distance education can be viewed as a situation or set of circumstances where time and distance separates learners and instructors (Keegan, 1996). Institutions of higher education employ mobile computer technology to bridge these gaps, delivering instructional content and facilitating the learning process in modes other than face-to-face classrooms. The landscape of online distance education will evolve as innovations emerge and offer new means of interaction and interactivity (Larreamendy-Joerns & Leinhardt, 2006).

The growth and increased prominence of online education requires that positive learning outcomes be reliably assured using sound theory and praxis. Educational stakeholders should encourage instructors to not only evaluate new and emerging methodologies, but also seek out strategies steeped in classical work and evidence relative to desired learning outcomes (Johnson & Aragon, 2003). Therefore, content, delivery mechanisms, ancillary technology, and other strategies are selected and leveraged with the primary proposition of facilitating learning under this premise.

Technologies facilitate various forms of instructional communication (Gal-Ezer & Lupo, 2002; Gilbert & Moore, 1998). For example, learner feedback is an essential function of any instructional system. Automated systems can provide students with potentially fruitful guidance relative to their learning goals (Gallien & Oomen-Early, 2008; Wiggins, 2012). Additionally, technology can aid instructors to manage the activities, assessments, and instructional content to facilitate the learning process in online distance education (Maloney, 2007; Watson & Watson, 2007).

While these methods for bridging gaps of time and distance can potentially benefit students, practical considerations in offering access to course content and experiences often require considerably increased instructor workload (Davidson-Shivers, 2009; Spector, 2005). Research informs instructors and instructional designers on how to achieve a balance between the time they spend creating meaningful learning experiences and the levels of student performance within the online context as it relates to stated instructional goals and expected learning outcomes. Not only must instructors perform more work up front to prepare students to engage in online content, they must also work in different ways compared to traditional college instruction (McKenzie, Mims, Bennett, & Waugh, 2000; Worley & Tesdell, 2009). For example, students prefer instructors who are very responsive to email and electronic forum messages in online courses (Hodges & Forrest Cowan, 2012). Students also face multiple challenges when engaging in online learning, but especially challenges related to time management (Song, Singleton, Hill, & Koh, 2004).

In short, instructors must work efficiently to achieve a balance between providing appropriate learning content and resources, effectively communicating with students according to their needs and preferences and doing so within time constraints imposed on online learners and instructors.

Efficiency

Due to limited time and resources, both in terms of technology implementation, and the time it takes instructors to prepare to teach and develop resources for online learning, the concept of learning efficiency is relevant to instructors as well as learners. Literature has described learning efficiency as utilizing the least time-consuming, mentally taxing, or most straightforward instructional methods or products possible to achieve positive learning outcomes in any given instructional situation (Ahern & Beatty, 1979).

From the perspective of the learner, efficient instructional design can be thought of as providing the least demanding online instructional content or experiences that will yield the best possible learning performance outcomes. The following concepts aid in deepening our understanding of efficiency as it pertains to instruction.

Cognitive Load. Some scholars describe cognitive load as the "mental energy" required to handle a given amount of information (Cooper, 1990, p. 108). The concept of cognitive load is useful in considering the concept of demand and reducing demands on one's mental capacity toward learning. Cognitive Load Theory (CLT) supposes performance and learning diminish when the amount of effort or load required exceeds the memory's capacity to process (John Sweller, 1988).

Lines of research from the last thirty years have suggested increases in cognitive load are tantamount to mental effort, and reducing various aspects of cognitive load to the greatest extent possible will increase productivity and/or learning outcomes (Paas, Tuovinen, Tabbers, & Van Gerven, 2003; John Sweller, 2010; J. Sweller, Ayres, & Kalyuga, 2011).

Self-rated mental effort is one of the most cited measures of cognitive load (Leppink & Pérez-Fuster, 2019). Reducing the amount of mental effort learners perceive they expend on a given unit of instruction is one way to increase the efficiency of learning conditions.

Time and cost. While not a focus of this dissertation, multiple studies suggest both the time it takes to create a unit of instruction or the time a learner spends engaging instructional content can serve as important markers for understanding both instruction and learning. Time on task is an often-cited metric that may predict learning outcomes. Generally, more time on task is moderately associated with positive learning outcomes (Admiraal, Wubbels, & Pilot, 1999; Wellman & Marcinkiewicz, 2004).

Study Content Area: Dyslexia

The purpose of this section is to provide essential background information on dyslexia as an impediment to learning and to provide justification of its use as a subject relative to learning modules included as part of a complement of online learning content in the college of education at a large public university.

Dyslexia is a neurodevelopmental disorder that affects the areas of the brain that process language. It primarily pertains to decoding or identifying the sounds contained in speech, sounds which relate to letters and words. Secondary problems arising from dyslexia are often deficits in reading comprehension and limited reading experience resulting in reduced content knowledge (Tunmer & Greaney, 2010). People with dyslexia are generally of at least average intelligence and can succeed in school with specialized interventions. The most common of all neurocognitive disorders, an estimated 40 million Americans have dyslexia (Snowling, 2013; The Mayo Clinic, 2019).

One of the greatest concerns relative to helping children with dyslexia is lack of proper identification. Most elementary teachers quickly observe students with reading delays or deficits. However, those same skilled educators may very well be untrained or even unaware that dyslexia is but one potential cause of reading deficiency. At the same time, they may hold false assumptions about the disorder (Johnston, 2019). Oftentimes, for various reasons, those with reading delays will be treated for dyslexia, while those with the actual disorder may not be offered appropriate interventions (Lindstrom, 2019). Additionally, students may be subjected to many inappropriate screening tools; some teachers assume normed achievement tests, perfunctory screening tools, and other non-accepted methods are sufficient in determining if dyslexia might be the cause for students' reading troubles. Some states have adopted policies and procedures for identifying and serving the needs of dyslexic students with the understanding that misdiagnosing students, especially the improper identification of non-dyslexics as having the disorder, is as harmful as failing to serve the needs of those with dyslexia.

Recent effort among civic organizations and grassroots groups toward increasing awareness about serving the needs of students with dyslexia has resulted in state legislation aimed at raising teacher awareness and increasing compliance identifying those with reading delays. Specifically, these groups suggest educators provide proper identification and diagnosis of dyslexia, along with evidence-based intervention for the condition, where appropriate (Ward-Lonergan & Duthie, 2018). Multiple states in the southeastern United States have created laws designating the establishment of programs, policies, and procedures to better serve those with dyslexia and related reading disorders (Johnston, 2019).

The Virginia General Assembly passed legislation mandating specific interventions and services to those with dyslexia. In 2016, they required those seeking initial teacher licensure or renewal of their license to complete a form of awareness training regarding dyslexia indicators as a legally defined term. Additionally, the training emphasized evidence-based interventions and accommodations for dyslexia (Virginia Department of Education, 2020).

South Carolina similarly required in-service educators, specifically literacy coaches and K-3 teachers to be trained regarding dyslexia and related reading disorders. These modules are designed for literacy coaches, interventionists, teachers, and others who work directly or indirectly with students who may experience reading difficulties, specifically targeting those grades (National Center for Improving Literacy, 2020).

In 2018, Kentucky legislators passed the Ready to Read Act (Kentucky House Bill 187, 2018), a dyslexia intervention bill designed to decrease the barriers students with dyslexia face receiving sufficient identification and intervention (The Lane Report, 2018).

Two provisions of HB 187 are of interest as it relates to this study. First, the Kentucky Department of Education (KDE) created a dyslexia toolkit that provides instructional guidance for students displaying characteristics of dyslexia. Second, HB 187 mandated the KDE to collaborate with Education Professional Standards Board, Council on Postsecondary Education, postsecondary teacher education programs, and other agencies to ensure that teachers are prepared to "utilize evidence-based interventions in reading, writing, mathematics, and behavior" ("Kentucky Ready to Read Act," 2018).

In response to the legislation, the KDE created the Dyslexia Toolkit, a document detailing the definition and characteristics of dyslexia, instructional approaches, screening, reading assessments, and evidence-based interventions designed to assist and support students (Kentucky Department of Education, 2019). Information from this document has informed the core content provided to participants in this study.

In response to the mandate set forth in HB 187, The college of education at a large public university will require successful completion of reading disorder and dyslexia modules for all pre-service educators in elementary, middle, and secondary education programs in order to graduate.

Drawing from content and critical information contained in the Dyslexia Toolkit, as well as subject matter expertise from literacy faculty, the online instructional modules were designed to provide essential information about dyslexia, as well as offer effective strategies to increase awareness and motivate preservice professionals to better serve students with reading challenges. Students access these online, self-paced modules using the web 2.0 based Digital Driver's License (DDL) tools and resources.

About the Digital Drivers License (DDL)

The DDL is organized instructionally through the user's completion of a series of licenses, or small units of study. A license in the DDL consists of one or more cases. These cases present material and content in the form of text, images, videos, and assessments. There are two main types of assessments learners engage in, each containing various kinds of content assessment item formats such as true/false, multiple choices, and open response. Once submitted, the learner receives immediate feedback to their responses and may review the feedback at any time. Prior to taking a final assessment, a student has two options to demonstrate mastery. First, they may complete a practice assessment, a purely self-informative confirmatory feedback loop to the learner, a method which research has linked to improved learning outcomes (Van der Kleij, Feskens, & Eggen, 2015). The learner may return to specific content items for review based on the practice assessment results. The second type of assessment is an opportunity for the learner to prove a level of understanding regarding the specific content. This type of assessment in the DDL is known as a "Prove-It!" assessment. Learners can take a "Prove-It!" assessment as many times as they wish by resetting the attempt. A student must obtain an eighty percent (80%) or higher on all Prove-It! assessments embedded in a case to demonstrate they have met a basic level of understanding. Interestingly, in other content licenses offered in the DDL platform, assessment data show there have been users that pass a Prove-it! the first time and retake it to advance their already passing score to achieve a perfect score of one hundred percent

(100%). Conversely, developers have also seen evidence that some users have systematically attempted to guess their way through a Prove-It!

Purpose of the Study and Research Questions

This study seeks to determine if there is a significant difference in the efficiency (measured through perceived cognitive load and the measured outcome of demonstrated performance) among online education students who first receive a self-paced Narrative Simulation (NS) module versus students who first utilize a traditional online distance learning module.

Based on the literature, this study will attempt to answer the following research questions:

- Does dialoguing interactivity resultant from NS have a significant effect of the various aspects of perceived cognitive load in learning dyslexia content, including time demand, mental demand, perceived performance, mental effort, and frustration?
- Do participants engaged in a NS learning module obtain a higher score on their first content test attempt compared with those learning from an expository online lesson?
- Do participants engaged in a NS learning module require fewer attempts to pass a content test compared with those who experience an expository learning module?
- Do participants engaged in a NS learning module ultimately receive a higher score above the minimum required passing score compared to those experiencing an expository learning module?

Organization of the Dissertation

The subsequent chapters will present the dissertation material according to the following order and organization: The conceptual framework and relevant literature for the study are developed in Chapter Two, the study methodology is described in Chapter Three, Chapter Four describes the results of the data collections and analysis, and Chapter Five discusses the conclusions and implications of the research findings.

CHAPTER TWO

LITERATURE REVIEW

Introduction and Scope

This study proposes to elucidate four key components:

1) As time demands on both instructors and students increase, the online environment is an actual, needful, and a valid means of instruction and learning; development of learning products using best practices may serve large numbers of individuals at a time convenient to their own needs and characteristics.
2) Interactive multimedia may be used to convey information and deliver instruction.
3) Meaning-making using narrative is a timeless instructional method. Narrative is deliverable through interactive multimedia.
4) The literature suggests the concept of learning efficiency may be used to understand the effects of instruction on cognitive load and performance concurrently.

In this study, narrative simulation (NS) within online and distance education is reviewed. Additionally, this chapter examines the concepts of learning efficiency and interactivity as they pertain to the delivery of a narrative simulation as an instructional intervention.

Online Learning in Education

This section discusses the growth of online learning and the need to select and utilize efficient instructional interventions in online education.

Online distance education has experienced tremendous growth. An estimated 5.8 million students take online distance courses in the United States (Allen, Seaman, Poulin, & Straut, 2016). The number of students taking only face-to-face courses continues to fall. Since 2012, an estimated 824,000 fewer students take only face-to-face courses.

The sustained popularity and market demand for online learning have given rise to instructional methods and other strategies designed to traverse the gaps created by distance and time (Ally, 2004, p. 29; Ko & Rossen, 2010, p. 20; Rovai, 2003). Many institutional affordances have changed how courses are delivered. For example, Park (2017) noted the ubiquity of tools and processes to facilitate the inherent deficits caused by gaps in time and distance experienced by online learners and their instructors compared to traditional instructional environments.

Another type of gap exists within the online instructional context. There has been a significant increase between the number of instructional tools and methods compared with the rather static capacity of instructors to discover and learn these tools and to then deftly deploy them (Berge, 1998; Lloyd, Byrne, & McCoy, 2012). Moreover, many postsecondary institutions offer online courses in a compressed format, shorter than the traditional sixteen-week semester. As a result, faculty have shorter development cycles and must spend additional development time outside of this course delivery window. They must then constantly respond to students and maintain a much more active presence in a course, giving faster feedback to submitted assignments, as well as general questions (Krug, Dickson, Lessiter, & Vassar, 2016).

The expansion of online distance education has given instructors and students alike more options for delivering instruction and meeting appropriate learning outcomes. At the same time, this expansion has raised questions and challenges centered chiefly on how to maintain a quality educational experience with reasoned expected results and to do so efficiently.

Instructors experience increased time demands in delivering online instruction (Spector, 2005). Instructors and instructional designers may not use many of the preferred instructional methods that foster critical and creative thinking in online education due to time constraints. These methods include problem-based learning, case-based learning, and online collaboration. Research suggests online instructors opt to implement tools with low barriers to entry rather than utilize more complex tools (Kim & Bonk, 2006).

The prior section suggested the practicalities and realities inherent in online distance education call for the most efficient instructional and delivery methods possible.

The next section suggests that narrative is an essential instructional method and that one form of narrative lends itself well to online instructional delivery.

Narrative in Learning

Many instructors leverage the power of stories and storytelling to entertain, communicate, and provide information with great success. It is an inherent part of our humanity. In broad strokes, the literature suggests the following aspects and applications of narrative are an effective and vital means of instruction.

The use of narrative allows complex or difficult concepts to be more accessible, as it provides a context or framework in which the knowledge or information may be contained (Szurmak & Thuna, 2013). Placing new information into a narrative structure offers an immediacy and emotional connection to information or knowledge to which learners more readily relate, and thus retain. The student may also compare and contrast stories to his or her personal history and experiences, thereby creating meaningful connections to the knowledge or information (Carter-Black, 2007). Narrative serves to clarify and coalesce abstract concepts or problems. It provides context to ideas and situations. Therefore, it facilitates the transfer of information in a context where the mind is often better situated to being open to receive it. This is often even more significant when the story's content and the instructional content are either directly related or complement one another. (Szurmak & Thuna, 2013).

Simple presentation of facts in learning often precludes learners from interpreting or using imagination. Because narratives can be employed to represent realistic events that simulate lived experience, they can leverage the power of storytelling in one's construction of knowledge (McCrary & Mazur, 1999). Because we utilize stories in so many facets of our lives, we can use narrative as a tool to understand and relate to the full range of human behavior (Sarbin, 1986).

Essential Aspects of Narrative

The Culture of Education (Bruner, 1996) clarifies the role and significance of narrative construction and utilization of narrative in meaning-making within the learning context. Bruner posits narratives are relevant to the realities they construct and offers universal precepts inherent to, and essential in, both human culture and the educational process. Some of these concepts are useful in informing our understanding of narrative as a teaching tool.

Narratives contain a "structure of committed time" (Bruner, 1996, p. 133), that is, the unfolding events dictate the pace and play of the story, but not necessarily a conventional sense of time.

Narratives are concerned with “generic particularity” (Bruner, 1996, p. 133). Although details are essential and often distinguish various types of stories, the similarity among stories tends to create narrative genres, and these serve to inform the reader, as well as providing a framework for understanding the narrative.

Bruner posited that “actions have reasons” in narrative (Bruner, 1996, p. 136). People and characters are motivated by their “beliefs, desires, theories, values, or other ‘intentional states’” (Bruner, 1996, p. 136). While this intentionality provides a sense of connection to the events contained in the narrative, there is also generally some element of freedom within the action that gives novelty and a sense of uniqueness inherent in compelling storytelling.

Comprehension of a narrative is hermeneutic or disposed to interpretation. Bruner argues there is neither necessarily a rational means of verifying the necessity of an explanation nor a practical way of doing so. Therefore, we rely on the interpretations or partial interpretations of others to make meaning of a narrative (Bruner, 1996, p. 137).

Bruner explains narratives contain some “centrality of trouble” (Bruner, 1996, p. 137), involving either some of the conflict, problem, or state of imbalance readers discover during the rising action of the story. The property of “trouble” inherent to narratives serves to engage the reader.

Stories engage students because they are relevant to, and resonate with, their life experiences (Goetz, 2013). These aspects of narrative serve to gain the learner’s attention through posing conflict or questions, exposing students to new ideas or new ways of thinking about familiar situations, and by allowing exploration of such concepts in a non-threatening context (Bruner, 1996; Goetz, 2013).

Narrative as Interactive Simulation

The literature suggests narrative, by its very nature, provides learners with the opportunity to engage in a type of simulation.

Interpreting the actions of another, even within the context of a story, allows us to employ mental processes. This process mirrors many of the same ways a person engages physical simulations, attempting to use creative methods to understand the perspectives of another or understand the behaviors outlined in the story (Hutto, 1997). Gordon (1986, p. 161) describes this as “a kind of practical simulation.”

When narrative cases describe believable behavior by the central characters and portray interesting and specific situations, they are apt to be more readily believable and facilitate immersion. Thus, they provide more opportunity to bring interactivity to narratives (Swartjes, 2007). Narratives are often tied inextricably to simulations, as they allow learners to understand necessary details in order to employ logical processes to solve complex problems. (Heldal, Backlund, Johannesson, Lebram, & Lundberg, 2017).

In this study, as one state in the southeast region of the United States seeks to better support individuals with dyslexia, more educators will be charged with identifying and assisting dyslexics than ever before. Therefore, narrative simulation is a potentially useful path for instructional interventions.

Narrative Simulation

In the context of this review and dissertation, the term narrative simulation (NS) refers to a particular implementation of interactivity within the context of a story designed to change behavior or inspire reflection upon one’s attitudes to evoke a change of thinking as it relates to one’s personal beliefs or predictable past behavior.

The history of NS is steeped in disciplines or fields related to accident prevention, health promotion, and education. The primary supposition in implementing narrative simulation as an instructional intervention is straightforward but multifaceted. One's culture and deeply held convictions will often dictate one's conduct relative to critical situations. Individuals may act upon these suppositions and folkways in a potentially deleterious manner. These actions might carry long-term and intractable consequences, affecting the safety and well-being of oneself or others (Arrowsmith, Cole, & Mazur, 2009; Henry P. Cole, 1997; Henry P Cole, Kidd, Isaacs, Parshall, & Scharf, 1997; McCrary & Mazur, 1999).

In the NS learning environment, participants receive stories as first-person participants without full knowledge of all the events, which lies in contrast to the more frequently utilized case-based instruction where learners generally have complete story details before initiating any formal interactivity (Al-Dahir, Bryant, Kennedy, & Robinson, 2014; Ali et al., 2018; Lee, Lee, Liu, Bonk, & Magjuka, 2009).

At critical points in the story contained in a NS, the environment prompts participants to answer one or more questions related to details in the developing plot. These questions are generally either factual, procedural, or attitudinal and usually either true/false or multiple choice. After participants select and submit a response, the system provides detailed feedback based on acceptable practices, conditions which may result from the given selection, or evidence-based consequences likely to arise because of that choice. One of the hallmarks of most NS design is that the participant's decisions generally do not affect the arc or the outcome of the story (McCrary & Mazur, 1999).

The prior section discussed the concept of narrative both as a standard feature in learning, as well as having applicability as a form of simulation for use in certain forms of interactive online learning. But what constitutes interactivity? The next section discusses the concept in broad terms, and then defines interactivity for the purposes of the study.

Interactivity

The concept of interactivity is complex. The Oxford English Dictionary (2009) presents two significant definitions that may serve as focal points in defining the term for the purpose of this study. The first use of the term appeared in 1832, in *Saturday Evening,* (A precursor to *The Saturday Evening Post*) Isaac Taylor wrote about theology and invention. The OED defined this reference to interactivity as a "state of reciprocal activity, where entities act upon or influence one another." The second definition comes from a 1967 publication of an Institute of Electrical and Electronics Engineers (IEEE) trade publication focused on the extent of relationships between humans and electronic machines (Jain et al., 2000).

These two broad constructs help to frame our understanding of interactivity across different contexts. This section discusses a few of the more salient aspects of interactivity to give precision and significance to the study.

Fundamental Conditions of Interaction

Relative to instructional systems, for a tool, technology, or process to be considered interactive, it should contain one or more of the following essential conditions, which can transcend most other contexts:

1. Involve multiple actors
2. Allow reciprocity
3. Receive and elicit response
4. Involve direct human communication

5. Mediate communication

6. Manage human/computer interaction.

The following section briefly discusses each of these.

Involve multiple actors. Although normally attributed to two or more people, interaction can occur simply between a human and at least one computer-based process, procedure, or entity. For example, early text-based games involved interaction between humans and computers, and became richer over time (Perlin & Goldberg, 1996). Educational computing eventually leveraged the utility of such systems as they became more popular (Doty, Popplewell, & Byers, 2001).

Allow reciprocity. A return made in kind for a given response, interactive environments allow for answers and responses to transact quickly and easily. Reciprocity also suggests an attempt to value the interactions, and whether the participant has experienced change as a result of the communication (Hemphill, 2001).

Receive and solicit response. At least basic mechanisms that afford actors the chance to give and receive responses based on a given topic or criteria, providing a level of engagement and communication that is a hallmark of effective instruction (Siau, Sheng, & Nah, 2006).

Direct human communication. An essential characteristic of many useful interactive situations, especially those involving the transference of information or in learning (Morreale, Osborn, & Pearson, 2000). Direct, personal interactivity often requires more time on the part of all actors.

Mediate communication. The transference of messages across one or more channels or platforms with regard to distance or time and considering human factors (Joinson, 2001). (Ijsselsteijn, van Baren, & van Lanen, 2003)

Manage human/computer interaction. The vast number of human/computer transactions have necessitated an automatization of the recording, tracking, and recall of these for the purposes of a better user experience (Parasuraman, Sheridan, & Wickens, 2000).

The prior section defined some of the essential qualities and functions that might explain or describe interactivity. The following segment is concerned with some of the possible perspectives related to environments containing interactive elements or situations in which practitioners might use interactive features.

Perspectives on Interactive Environments

In the following section, this review focuses on aspects of interactive environments that have emerged with the advent of the personal computer. Three perspectives highlight different types of specific transactions, defining and describing the interplay between multiple actors.

Kiousis (2002) asserted that arriving at a coherent construct of interactivity is difficult because there is no single operationalization of the term interactivity which fits every scenario. The term is ambiguous across different contexts. Kiousis proposed multiple theoretical frameworks that define interactivity from communications, technological, psychological, sociological, and perceptual perspectives.

Communications and social perspective. One viewpoint is that interactivity is a communication construct. The ability to send and receive messages is paramount to any interactive environment. Scholars emphasize the need for generalizable approaches to communication to better inform interactivity use both in learning and in other disciplines (Sundar, Xu, & Bellur, 2010).

A sociological approach to interactivity informs analysis through concepts applied in both interpersonal and mass communications (Domagk, Schwartz, & Plass, 2010). How we send messages, whether interpersonally or as a form of broadcast to multiple people, changes how we think about interactivity and what is vital in trying to assess the efficacy of the interaction: Vicker (2010) considers an interaction effective when a person is able to express their own concerns, exchange ideas, and construct a shared understanding of a given topic. This in turn elevates that person's self-esteem and sense of purpose. From an interpersonal perspective, humans communicate to learn and to achieve personal and work-related goals in teams (Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002) or to establish myriad types of relationships (Berger & Calabrese, 1975). An understanding of interactivity has the potential to improve future interactions with others, positively influencing individual interactions and as a result, potentially all of society.

User control toward social application. Interactivity is also defined as a set of system attributes, enabling individuals to control the source, medium, and message of their communications using a given system (Sundar, 2007, 2008; Sundar et al., 2010). Interaction must have more social and psychological importance than merely exchanging messages if it is to be considered meaningful (Bucy, 2004). From this perspective, we might use interactivity to promote a healthier society by replicating communications and situations occurring between individuals or groups of individuals to solve various problems.

Technological/Functional perspective. Much of the interactivity transpiring in today's information age often requires tools or technologies. Much scholarship has attempted to describe interaction relative to the technological or functional attributes inherent in its makeup (Delen, Liew, & Willson, 2014). For example, researchers have observed whether having the user to control the pace of the on-screen appearance of instructional content has featured prominently in positive learning outcomes (Mayer & Chandler, 2001).

This navigational interactivity is concerned with moving through computer-based information via controls such as commands, menus, searching, hypertext links, or by search functions. These methods contain some of the more sophisticated forms of navigational interactivity. Navigation is a less advanced form of interactivity, as it imposes limits on what a person may access next within the confines of a web site or other digital product or experience. However, navigational interactivity is still essential as it is the most fundamental aspect of interactivity. Moreover, an excellent navigational layout is integral to the success of a website or learning object (Kimelfeld & Watt, 2001).

From this perspective, the selection of the specific tool, operations signifying the placement of controls or features, and the overall functionality of the instrument is paramount in solving problems related to effective instructional design and learning outcomes.

Perceptual/Behavioral Perspectives

Two critical perspectives related to interactivity focus on how the individual perceives and refers to an interactive environment and the behaviors that may change because of experiencing an interactive situation within an environment.

Individual Perception. Other perspectives focus on the individual in terms of different perceptions and needs. Numerous industry actors attempt to assess the essential elements that make the interaction more accessible and more efficient (Garrett, 2010). These actors are as concerned with ease of use and utility as with other functional or technical operations or characteristics to convey the content or message the creator hopes to deliver (McMillan & Hwang, 2002).

There is convergence among, business marketing and e-learning research concerned with perceptual effects on outcomes as they relate to the end-user. Both of these fields consider user engagement as they both have active target audiences to which they must communicate and generate a sufficient level of interest and enthusiasm in order to attain desired goals and objectives (Mollen & Wilson, 2010).

The literature suggests prior positive experience with interactive technology positively affects outcomes of future experiences, especially when collaborative experiences are encouraged (Jung, Choi, Lim, & Leem, 2002). Users react positively when the activity or environment evokes a stronger flow experience, or when users experience a fully immersive and enjoyable experience (Ho & Kuo, 2010). Users report positive perceptions when there is an opportunity for them to control the experience and that opportunity is made known to her or him (Sims, 2003). Additionally, individuals may carry pre-existing beliefs in terms of their own aptitudes and capacities concerning technology. These values affect their ability to navigate interactive environments successfully. (Salajan, Schönwetter, & Cleghorn, 2010). From this perspective, end-user satisfaction should be a high consideration when utilizing interaction to solve a problem.

Behavior Another critical area of focus is the effects of interactivity on behavior. Since the time of Edward Thorndike, whose *Law of Effect* became an essential perspective regarding how the mind operates, scientists and others have been interested in ways to measure and shape behavior in individuals. The premise is that a) Responses that trigger a satisfying result reinforce that response and b) Stimulus-response connections not often repeated are weakened (Plucker, 2007). Instructors and instructional designers may utilize technologies that support the cognitive and social processes of learning, as well as other significant forms of interactivity and their technical underpinnings to promote or encourage desired behaviors (Deubel, 2003; Siau et al., 2006).

Jerome Bruner notes that the will to learn is intrinsic and that motivational aspects of learning have not received the attention they deserve:

"The problem exists not so much in learning itself, but in the fact that what the school imposes often fails to enlist the natural energies that sustain spontaneous learning." (Bruner, 1966, p. 127). Interaction utilized from such a perspective might be interested in how such an intervention elicits a behavioral outcome.

The prior section discussed a few of the predominant perspectives of interactive environments. These perspectives may inform instructional design.

The following section discusses a few fundamental approaches and taxonomies that have been created to employ interaction within learning.

Interaction Approaches and Taxonomies in Learning

The realms of education and computing have provided classification systems to aid in understanding interaction and interactivity. These taxonomies arrange and classify some discrete aspects of what it means to act, react, and influence in ways that might better inform research and praxis.

Taxonomy of Interaction for Instructional Multimedia (Schwier, 1992)

Schwier rejected a simplistic view of human-computer interaction in favor of a learner-media approach. This view analyzes the level of cognitive engagement influenced by the learner. Schwier proposes classifying interactive transactions within five general functions under three levels of interaction (Goolkasian, 1996). Schwier described *Reactive* interaction as a response to a presented stimulus. *Proactive* interaction emphasizes meaning-making and having the learner become the central character in the environment or intervention. *Mutual* interaction, the highest level in this taxonomy, utilizes machine learning, artificial intelligence, or aspects of virtual reality. In these systems, both the learner and the learning system can adapt and respond robustly to one another (Schwier, 1992). This iterative process within the environment is suggestive of a dialogue between learner and learning system.

Table 2.1 Schwier's taxonomy for instructional multimedia (1992)

	Reactive	**Proactive**	**Mutual**
Confirmation	Touch Target Drag Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality
Pacing	Space Bar/Return Drag Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality
Navigation	Touch Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality

Table 2.1 (Continued)

Inquiry	Touch Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality
Elaboration		Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality

Schwier noted that at the time of his presentation to the Annual Conference of the Association for Media and Technology, multimedia systems were not capable of such robust interaction. He also noted direct, sophisticated communication with machines might one day be possible to advance the cause of learning and instructional intervention (Schwier, 1992).

The Better "Mouse" Trap Taxonomy

Schick (2000) proposed taxonomy and conceptualization of interactivity to stimulate the development of educational software to promote critical thinking about history. First, he differentiated software that directly responds to the user's feedback versus software that allows for a more profound, reflective experience. Second, he sought to identify if the application is *giving,* or provides ready additional information for the learner, or *taking*, meaning it asks the user to do something new with the data presented. This taxonomy consists of twenty-six types of interaction divided among two main categories (Schick, 2000).

Table 2.2“Giving” Application Elements According to Schick

Name	Description
Mechanical	Involving actions such as page turning or advancing to the next slide
Right/Wrong	Shows the words "Correct" or "Incorrect" as appropriate before moving on to the next question
Look It Up	Displays page numbers in the textbook where the right answer may be found for all incorrect responses
More Anon	Corrects misunderstandings and/or amplifies the original statement when the correct answer has been selected in a succinct paragraph or two
Outcome	Tallies right and wrong answers, perhaps also analyzes the results insofar as they show patterns
Comparison	Compares this student's result with previous users of the tutorial
Depth	Greatly expands the information available on the topics
Context	Broadens the discussion by examining each topic's context
Satellite View	Widens the scope across geopolitical lines
Microscope	Augments the knowledge by displaying focused readings drawn from primary and secondary sources
Inclusion	Incorporates the instructor's views
Historiography	Presents the perspectives of historians
Crossfire	Identifies issues in dispute regarding the statements

Table 2.3 “Taking” Application Elements According to Schick

Name	Description
Rewind	Facilitates unlimited backtracking through the material should the user wish to refresh a memory or double-check a fact
Notes	Allows the student to record observations, questions to ask the teacher or pursue in the textbook, quibbles about answers given in the stimulation, and the like
Kaleidoscope	Provides access to a vast collection of primary and secondary sources by means of a search engine (by keyword, phrase, wildcard, proximity) to find relevant information

Table 2.3 (Continued)

Analysis	Interprets the user's choices
Questions	Invites the user's written responses, with the result being saved and printed for analysis by the teacher
Collage	Displays a series of images - visual, aural, text - and challenges the user to gather them into coherent narratives on these topics
Chain of Events	Asks users to apply their reasoning skills to determine precursors for an event, predict outcomes, or find a common thread, based on the information provided
Doing History	Asks students to become historians
What Ifs	Offers counterfactual questions to challenge the user's thinking
Consultation	Magnifies learning through correspondence in listservs, chatrooms, and other web sites
Response	Allows for answers to questions outside the focus of the stimulation in two ways by providing: a list of supplemental questions to which the author has prepared replies and/or a website monitored by the application's author who will answer to questions seeking information, explanation, or historiographical suggestion
Living History	Weblinks allow students to "visit" sites that actually reflect or virtually create situations
Simulation	Users make choices reflecting those covered by the tutorial to better understand how history happened.

Multi-modal Interactivity

Moreno and Mayer (2007) apply an understanding of interactivity toward the learning processes where interactivity is concerned with the actions of the learner and advancing or changing his or her knowledge as it relates to the instructional goal. Moreno and Mayer delineate delivery mechanisms offering one-way communication (perhaps from instructor to the learner) versus those affording multi-directional communication, such that a learner may send and receive messages. From one perspective, the goal of interactivity in multimedia learning where communication is multi-directional, it is centered on knowledge construction and meaning-making as opposed to simple knowledge transference. Multi-directional communication supports constructivism to a greater extent than unidirectional interactivity or environments where learner control is featured, but no real means of response and feedback is possible (Mayer, 2002).

Moreno and Mayer (2007) offer five types of interactivity in multi-modal, or using both verbal and non-verbal modes in learning:

1. dialoguing
2. controlling
3. manipulating
4. searching
5. navigating.

The following section defines these types.

Dialoguing. The learners receive questions and answers or similar feedback relative to their inputs in the instructional environment or intervention.

Controlling. The learner determines the pace and sequence of a presentation or scenario.

Manipulating. The learners set boundaries, characteristics, or rules for a simulation, or have the ability to control the relationship to objects on the screen in terms of distance.

Searching. The learners find new topics or content by entering questions or inquiry, receiving a list of choices, and selecting a preference.

Navigating. The learner continues to a different area of content by selecting from multiple sources of information.

The prior sections explained some of the fundamental, accepted conditions of interactivity, mainly as they pertain to digital online instructional situations. Additionally, some interactive taxonomies, as well as perspectives on interactivity, were reviewed. The literature suggests they may be valuable in creating various instructional interventions.

Interactivity in this Study

This study utilized an interactive invention with the following essential features: First, the intervention is only concerned with the exchange between a human participant and the online instructional learning system, in this case the DDL. The student will receive a type of dialogic feedback based on participant choice at critical points in a narrative.

Second, although not the primary focus of the study, the intervention in this study emphasizes modifying behavior or increasing awareness as it relates to policies and procedures that are inclusive of diverse populations. The intervention is less concerned with individual matters of perception in favor of communicating an expected attitude and, therefore, a behavioral outcome.

Third, although the interactivity of this study's intervention incorporated many of the multi-modal features described above, the primary focus attempts to take a learner-media proactive approach where the learner has a central role as an observer in the story. It contains light to moderate amount of interaction, permitting the learner reflective time regarding the issues presented in the intervention. Also, the initial interaction design involves a form of a dialogue between the learner and the system that delivers the narrative simulation.

The following section discusses learning efficiency as a theoretical underpinning and the basis for the of the instructional framework.

Theoretical Framework for the Study: Efficiency in Learning

While the introduction of this dissertation presented a need to design, develop, and deploy learning products and experiences efficiently from an instructor's perspective of saving time, the concept of efficiency relative to the inherent processes in learning is also viable, practicable, and worthy of consideration. Systematic approaches to the educational process are certainly not novel. Theories and empirical research about how the brain processes information have emerged over the last 60 years providing empirical data about how instructional design can improve learning outcomes.

Not coincidentally, scholars and researchers have perhaps always given thought to the concept of improving learning outcomes in the most convenient ways possible. For example, William James (1916) in *Talks to Teachers* presented an understanding of the attributes of the mind's ability to hold a limited amount of information at a time and suggested specific strategies to facilitate the learning process. He admonished teachers to "show concrete examples" to make unfamiliar objects figures as "part of a story," claiming "no unvarying object can hold the mental field for long" (p 111-112).

George A Miller's (1956) exposition of the retentive cognitive capacity of the human mind, though at the time untested and still today controversial, was perhaps one of the most influential early works exploring the nature and limits of human cognitive architecture and its relationship to one's ability to temporarily hold and process information (Cowan, 2000).

Multiple studies from the 1970s focused on the amount of effort required to learn a given topic. One research line described the use of a rating scale for the perceived difficulty of mental tasks, and the perception of mental effort needed to complete them (Borg, Bratfisch, & Dorni'c, 1971; Bratfisch, 1970, 1972a, 1972b).

Mental Effort

The concept of mental workload, scarcely present before 1970, is concerned with the multifaceted, aggregated mental demands imposed upon an individual by various tasks performed within a relatively short time frame. The construct explains the incapacity for humans to complete the requirements of a task or a given set of functions (Cain, 2007). Even today, both researchers and practitioners utilize the concept of the mind’s capacity to hold information on a short-term basis with the presumed goal of retaining information in a more enduring way to be an essential aspect of learning.

The Media Debate: Economy and Replicability

The work of Richard E. Clark underscores a firmly held view among many instructional design researchers and theorists: The chosen delivery method of instructional content has little bearing on learning outcomes. Through analysis of prior studies and his own research, Clark posits that the chosen instructional medium should be seen merely as a method of transport, and one might convey instructional strategies in several different ways (Clark, 2001). Others, such as Robert Kozma (1991), assert an opposing and alternative viewpoint on the relevance and significance of media in education. Although this study does not seek to examine the complexities of this debate and Clark’s position therein, he mentioned two critical aspects of instructional development relevant to the efficiency concept.

In multiple articles, Clark (1994, 2000, 2001) asserts one form of media may serve as a replacement for the delivery of instructional content over most others. For example, although true animation is limited to television, film, and computer animation, static visual representations may be created to symbolize or convey a sense of motion (Anglin, Vaez, & Cunningham, 2004), Therefore, the placement of images and text on a written page, TV, or computer screen may also deliver similarly rich content when done strategically.

Although Clark warns against the effect novelty may play in the delivery of an instructional unit, he suggests the selection of one media type may convey certain advantages of economy or efficiency (Clark, 1994). Morrison (1994) suggests one should examine the instructional unit overall, comparing it with an alternative form to determine the effectiveness of the proposed unit (Anglin et al., 2004).

Workload and Mental Effort

Multiple theorists attempted to define and measure perceived mental effort. Mental workload is a term representing multidimensional constructs (Reid & Nygren, 1988; Tein, 1989). The dimensions or workload defined by Sheridan and Simpson (1979) claim that mental workload consists of three conceptually independent dimensions: time load, mental effort load, and psychological stress load.

Time load refers to the amount of time an actor or participant has to perform a task (Reid, Eggemeier, & Nygren, 1982; Reid & Nygren, 1988). It estimates the general time required to complete a task and a pace or speed at which a person must work to keep up to that pre-determined time. This pacing is determined not only by the complexity of a task but also an individual's skill or ability. For some, tasks may require more time either because the individual cannot keep up with the expected pace, or because it merely takes more time than the task designer anticipates.

Mental effort load is defined in terms of an individual's capacities and is concerned with information retrieval, processing, and decision-making. All of these factors compete for an individual's available mental capacity (Reid et al., 1982; Reid & Nygren, 1988).

Psychological stress is the third aspect of mental workload. It involves anything that complicates the activity or task by producing anxiety, confusion, or frustration. Psychological stress may result due to fear of physical harm, failure, tension, or unfamiliarity with a situation (Reid et al., 1982; Reid & Nygren, 1988).

Measuring workload is a complex and challenging endeavor given the multi-faceted aspect of work in various fields and the complexity of such activity. Understanding how humans view work in relationship to the individual workload is essential to improving performance-related outcomes:

> "If people could accomplish everything they are expected to do quickly, accurately, and reliably using available resources, the concept would have little practical importance. Since they often cannot, or the human cost (e.g., fatigue, stress, illness, and accidents) of maintaining performance is unacceptably high, designers, manufacturers, managers, and operators, who are ultimately interested in system performance, need answers about operator workload at all stages of system design and operation. The many definitions that exist in the psychological literature are a testament to the complexity of the construct, as are the growing number of causes, consequences, and symptoms that have been identified. Given the confusion among the experts, it seems equally likely that people who are asked to provide ratings will have a similar range of opinions and apply the same label (workload) to very different aspects of their experiences" (Hart, 2006a, p. 904).

As the concept of mental workload developed, it became more salient in learning theory, considering variation in the rate, accuracy, and reliability of human performance relative to a given task. In the following section, this review considers developments in cognitive load theory and learning theory.

Cognitive Load Theory and Measures of Workload

Cognitive load is conceptualized as the level of “mental energy,” necessary to handle a given amount of information (Cooper, 1990, p. 108). Cognitive Load Theory (CLT) supposes performance and learning diminish when the amount of effort or load required exceeds the memory’s capacity to process (John Sweller, 1988).

Prior studies from the last thirty years have suggested increases in cognitive load are tantamount to mental work, and reductions in the various aspects of cognitive load to the greatest extent possible will increase productivity and/or learning outcomes (Paas et al., 2003; John Sweller, 2010; J. Sweller et al., 2011).

Instructional Efficiency

The concepts of efficiency and economy are also not new in educational research. The scholarship and praxis of instructional efficiency are primarily concerned with achieving the highest possible learning outcome with the lowest expenditure of resources or effort. This section discusses the multiple conceptions of these terms and their potential implications.

Paas and Van Merriënboer (1993) developed a measure to both define the concept of efficiency related to instruction, as well as a practical measurement of it. They state that issues of overwork relative to mental processing are of great concern, from both an instructional design perspective, as well as the significant safety issues extant in many occupations requiring keen focus over a period. They define performance as “the effectiveness in accomplishing a particular task, often measured by speed, accuracy, or in educational settings, test scores" (Paas & Van Merriënboer, 1993, p. 738).

Figure 2.1 Paas Efficiency Equation where R = cognitive load and P = Performance

$$E = \frac{[\mathrm{R} - \mathrm{P}]}{\sqrt{2}}$$

Paas represented efficiency as the test score represented as a percentage subtracted by the perceived efficiency score on a nine-point scale (see figure 2.1). The sample test scores and efficiency scores are standardized by computing z-scores. The grand means are computed and compared to arrive at an index score used for the purposes of comparing various instructional conditions.

The NASA Task Load Index (TLX) is a six-item subjective survey instrument developed in 1980 by Sandra Hart and Lowell Staveland designed to measure ergonomic factors in aviation and aeronautics prototypes. In the ensuing years, the TLX has been used in hundreds of studies across myriad fields (Hart, 2006a).

The next section discusses the specific measures of instructional efficiency used in this study.

Primary Review of Narrative Simulation

The following section highlights the search methodology used, the data collection process, search results, and a summary of findings of narrative simulation (NS) instruction.

This study reviewed a variety of sources related to the concept of delivering real or realistic cases via online instruction, including academic journals, online journals, scholarly databases, Google Scholar web searches, and reference articles in primary research. These searches covered multiple article types, such as primary research articles, conceptual articles, theoretical articles, or what some describe as *talk-talk* articles (articles that relay relevant ideas and facts but are generally not comprised of primary empirical data). This review utilized only primary research, retaining other types of literature for reinforcement purposes. Out of the total number of journal articles found, only one (Bearman, Palermo, Allen, & Williams, 2015) reviewed known literature on topics similar to the proposition of this review. However, it was not focused on the subject as broadly and included other types of simulations about healthcare education.

The specific search process included investigations of the Ebsco Host's Academic Search Complete, which contains over 73 major research databases, including but not limited to the following: *Academic Search Premier, ERIC, Education Full Text with Wilson Web, Education Source, Education, and Administration Abstracts*. Additionally, standalone searches were performed at *eric.ed.gov* and using *Google Scholar*. These search results included terms such as *online narrative simulation; learning with narrative simulation; narrative simulation for learning*. Related terms such as *simulation exercises with narrative* were also used in searches. Table 2.1 identifies the journals where original research articles to the literature review were discovered.

Table 2.4 Academic Journals Used in Research Literature Review (2000-2020)

	Journal Title
1.	Cognition
2.	Educational Technology Research & Development
3.	Expert Systems with Applications
4.	Health Education Journal
5.	Journal of Agromedicine
6.	Journal of Knowledge Management Practice
7.	Mining Engineering
8.	ReCALL
9.	Theory & Research in Social Education

Summary of Search Results

The previously described search process produced 38 relevant articles that classified as either primary, theoretical, literature review, conceptual, case study, or *talk-talk*. Of the total number of articles collected, 26% (10) of the 38 articles are categorized as primary research studies, while 34% (13) are theoretical, 36% (14) are conceptual or talk-talk in nature, and 2% (1) was a literature review.

The ten primary research studies revealed using NS to address two significant areas of concern. The first is related to personal and professional safety as it pertains to accident prevention and loss mitigation. Areas such as mine safety, proper machine operation, fire mitigation and evacuation, equestrian rider and helmet safety are significant areas mentioned. The second area is related to using NS to bring about attitudinal changes related to diversity and inclusion. One research line explicitly dealt with the disenfranchisement of LGBTQ persons.

The binding factor inherent in both lines of research is that attempting to alter closely held attitudes that underpin and may predict behavior presents unique challenges for instructors. Providing content and instructional strategy to leverage affective learning may require more than straightforward approaches such as teacher-centric methods like direct instruction, or even student-centered methods such as independent instruction.

How might we distinguish NS from other instructional interventions? First, NS depicts realistic situations or circumstances in which learners experience engaging and practical stories. Realistic and engaging conditions are the hallmark of NS and the most crucial aspect of its delivery. Surveys or focus groups in most of the research indicated the level of detail or authenticity allowed them to be concerned with the characters or concepts contained in the story. Second, NS requires the intervention to provide for some reflective mechanism so that the learner may evaluate his or her attitudes and values under the auspices of realistic consequences given multiple courses of action. This reflective affordance allows the mind to consider various possibilities relative to multiple decision points within the story. By way of reflection, one may envision herself or himself as a potential participant of the story. Therefore, a form of mental simulation occurs in which the learner may consider possible decisions and the consequences that may result from any or all decisions.

The ability to individually evaluate a story, consider possible decisions, and then reflect upon the choices made by a third person character within a realistic story is what makes NS an appropriate intervention for affective learning to alter attitudes, thereby potentially changing behavior. The research has suggested the utility of NS in domains related to accident prevention and safety, and in promoting tolerance and acceptance of those who differ from ourselves.

Review of Dissertations

The primary literature review yielded three dissertations related to the significance and use of NS. Two of these cited much of the primary research lines presented in this review.

Two dissertations dealt with different aspects of accident safety. Goetz (2013) utilized NS to change behavior and promote awareness about fire prevention in rural populations and attempted to measure the behavioral intentions of participants as a result of the intervention. Schneider (2015) utilized theories of digital gaming to deliver an instructional intervention featuring NS in the awareness of accidents related to misuse and improper safety practices when riding all-terrain vehicles when compared with a non-game intervention.

The third dissertation (Zou, 2012) utilized NS as one of the frameworks in understanding the creation and utilization of mental models related to the participation and operation of teams in business environments.

Conclusions for Distance Education, Narrative Simulation, and Instructional Efficiency Research

The literature review presented research findings, as well as questions which attempt to understand NS.

It is apparent learners and instructors alike enjoy and accept NS. Students find benefit from the engagement, the opportunity to consider realistic situations relative to the subject matter and to practice thinking about complex scenarios. This process invokes a form of mental simulation. In general, simulations have been well-studied and been shown to have demonstrated value as learning interventions across many disciplines and domains.

Constructivist learning precepts feature prominently in the theoretical frameworks of the NS studies discovered in this review. Research offers the viewpoint that meaning is made more robustly in groups. Students gain more than the transfer of knowledge when learning and working in groups.

NS as an instructional strategy may take multiple forms. It can certainly be offered in face to face (F2F) courses but is also well-suited to individual delivery with students learning by themselves. NS can be delivered via text and picture or other traditional approaches, or by using more complex web-based, data-driven applications that offer instructors greater flexibility in both delivering stories, as well as measuring student responses and the pacing and branching aspect of delivery when applied.

There are many avenues one might explore to examine NS. Only ten studies were discovered in the primary literature review spanning the years 1990 through 2020. Most of the articles included a significant satisfaction or acceptability component relative to the concept of presenting narratives.

There was no research discovered which attempted to assess the impact NS might place on cognitive load. Moreover, few studies have looked at self-paced NS without some peer interaction.

The purpose of this study was to determine whether there is a significant difference in the efficiency (measured through perceived cognitive load and the measured outcome of demonstrated performance) among distance education participants who engaged in a self-paced NS module versus students who participated in a traditional online distance learning lesson.

Summary

This review of literature sought to examine the suitability of NS as a viable interactive instructional treatment in online distance education; some lines of research explored the concept of interactivity and explicated the interactive features of the NS intervention in this study. Additionally, existing learning efficiency literature was summarized. The analysis of the research yields the following considerations.

First, NS can be used to provide information of various kinds in an attempt to change attitudes, and therefore, alter perceptions or behavior. Moreover, it is an instructional method and not bound to a particular medium or mediation, and therefore would be suitable in myriad instructional situations, but especially within online, self-paced instructional units.

Second, NS poses questions at critical points in the arc of an unchanging story. Responses to the items do not typically change the story's outcome. Instead, they allow a learner to consider various factors, receiving information and feedback as it relates to their choices. These decision points afford a type of interactivity that is not only dialogic but also allows for a kind of reflection that provides an opportunity of more profound thinking on a given issue.

Finally, NS, a tested instructional intervention, has not been analyzed relative to the concept of learning efficiency. As teachers and learners strive to attain the best possible learning outcomes in the most expedient manner possible, the idea of learning efficiency by Paas and Van Merriënboer (1993) may serve to inform the research to assess the effectiveness of using NS as an online instructional intervention as opposed to more traditional methods of instruction. The development of instructional interventions requires considerable time and resources. Moreover, asking students to examine a newer instructional approach and expend mental effort in comprehending and possibly applying the concepts learned are all costs associated with the learning task. Learning efficiency, an application of cognitive load theory (CLT), provides a framework by which we may consider NS as a learning intervention. Learning efficiency considers the assessment performance and compares the difference between that performance score and the perceived mental effort expended in learning a lesson.

This study seeks to determine if the costs involved with utilizing NS as an instructional intervention might return a higher learning efficiency, and therefore garner an acceptable return on the learner's investment of time and effort.

CHAPTER THREE

METHODOLOGY

Although ample literature related to online and distance education and cognitive theories for multimedia learning exists, this research should further study the effects and comparisons between the media and methods of interactivity. Moreover, it should make some inference whether developing different instructional methods for online delivery might result in an enhanced learning efficiency relative to perceived cognitive load and learning performance. This study aims to inform instructors and instructional design practitioners if the effort of developing such interventions will result in a more efficient learning outcome for students.

This study seeks to provide a perspective on preservice educators participating in an open online distance education module, and if a narrative simulation (NS) learning intervention affected their levels of dyslexia awareness, as well as overall success in recognizing some of the issues related to identifying and intervening on behalf of children with dyslexia.

Research Questions

Based on the literature, this study seeks to answer the following research questions:

- Does dialoguing interactivity resultant from NS have a significant effect of the various aspects of perceived cognitive load in learning dyslexia content, including time demand, mental demand, perceived performance, mental effort, and frustration?
- Do participants engaged in a NS learning module obtain a higher score on their first content test attempt compared with those learning from an expository online lesson?

- Do participants engaged in a NS learning module require fewer attempts to pass a content test compared with those who experience an expository learning module?
- Do participants engaged in a NS learning module ultimately receive a higher score above the minimum required passing score compared to those experiencing an expository learning module?

Hypotheses

Based on the research questions stated above, the following hypotheses will be tested:

- Hypothesis 1: There will be significant difference in the perceived cognitive load on assessments in an online open distance education course when comparing learners using NS interactivity compared with a traditional digital expository instructional intervention.
- Hypothesis 2: There will be a significant difference in instructional efficiency in an online open distance education course when comparing the NS interactivity sequence group and expository instruction group.
- Hypothesis 3: Significant differences exists between NS and Expository treatment groups regarding other argued measures of efficiency which are test score and number of attempts required to pass the test.

Participants

This research included preservice teacher education professionals at a large research university. Upon receiving directions from their instructors, participants self-registered and enrolled in an open distance education lesson on dyslexia located on the Digital Drivers License (DDL) at https://otis.coe.uky.edu/DDL/.

For this study, lessons on dyslexia were provided by university literacy experts to be utilized in the research. Within the module, 119 students registered and participated.

Instrumentation

This study collected learner performance and interactivity data via the participatory (Web 2.0) web site Digital Driver License (DDL), comprised of user interface and a backend database providing content and interactivity in an open online learning management system originally focused on digital citizenship. Participants interacted with the digital content and took assessments to measure their understanding. They created an account in the DDL platform linked with their institution or school district to share their work and progress with teachers and administrators.

Two types of instruments were used in this study: a *Prove It!* assessment occurring at the end of each lesson and the NASA TLX ("NASA TLX: Task Load Index", n.d.),given after the conclusion of the *Prove It!* for the assessment of cognitive load experienced resulting from learning the dyslexia content.

Prove IT! Assessment

Prove It! assessments consisted of a total of eleven true or false questions related to general dyslexia knowledge and awareness. These questions were written and vetted by literacy education experts at a large public research university in the southeastern United States.

NASA Task Load Index (TLX)

NASA-TLX (TLX) is a multi-dimensional assessment subjective rating tool. It has been extensively utilized for the analysis mental workload in people utilizing various human-machine systems (Cao, Chintamani, Pandya, & Ellis, 2009; National Aeronautics and Space

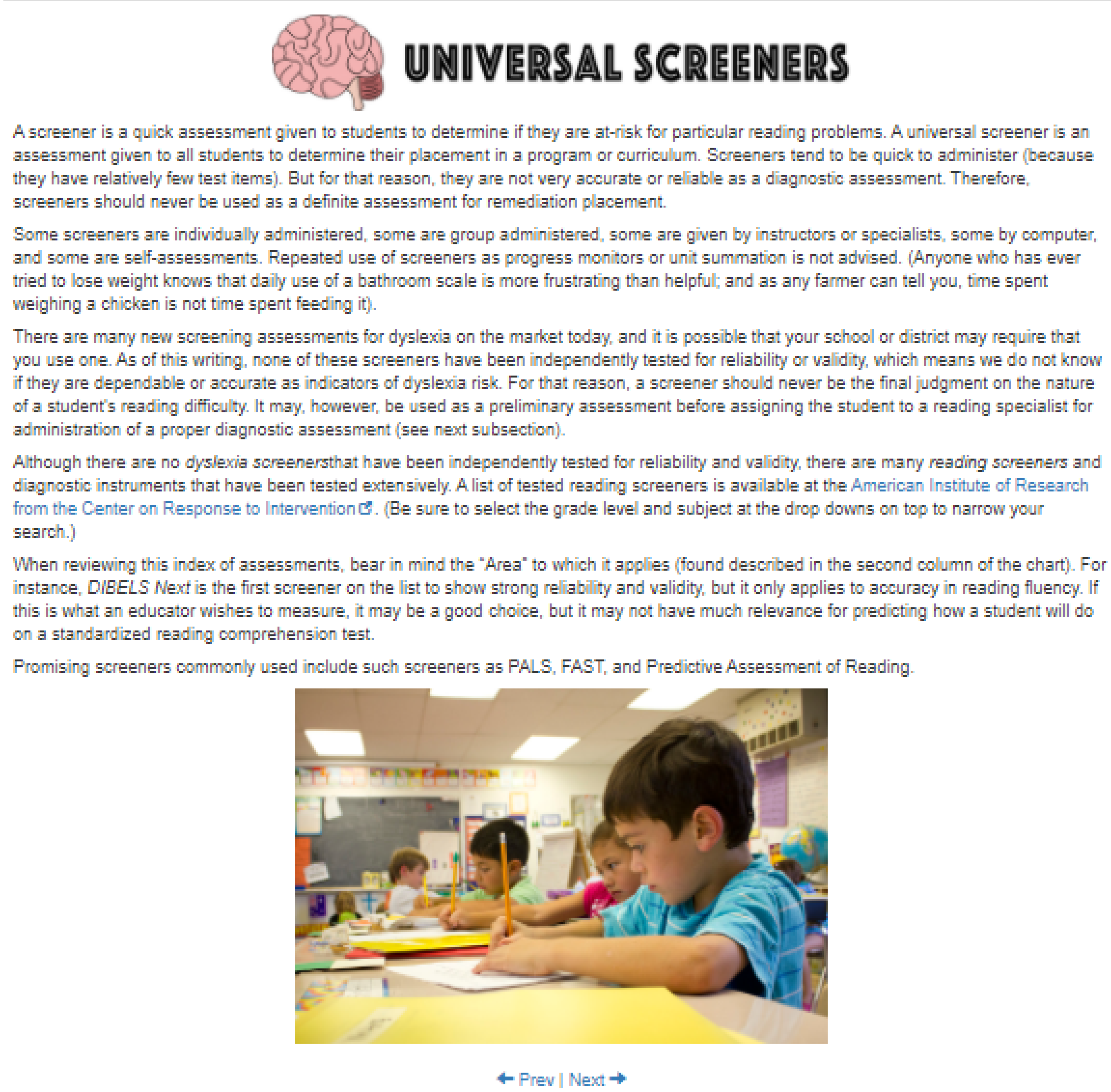
Administration, 2019). It has seen extensive, nearly ubiquitous use in fields related to aeronautics, and has also seen broad adoption in fields related to the United States military, medicine, automobile operations, and computer operations and usage (Hart, 2006a). NASA-TLX consists of a multidimensional rating procedure that derives an overall workload score based on a weighted average of ratings on six subscales (National Aeronautics and Space Administration, 2019). These scales consist of the following areas: 1. Mental Demand, 2. Physical Demand, 3. Temporal Demand, or Time Pressure, 4. Self-Performance, 5. Effort, and 6. Frustration. The original TLX utilizes a paired comparison technique between certain of the above tasks to determine the extent to which of each of the scales most contributed to the workload in the evaluated performance.

This study used what Hill et al. (1992) and Hart (2006a) refer to as the Raw TLX (RTLX), a more simplified version of the TLX. The original TLX requires participants to perform additional ratings, weighing the various subscales in order to determine which factor contributed the most to the overall mental workload. The result would not significantly influence either the implications or the central objective of the study. The RTLX was performed by adding the scores of six ratings and averaging them. The resulting number is an estimate of the overall mental workload.

Instructional Treatments

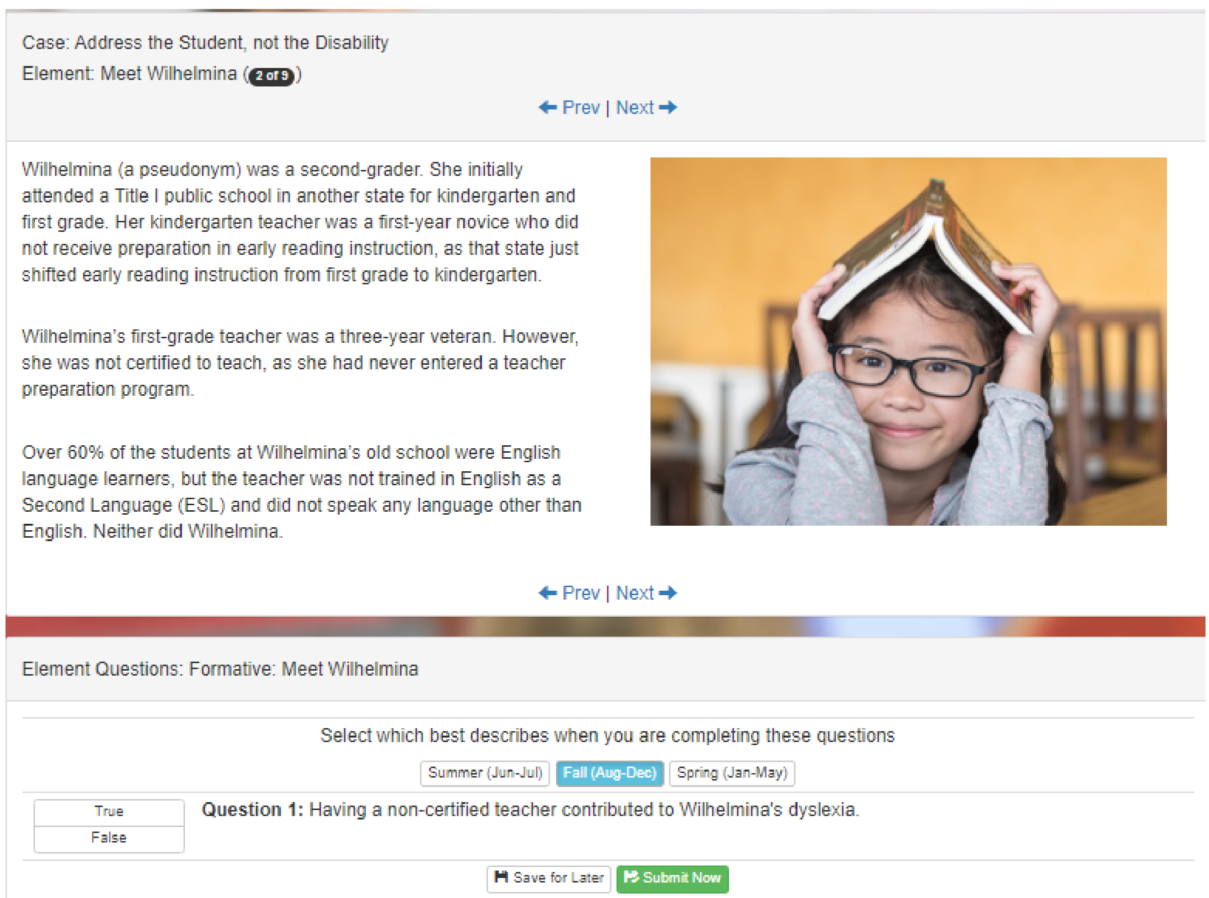
Expository Treatment. The Expository treatment contained text with supporting images that closely patterns the NS in terms of content. The Expository treatment was also offered in a web accessible format and available in the same location as the NS. The Expository treatment should take no longer than twenty minutes to read based on an average reading speed of 200 words per minute.

Figure 3.1 Example of one screen of the expository lesson, consisting of mostly text and picture



Narrative Simulation Treatment (NS). The NS was a dyslexia lesson comprised of a story containing text and pictures. At five key decision points in the story, participants are asked a series of either true/false or multiple-choice questions. Participants answered one to five questions posed at each key decision point with an average (mode) of two questions per decision point. As participants provide answers at each point, the treatment offered the correct answer, along with text-based feedback confirming the correct answer or providing corrective or informational feedback providing rationale supporting the best response. The treatment was self-paced in that the participant was able to take as much time as needed before progressing to the next part of the story or return to prior sections if desired. Completion of the NS should have taken less than twenty minutes depending on how long he or she spent actively engaging each part of the story to answer the questions at each point promptly.

Figure 3.2 Example of narrative simulation screen consisting of one or more questions at key points in the story.



Both treatments were developed in conjunction with the University of Kentucky professors who have literacy and dyslexia expertise who have both reviewed and approved the general information and specific content of each lesson. Each lesson was designed to contain similar content related to the summative assessments.

Procedure

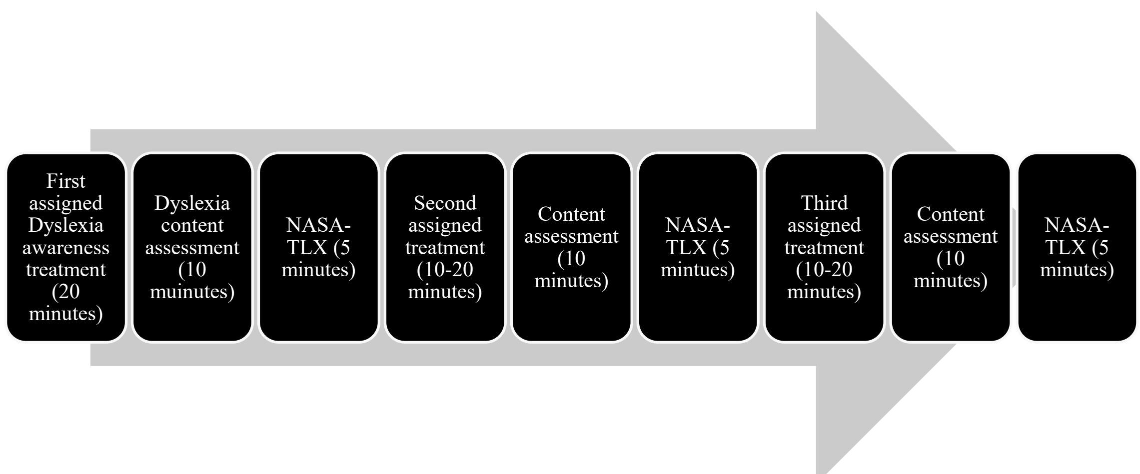
This research was conducted using pre-existing data from this endeavor via an online platform called the Digital Driver's License (DDL), hosted by the College of Education of a large public university located in the Southeastern United States. It is the largest university in the state in terms of student enrollment. It is also the highest-ranked research university in the state (Council on Post Secondary Education, 2018).

The total platform participant count since the launch of the open online distance education course in August of the 2019-2020 school year, included 147,024 students, 1,392 administrators, and 9,584 teachers participated in modules hosted on the DDL. Participants submitted over five million assessment attempts. DDL courses are configured so that students, instructors, or practicum supervisors can decide when to start and when to stop a session.

The study adopted a form of ex post facto design. Participants were randomly assigned to either the expository group or narrative simulation (NS) group. Participants took each of the three online lessons in stages according to this random assignment; the expository group took two expository lessons first and the NS group took the NS lesson first, after which they completed a content assessment and then the NASA-TLX subjective measurement of cognitive load. After completing the NASA-TLX for the respective lesson each group took the other modules, content assessment, and respective NASA-TLX.

There was no time limit established for the module, each module was estimated to last approximately 35 minutes, for a total of approximately 105 minutes. Participants registered to take the modules through the Internet DDL platform located at https://otis.coe.uky.edu/DDL and completed the activities contained in the study at their convenience online at their own pace in the following order: 1. dyslexia lesson (10-20 minutes) 2. dyslexia assessment (10 minutes) 3. NASA-TLX (10 minutes). At this point, participants received the other assessments they were not offered in the first space.

Figure 3.3 Total Procedure for all three dyslexia modules



This research was conducted using pre-collected from the DDL online learning management system. Participants interacted with materials included from within the system.

About the Digital Driver's License (DDL) System

The Digital Driver's License is a learning platform designed as an Online Open Course experience for custom learning solutions (Swan & Park, 2015). The project began as a specific curriculum consisting of content designed to impart knowledge of good digital citizenship (Noonoo, 2014). The "license" consists of a set of scenarios, or cases, designed to expose students to crucial concepts and build their skills in the nine elements of digital citizenship according to Ribble (2015). The DDL platform currently hosts cases dealing with a broad range of topics, such as civics, social studies, and equity in education. It also hosts the ability to create online digital teacher portfolios.

The lessons comprised in this study are cases as well. DDL Cases contain two general types of assessments: practice-its and prove-its. Practice-its explain the cases, allows students to answer questions, and then provides feedback to those responses. For example, one question might ask if a course of action is appropriate for a student with a reading deficiency. After students answer the question, they receive an explanation which either affirms their answer or offers corrective feedback.

Prove-its are essentially traditional quizzes where students do not receive specific feedback about their answers.

Measures

The study consisted of two instruments: 1. Literacy assessment developed in conjunction with university subject matter experts on dyslexia and literacy for assessment of dyslexia knowledge; 2. Variation of the NASA Task Load Index (TLX) (Hart, 2006b; Hart & Staveland, 1988) for assessment of cognitive load experienced during the two instructional treatments.

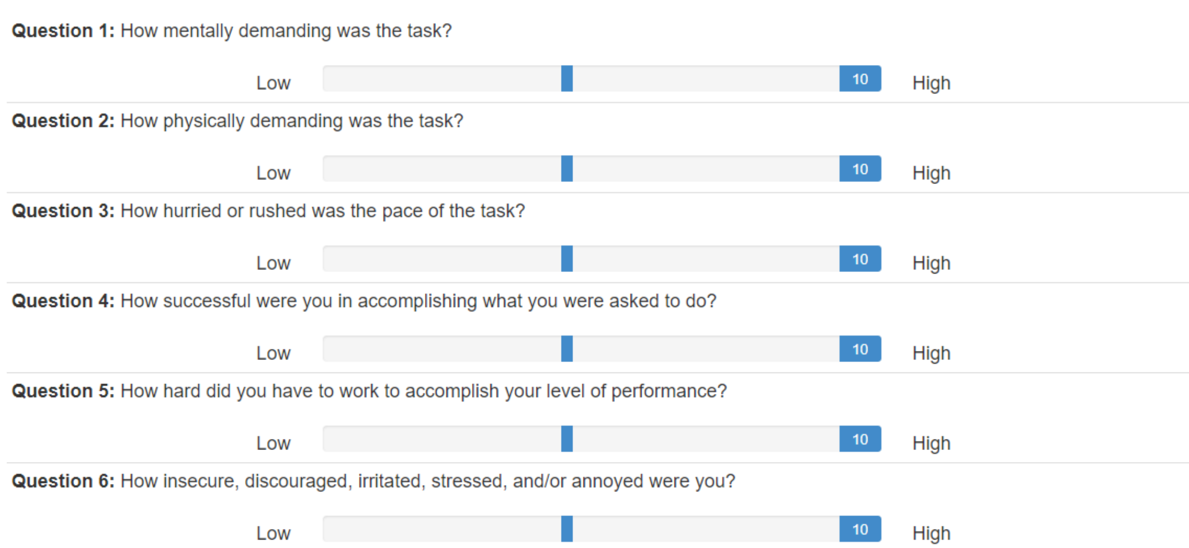
Cognitive Load Measures

The concept of cognitive load is applied in this study to describe the amount of mental effort required to process a particular learning task. There are two predominant subjective measures of cognitive load in academic educational literature. This study will use more simplified raw version of the TLX (RTLX).

Although the original quantification of the ratings scale for sub-tasks was from 1-100, the original study authors note an optimal reference scale be from either 1 to 10 or 1 to 20, because subjects may not be disposed to providing very minute distinctions. In addition, the original authors suggested whenever possible, the TLX be used within a graphical scale with an unmarked continuum marked with extreme bipolar descriptors at both ends of the continuum. They also suggest that values may be applied retroactively when scoring is applied (Hart & Staveland, 1988).

The RTLX was given to participants after they answered summative assessment questions related to dyslexia awareness. They responded to objective questions asking them to rate the various aspects of task load from Very Low to Very High on a sliding graphical scale with a division mark equating to a twenty-point scale (Figure 3.4).

Figure 3.4 NASA Raw TLX (RTLX) as used to measure cognitive load in DDL Dyslexia Lessons



Experimental Validity

External Validity

One potential threat to the external validity of this study is the sampling bias and characteristics of the participants. Having an actual random sample from the entire population of teachers within a region or the country is not feasible. Although a selected sample of this population may not be an accurate representation of the broader population or preservice teachers, it may generalize the experience and outcomes for the preservice teachers at only one institution.

Internal Validity

The following measures were taken to minimize threats to internal validity in this study.

Instrumentation threats. The same measures and questions will be used on both the narrative simulation group as well as the expository lesson group. Participants received the same intervention and control. Participants received the same version of the RTLX for reporting cognitive load.

Maturation. Participants generally completed all the learning content and assessments within a short time frame: instructional intervention, summative assessment, and RTLX.

Random group assignment. Participants were randomly assigned into either the Expository sequence group or the Narrative Simulation (NS) group. The Expository group received Expository Lesson One first and were then presented the Narrative Simulation after completion of the ProveIt! assessment and RTLX for both Expository Lesson one and Expository Lesson Two. The NS group received the Narrative Simulation Lesson first, and then the expository lesson (Expository One and Two) after completing the ProveIt! assessment and related RTLX.

Research Design

This study used an ex post facto quantitative data analysis to both describe the instructional environment as well as accept and reject the research Hypotheses (Table 3.1). Descriptive statistics consisting of summative test scores, number of attempts, first attempt, reported subjective cognitive load. This type of design allows for the manipulation of independent variables, including the participant's spatial abilities and prior astronomy knowledge. Dependent variables in this study include the cognitive load and post dyslexia knowledge.

Table 3.1 Research Design

Measurement	Variable	Instrument	Analysis
Attempts	Dependent	Prove It!	This variable is a concatenation of all attempt scores on the Prove It! Assessments for this module.
Cognitive Load	Dependent	NASA TLX	This variable was used to determine which lesson introduced the most cognitive load.
Efficiency	Dependent	Computation	This is an index score derived by comparing z-scores from Attempts and Cognitive load measures.

Table 3.1 (Continued)

First Attempt Score	Dependent	Prove It!	This variable was used to compare knowledge gained between the two sequence groups.
Number of Attempts	Dependent	*Prove It!*	The variable was used to compare the number of times sequence groups repeated the *Prove It!* Assessments until a passing score of at least 82 was achieved.
Sequence Group	Independent	Digital Driver's License (DDL) System	The DDL system assigned participants to either the expository or NS group. Each group received lessons and assessment related to their assigned group first before receiving the other content

Variables

This study included the following instrumentation or research variables: Attempts, First attempt, Cognitive load measures, Number of attempts, and Sequence Group.

Attempts. The attempts variable is a dependent interval variable that represents the values of attempts the learner made for each assessment on a quantitative scale.

First Attempt. The first attempt the participant made at their assigned *Prove It!* assessment.

Measures of cognitive load. Measures of cognitive load are all dependent interval level variables comprised of the following measures

NASA Task Load Index (TLX). The NASA TLX is a multi-dimensional assessment subjective rating tool comprised of the following subscales: 1) Perceived Mental Demand, 2. Perceived Physical Demand, 3. Perceived Temporal Demand 4. Perceived performance, 5. Perceived effort, 6. Frustration.

Raw TLX (RTLX). A mean score is computed from the above individual subscales to arrive at a single raw score. Additionally, one or more of the subscales may be omitted if it does not pertain to the study or situation.

Instructional efficiency scores. Instructional efficiency will be computed via a procedure outlined by Paas and Van Merriënboer (1993) comparing mean z-scores from both the first attempt and cognitive load measures to compute an index score for the purposes of comparing multiple instructional conditions, in this case an expository instructional treatment versus a NS treatment related to dyslexia awareness.

Number of Attempts. The total number of attempts made by participants.

Sequence Group. The group designation indicating whether the participant received the expository instructional treatment or the narrative simulation treatment first.

Instructional Efficiency

The concepts of efficiency and economy are not new in educational research. The scholarship and praxis of instructional efficiency is primarily concerned with achieving the highest possible learning outcome with the lowest expenditure of resources or effort. This section discusses the multiple conceptions of these terms and their potential implications.

Paas and Van Merriënboer (1993) developed a measure to both define the concept of efficiency related to instruction, as well as a practicable measurement of it. They state that issues of overwork relative to mental processing are of great concern, from both an instructional design perspective, as well as the significant safety issues extant in many occupations requiring keen focus over a period of time. They define performance as “the effectiveness in accomplishing a particular task, often measured by speed, accuracy, or in educational settings, test scores” (Paas & Van Merriënboer, 1993, p. 738).

Learners’ behavior is more efficient if either their performance is higher than expected relative to the amount of effort expended or if such mental effort is lower than expected based on the outcome of their performance (Ahern & Beatty, 1979).

Paas and Van Merriënboer presented a calculation to equate this level of performance relative to the expended mental effort, or efficiency. Utilizing Pass’s SR-9, participants reported the perceived mental effort expended on a skills assessment. They then subtracted these values from participants’ raw (performance) score. Z-scores are then computed for both the score range as well as the perceived mental effort. The performance z-score is then subtracted from the reported mental effort z-score. The result is then divided by a square root of two. These procedures were repeated in multiple studies (Paas & Van Merriënboer, 1993; F. G. Paas, 1992; Van Gog & Paas, 2008).

Efficiency Revisited

Van Gog and Paas (2008) revisited Paas and Merriënboer’s (1993) measure of relative condition efficiency, potentially utilized by educators and researchers to differentiate the effects that instructional methods may have on learning. Their measure relied on performance and mental effort on an evaluation or test. The result is an index of the quality of learning outcomes. Combinations of higher performance to lower mental effort indicate the acquisition of more efficient cognitive schemata. Inversely, constructing a less efficient cognitive schema is indicative of lower performance or potentially higher mental effort. They noted that while this measure has become widely utilized, it has been so in an adapted form that observes mental effort expended during the learning phase and not the test phase.

Van Gog and Paas demonstrate how these methodological adaptations measure the potential total cognitive load of the lesson (including all the subtypes such as extraneous, intrinsic, and germane) and not the actual load of the learning process. Therefore, measures of efficiency that determine how an intervention improves learning outcomes are effective when assessing the testing mechanism and not on the instructional situation itself (J. Sweller et al., 2011). Learners who gain more knowledge via effective instruction experience less intrinsic cognitive load during the testing phase (Van Gog & Paas, 2008).

NASA TLX in Educational Research

NASA-TLX is a multi-dimensional assessment subjective rating tool. It has been extensively utilized for the analysis mental workload in people utilizing various human-machine systems (Cao et al., 2009; National Aeronautics and Space Administration, 2019). It has seen extensive, nearly ubiquitous use in fields related to aeronautics, and has also seen broad adoption in fields related to the United States military, medicine, automobile operations, and computer operations and usage (Hart, 2006a). NASA-TLX consists of a multidimensional rating procedure that derives an overall workload score based on a weighted average of ratings on six subscales (National Aeronautics and Space Administration, 2019). These scales consist of the following areas: 1. Mental Demand, 2.

Physical Demand, 3. Temporal Demand, or Time Pressure, 4. Self-Performance, 5. Effort, and Frustration. The original TLX utilizes a paired comparison technique between certain of the above tasks to determine the extent to which of each of the scales most contributed to the workload in the evaluated performance.

Given the current trends and historical perspective regarding the use of NS in education, the focus of this research extends to the use of NS as instruction presented in online courses or online instructional environments as a specific function of the quality of the instruction by Van Gog & Paas' recent work (2008). This design utilized the concept of instructional efficiency presented by Paas and Van Merriënboer (1993), but instead of implementing Paas's SR-9 measure of cognitive load, it used the NASA-RTLX's multidimensional ratings tool in order to determine whether NS is an equal or higher quality instructional method when compared to commonly seen instructional methods.

Summary of Methodology

Research participants in this study are primarily teacher education students from a large public university. There were also a smaller number of participants from other four-year institutions. Initial participants were solicited through their affiliation with various colleges of education, as well as the DDL system. Instruments used in this study included the following: a summative assessment and the raw NASA-TLX which will be used to assess mental workload for each treatment.

Two sequence groups were observed in this study: The Narrative Simulation (NS) group received the narrative simulation first and then a more traditional expository instructional unit, while the Expository Group received the expository lesson first (consisting of two lessons) and then the narrative simulation unit. The narrative simulation treatment was a lesson on literacy and dyslexia awareness containing multimedia, multiple-choice questions at key points in the treatment, and feedback based on selected answers. The traditional expository intervention consisted of text and pictures.

The process of data collection lasted an estimated 35 minutes per lesson. Upon accessing the learning management system, research participants will be assigned to one of two treatments: expository or NST; Upon the first login, participants received the instruments in the following order: instructional treatment, summative assessment, and then RTLX. After completing the assessment, the participants received the other instructional treatments, as they were a required assignment.

CHAPTER FOUR: RESULTS

The findings discovered during the analysis of data can be divided into two categories: descriptive statistics and primary data analysis. The descriptive statistics section describes the main features of the data. The primary data analysis reports the indices generated from the calculation of efficiency within instructional conditions contained in the sequence groups as well as the result of inferential statistics.

Demographics Statistics

This study followed an ex post facto research design. Limited demographic data was available due to privacy concerns. Therefore, de-identified data was used as the basis of the analysis. A total of 119 participants took at least one portion of the dyslexia module.

Upon login to the DDL system, participants were randomly assigned into sequence groups consisting of expository and narrative simulation (NS). The expository group first received expository treatments one and two (each consisting of lesson, content assessment, and then the NASA Task Load Index (TLX) subjective cognitive load measurement) and then the NS treatment, while the NS group received the NS treatment first and then expository treatments one and two along with their corresponding content assessment and TLX.

Descriptive Statistics

Before performing any index or statistical analysis, essential descriptive data were measured. Means and standard deviations for both the content knowledge assessment, as well as the NASA Raw TLX (RTLX) associated with each of the three lessons are reported in Table 4.1.

Table 4.1 Mean and Standard Deviation scores for Content Assessment First Attempt and Perceived Cognitive Load (RTLX)

Assessment	Sequence Group	M	SD
Expository 1 Content	Expository	78.22	19.48
	NS	84.16	15.66
Expository 1 RTLX	Expository	6.948	2.822
	NS	7.918	3.270
Expository 2 Content	Expository	74.83	12.72
	NS	78.31	14.96
Expository 2 RTLX	Expository	8.308	2.667
	NS	8.604	2.270
NS Content	Expository	82.44	13.76
	NS	76.40	13.00
NS RTLX	Expository	8.116	2.343
	NS	8.867	1.968

Note. Expository means an online expository lesson consisting of text and picture. NS stands for narrative simulation, a story-based lesson where probing questions are posed at key points in the story with appropriate corrective feedback. RTLX represents the Raw NASA TLX subjective assessment of mental effort. The physical demand subscale was excluded from the calculation.

Primary Data Analysis

Hypothesis Testing

In this section, the primary hypotheses of the study will be tested using an index comparison of multiple computed variables related to the concept of efficiency, two sample independent t-test, and chi-square analysis of nominal and interval-level variables.

Hypothesis #1 states that *there will be significant difference in the perceived cognitive load on assessments in an online open distance education course when comparing learners using NS interactivity compared with a traditional digital expository instructional intervention*.

This hypothesis was tested by performing a t-test on the following variables by sequence group: Respective first attempt RTLX, Expository 1 RTLX, Expository 2 RTLX, NS RTLX. The Raw TLX was derived by computing the mean of five out of six subscale measurements from the original NASA task load index, but excluding the subscale measuring perceived physical demand. The RTLX in this instance is based on a scale from one to twenty from among five subscale questions:

1. How mentally demanding was the task? (Mental Demand)
2. How hurried or rushed was the pace of the task? (Temporal Demand)
3. How successful were you in accomplishing what you were asked to do? (Performance)
4. How hard did you have to work to accomplish your level of performance? (Effort)
5. How insecure, discouraged, irritated, stressed, and/or annoyed were you? (Frustration Level)

The resulting t-test scores indicated the following:

Respective First Attempt. This is considered the first test taken by each respective group. The expository sequence group took the test for expository lesson one first, while the NS group took the test narrative simulation one before taking the others. An independent samples t-test was also used to analyze the means scores, and a significant statistical difference was observed in the two sequence groups t(119) = -4.25, p= < 0.01. The RTLX

Based on obtained data, it can be concluded with 95 percent confidence that the cognitive load for the participants taking expository lesson 1 first was significantly lower than the cognitive load experienced by students who first began the narrative simulation lesson (Table 4.2).

Table 4.2: RTLX Means of Sequence Groups

Sequence Group	N	M	SD
Expository	63	6.98	2.78
NS	56	8.83	1.94

Expository Lesson One. There was no significant difference between the RTLX means for the two treatment groups t(117) = -1.71, p= >.05. It can therefore be concluded with a greater than 95 percent confidence level that there was no significant difference between the two sequence groups.

Expository Lesson Two. There was no significant difference between the RTLX means for the two treatment groups t(113) = -0.61, p= >.05. It can therefore be concluded with a greater than 95 percent confidence level that there was no significant difference between the two sequence groups.

Narrative Simulation (NS) Lesson. There was no significant difference between the RTLX means for the two treatment groups t(111) = -1.83, p= >.05. It can therefore be concluded with a greater than 95 percent confidence level that there was no significant difference between the two sequence groups.

Summary

Measures of cognitive load were computed based on five of the six subscales from the NASA Task Load Index. A mean was calculated from these variables on a scale of twenty points and t-test comparisons were performed for each lesson's content assessment. An additional t-test was performed which compared each group's respective first assessment attempt; the expository sequence group took the expository lesson one first, and the NS group took the narrative simulation lesson first.

Hypothesis #1 was accepted on the basis of the statistically significant differences in the first attempt RTLX.

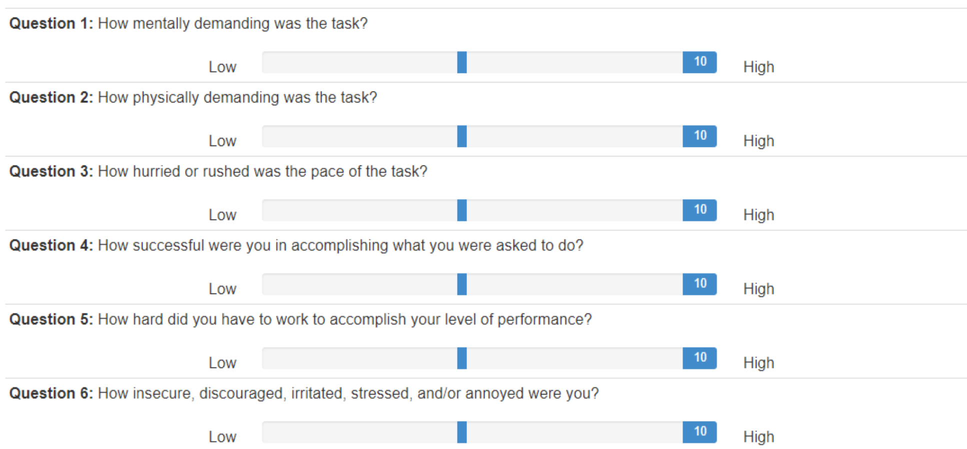
Hypothesis #2 states *There will be a significant difference in instructional efficiency in an online open distance education course when comparing the NS interactivity sequence group and expository instruction group.* This hypothesis was tested in two ways:

1) Comparing efficiency index scores from NS group's first assessment attempt with the expository group's first assessment attempt. Additionally, a t-test was performed comparing the mean efficiency scores of each group.
2) Performing a one-way ANOVA to test for interactions based on sequence group or lesson.

Efficiency Procedure

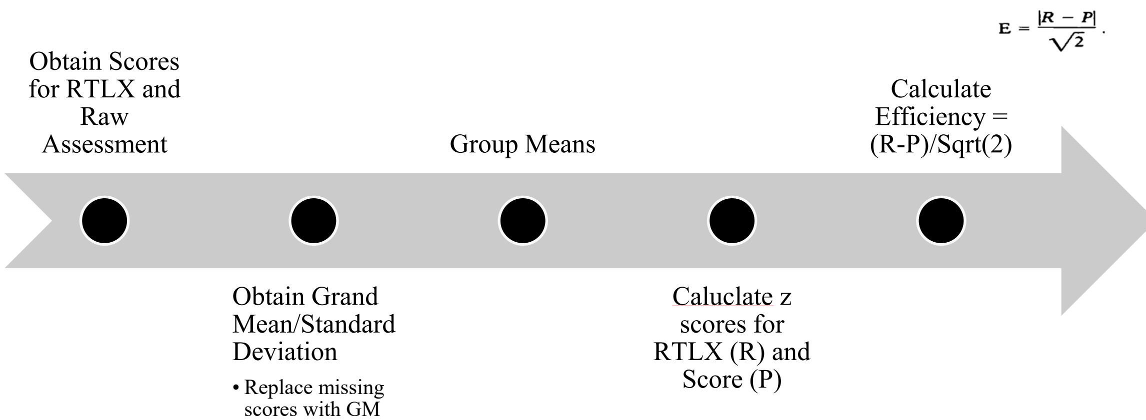
Paas and Van Merriënboer (1993) originally devised the efficiency measure of instructional conditions. Researchers have since repeated it numerous times (Van Gog & Paas, 2008). It continues to be cited often today. This study diverges from the Paas and Van Merriënboer procedure by replacing the seven or nine point Likert scale to measure the subjective cognitive load experienced by the individual with a mean score computed from five of the six TLX subscales in conjunction with a webbased range slider for each on a scale of 1-20.

Figure 4.1:NASA Task Load Index questions with concomittant sliding scale ranging from 1 (low) to 20 (high).



Z-scores were computed for both assessment percentage scores and the NASA Raw TLX (RTLX). The RTLX is a well-documented and repeated modification of the original NASA-TLX. Researchers opted to omit subscales in other studies or have used them individually to report various aspects of task load (Hart, 2006). To arrive at an efficiency index score, each participant's performance z-score (P) was subtracted from the RTLX z-score (R) and the result divided by the square root of two. Thus, the lower the reported efficiency index score, the greater the efficiency, as the normed performance value is greater than the normed reported amount of mental effort expended in learning or recalling the information in question.

Figure 4.2 Efficiency Index Procedure



A mean comparison of the resulting efficiency scores was then performed. For this study, two such comparisons were conducted:

1. An efficiency score mean comparison of each sequence group's respective first attempt
2. A one-way ANOVA to determine the potential statistical difference of the mean efficiency score among the three dyslexia lessons: expository one, expository two, and the narrative simulation (NS).

First attempt results.

Comparing the expository group's efficiency score on the first attempted assessment with that of the NS group's yielded the following result:

Table 4.3: *Efficiency of First Attempt*

Sequence Group	M	SD
Expository	-0.48	1.81
NS	0.25	1.30

The expository sequence group yielded a higher efficiency (M= -0.48) when compared with the narrative simulation group (M=0.25). A t-test comparing the means from each respective group revealed a statistically significant difference between each group $t(119) = -2.55$, $p = 0.012$. It can therefore be concluded with a greater than 95 percent confidence level that there was a significant difference between the two sequence groups' first attempts.

Total comparison of lessons

A one-way ANOVA was conducted to compare the effect of instructional treatment sequence on efficiency score between the three instructional treatments (Expository 1, Expository 2, and Narrative Simulation). The results of the ANOVA were as follows: Statistically significant differences were found between three lessons $F(2, 354) = 5.87$, $p = 0.003$. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the expository one condition (M = -0.363, SD = 1.676) was significantly different than the expository two condition (M = 0.235, SD = 1.242) However, the NS condition (M = 0.057, SD=1.172) did not statistically differ significantly from either the expository 1 or expository 2 conditions.

Summary

An efficiency index score was computed to describe the potential synergy between cognitive load and performance on content assessments among three lessons. This efficiency score was used in two ways:

1. A two-sample t-test was conducted to compare the expository group's first assessment attempt with that of the NS group.

2. A one-way ANOVA was conducted to determine if there was a statistical difference in mean efficiency scores relative to the assessments themselves.

Expository lesson one was more efficient for the expository group than was the NS group’s first lesson, the narrative simulation lesson. The one-way ANOVA demonstrated a difference between each of the three lessons. Post-hoc testing suggested there was only a statistical difference between expository lesson 1 and expository lesson 2.

Given the above results, Hypothesis #2 was accepted based on the index comparison between sequence groups’ respective first attempts.

Hypothesis #3 states *significant differences exists between NS and Expository treatment groups regarding other argued measures of efficiency initial test score and number of attempts required to pass the test*.

To test this hypothesis, two individual sample t-tests were conducted with regard to the first attempted test scores for each of the instructional treatments and chi square tests were performed comparing the number of attempts on the respective assessments until participants attained a minimum score of 82 percent. The results are as follows:

Respective first attempt performance score. There was no significant difference between the performance score means for the two treatment groups $t(118) = 0.60$ $p= >.05$. It can therefore be concluded with a greater than 95 percent confidence level that there was no significant difference between the two sequence groups’ respective first attempt.

Expository lesson one performance score. There was no significant difference between the performance score means for the two treatment groups $t(119) = -1.84$, $p= >.05$. It can therefore be concluded with a greater than 95 percent confidence level that there was no significant difference between the two sequence groups.

Expository lesson two performance score. There was no significant difference between the performance score means for the two treatment groups t(113) = -1.33, p= >.05. It can therefore be concluded with a greater than 95 percent confidence level that there was no significant difference between the two sequence groups.

Narrative Simulation performance score. There was a statistically significant difference between the performance score means for the two treatment groups t(112) = 2.39, p= 0.019. It can therefore be concluded with a greater than 95 percent confidence level that there was a significant difference between the two sequence groups.

Table 4.4 *Narrative Simulation Performance Score*

Sequence Group	N	Mean	SD	SE Mean
Expository	57	82.4	13.8	1.8
NS	55	76.4	13.0	1.8

Number of Attempts to Pass

Chi square tests of independence were performed on each of the knowledge assessments to determine if the results of one sequence group was different from another. No statistically significant differences were found in the expository 1 (χ^2 (4)=0.54), expository 2 (χ^2 (3)=2.57, p=0.46), or narrative simulation lesson (χ^2 (4)=5.34, p=0.25).

Summary

Other measures of efficiency were tested to include t-tests on participants' first attempts on the content assessment (ProveIt!) for each lesson, a comparison of ProveIt! scores for each lesson by sequence group, as well as chi-square analysis on the number of attempts required to achieve a passing score of 82 or higher. No significant differences were observed The expository group scored higher on the narrative simulation lesson compared to the NS, which was found to be a statistically significant difference. The chi-square test yielded no statistically significant difference.

Based on the above results, we may accept hypothesis #3 based on a statistically significant higher mean score on the narrative simulation assessment score reported from the expository sequence group compared to the NS group.

Summary of Data Analysis

After comparing the means of Raw TLX (RTLX) scores across the three instructional treatments, no statistically significant difference was found for perceived cognitive load between the expository and NS groups. Additionally, the RTLX from each group's respective first attempt was compared and ~~for which~~ no statistically significant difference was reported. Therefore, hypothesis #1 was rejected.

Tests of the second hypothesis were performed to determine whether a statistically significant difference existed in instructional efficiency between expository and NS sequence groups by comparing efficiency index scores along with a t-test to compare these mean scores and also by performing a one-way ANOVA to test for interactions based on sequence group by lesson.

The expository sequence group yielded a higher efficiency compared with the narrative simulation group. A t-test comparing the means from each respective group revealed a statistically significant difference between the two groups. Additionally, ANOVA among the efficiency scores for each lesson resulted in statistically significant findings. Post-hoc results suggested there was a difference between the expository 1 and 2 treatments, specifically, expository 2 was less efficient that expository 1. The narrative simulation efficiency mean score was found not to differ statistically from the two expository scores.

Therefore, Hypothesis #2 was accepted, although the observed result differed from that which was anticipated.

The third hypothesis tested on whether significant differences exists between NS and Expository treatment groups regarding other argued measures of efficiency; initial test score and number of attempts required to pass the test. There was an observed statistically significant difference between sequence groups on the narrative simulation performance score where the expository group scored higher on the Narrative Simulation lesson than the NS sequence group.

Chi Square testing of independence between sequence groups relative to the number of attempts necessary to pass the content assessments resulted in no observed statistically significant differences. Therefore Hypothesis #3 was accepted.

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

In myriad instructional contexts, but especially within online learning, instructors spend so much time developing and deploying instructional materials upon which students so greatly depend and utilize, it is helpful to understand which instructional methods may yield the greatest learning outcomes while considering the need to reduce workload. This concept applies not only to the time it takes to develop such resources, but also to the mental workload students must expend to achieve positive outcomes.

Many effective instructional methods are timeless and extensible. They transcend technology and delivery. Students make meaning in various ways as they learn, and especially so through the use and creation of narrative. Stories are familiar and adaptable. We use them to provide context and purpose to subject matter.

The theoretical framework for this study was guided by the concepts of Cognitive Load Theory (CLT) and the efficiency of instructional conditions. CLT considers an understanding of human cognitive architecture within the context of learning. Instructional design in adherence to CLT tenets seeks to greatly minimize extraneous cognitive load. Effective instructional design applies evidence-based practices which attempt to improve learning outcomes by achieving the following objectives:

1. Mitigate the impact of intrinsic cognitive load, often attributed to the inherent difficulty of the content to be learned.
2. Support an increased but tolerable germane cognitive load, a phenomenon related to the creation of knowledge schemata, which equates to learning and greater cognitive processing.

Measuring the efficiency of various instructional conditions allows us to compare various instructional elements via an index. Instructional Efficiency is a phenomenon where individual performance exceeds the perceived workload required to achieve that performance. Additionally, while the concepts and implications of interactivity can be formidable and complex, the literature suggests proper implementation of interactive features of online and electronic learning will support the tenets of CLT.

Within an online instructional context, narratives can be readily incorporated with interactive features. The very nature of story itself can be considered a form of interactive simulation. The human mind can consider a story's elements and make hypothetical decisions, judgment values, or infer a proper course of action based on the material facts presented in that story. The power of simulation inside of narrative lies with the reflection and internal mental processes enacted by the learner and how these are applied to the lessons to be learned.

If learning is defined as the acquisition of knowledge, skills, or changes in attitudes or behavior, then narrative simulation is a safety zone in which ideas, attitudes, actions, or decisions can be considered without threat of negative consequence. The process of reflecting upon what learners know and relating those elements to new information and concepts is what sets narrative simulation apart as a distinct and purposeful instructional method.

Therefore, the purpose of this study was to determine whether there was a significant difference in the efficiency among distance education participants who engaged in a self-paced narrative simulation module versus those who participated in a traditional online distance educational lesson.

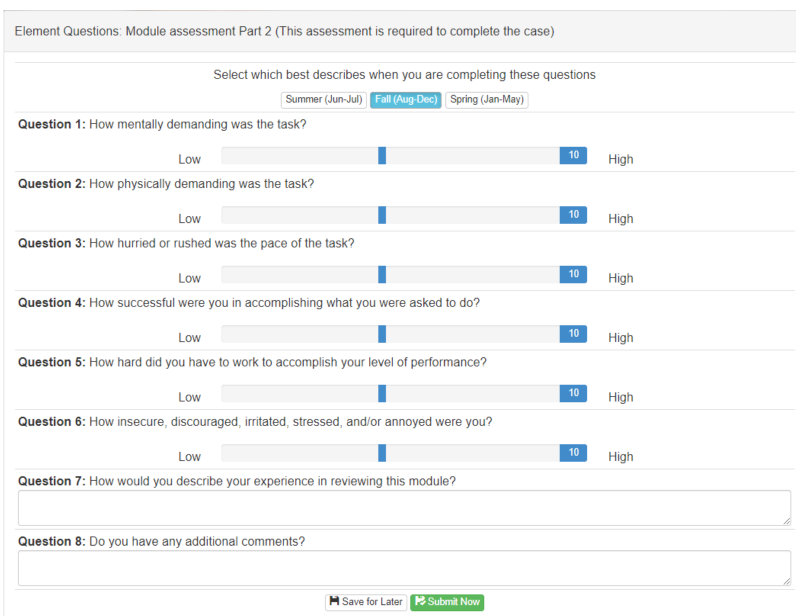
Discussion of Hypotheses

The following discussion is based on the three hypotheses for this study.

Comparison of Raw TLX (RTLX) Results

Hypothesis #1 states that *there will be significant difference in the perceived cognitive load on assessments in an online open distance education course when comparing learners using NS interactivity compared with a traditional digital expository instructional intervention*. Two sequence groups received the NASA Task Load Index (TLX), a subjective scaled assessment of the perceived mental workload of a given task or condition (Figure 5.1). Participants received the TLX after each of the three lessons.

Figure 5.1 NASA Task Load Index as it appears in the Digital Drivers License



A mean was computed from five of the six TLX subscales (omitting the physical demand subscale) to form the Raw TLX (RTLX). Mean comparisons were performed to determine whether statistically significant differences existed in any of the lessons between sequence groups. Additionally, a RTLX mean comparison was performed between each group's respective first attempted assessment; the expository group received Expository One first. The Narrative Simulation (NS) group's first lesson was the Narrative Simulation. Statistical analysis indicated that while there was no observed statistical significance in RTLX score between cognitive load scores on individual lessons, there was an observed statistical difference when comparing each group's first ProveIt! (test) attempt.

Comparison of First Attempts

The comparison result of each sequence group's first attempt suggested that Expository One is less mentally demanding than Narrative Simulation lesson as the first lesson participants received. This stands to reason, as the simulation lesson is more complex; there are more elements to consider, and the character Wilhelmina is introduced here along with the backstory of her struggle to overcome reading difficulties. Moreover, participants considered nontrivial questions related to addressing Wilhelmina's challenges and reflect upon the potential choices before responding. After participants provided a response, appropriate courses of action are revealed. Additionally, the ProveIt! in the narrative simulation lesson is longer, comprised of all eleven questions whereas Expository One contains a subset of five of the eleven questions.

RTLX Comparison of All Lessons

It is encouraging that there were no statistically significant differences in the perceived cognitive load within the lessons themselves: Expository Lesson One (*Defining Dyslexia*) is arguably a more cohesive and straightforward lesson compared to Expository Lesson Two (*Assessing Reading Difficulties*). Comprised of ten slides, a significant amount of time was devoted to the construction of Expository One. Eight of the ten slides contained carefully crafted organizing graphics referenced in the text of the lesson on the same screen (figure 5.2). By comparison, Expository Two contained graphics, but they were all decorative in nature. Additionally, the subject matter in Expository Two, covered identification and treatment of individuals with reading difficulties and was more complex in nature.

Figure 5.2 Example of complimentary graphic in Expository One

Case: Defining Dyslexia
Element: Reading Development (8 of 12)

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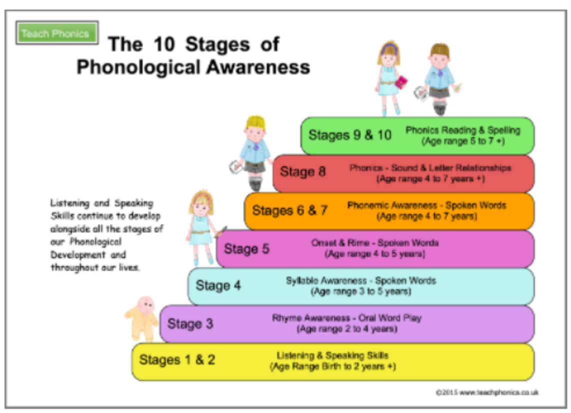
What students are most likely to struggle from when learning to read will depend in part on their grade level. At the earliest grades (K-1), where students are just beginning to master their alphabet, phonemic awareness, beginning phonics, and so on, many students will struggle simply because these skills are unfamiliar to them and will require time and effort, plus much practice, to develop. Some will struggle more than others. Some will require more time and effort than others, and some will require more time before they are ready to start learning these skills, and more time before they master them to proficiency. These students do not have dyslexia, they are just new to reading.

By first-grade, phonemic awareness will cease to predict a student's achievement on a reading test, and by first and second-grade, decoding skills and language comprehension will predict the outcome of a reading test with equal probability. At that point, students who struggle inordinately with sounding out words or letter sequences may be at risk for dyslexia. But such difficulty is often temporary, and in those cases, the student does not have dyslexia. A competent reading specialist who can provide effective interventions for a student's persistent developmental delay in reading is effective in helping that student catch up to expected decoding speed and accuracy.

By the later primary grades (grade 2-3), children are typically in the full alphabetic phase or the consolidated alphabetic phase of learning to read words. Thus, instruction in word recognition in grades 2 and 3 usually focuses the student on processing text as multi-letter chunks rather than focusing on individual letters and learning to use knowledge of rimes (common word endings such as "an" as found in "pan," "man," "ran," etc.) and affixes (prefixes and suffixes; standard meaningful word units such as "-ing," or "-ed," or "-s") and to recognize larger units in words. These skills should become easier for students with time.

By 4th grade, decoding skills (automatic recognition of auditory and visual word forms) will cease to predict the variance on end-of-year reading comprehension tests because most students will have essentially mastered these abilities. For students at this grade level and beyond, language ability, basic reasoning skills, prior knowledge, and motivation to read, among other issues, will be the major challenges to their success on a reading test. If it turns out, however, that they are still slow and inaccurate at sounding out words, even though they have had effective reading instruction, they may be at-risk for dyslexia.



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The Narrative Simulation lesson (*Address the Student, Not the Disability*) used narrative simulation (NS) as an instructional method, and was thus potentially more time consuming, and certainly required more steps to complete. As it posed meaningful questions with appropriate corrective feedback at key points in the story, the lesson potentially introduced additional extraneous and well as intrinsic cognitive load. Moreover, all eleven

ProveIt! questions in the NS lesson were presented at the end, whereas these questions were divided between Expository Lessons One and Two.

Given these differences in presentation and instructional strategy when comparing mean scores across both groups for each of the three lessons without regard to sequence, there were no significant differences observed. This suggests that while sequence may have some bearing upon instructional outcomes within this context, the lessons themselves introduced similar cognitive load. Additionally, based upon analysis of cognitive load variables, selecting either a straightforward instructional method, one that introduces more complexity, or one that requires a higher interactive exchange may be appropriate depending on instructional goals and objectives and the value placed upon using story as a vital element in the instruction relative to the needs of the instructor or students.

Computation of Efficiency Measures and Comparison of Mean Efficiency Scores

Hypothesis #2 states *There will be a significant difference in instructional efficiency in an online open distance education course when comparing the NS interactivity sequence group and the expository group.* This hypothesis was tested in three ways: As with Hypothesis #1, a mean comparison via t-test was performed on each group's very first test attempt. A total comparison of mean efficiency index scores was then conducted along with a one-way ANOVA to test for any statistically significant differences which existed in these three lessons.

A similar result was noted as with Hypothesis #1. The expository group's first attempt was more efficient than the NS group's first attempt on an arguably more involved lesson (Table 5.1). Results of this two-sample t-test was statistically significant.

Table 5.1 Efficiency of First Attempt

Sequence Group	M	SD
Expository	-0.306	1.193
NS	0.305	0.879

When considering the three efficiency index scores across three dyslexia lessons, there was much less observed variation among mean index scores (Table 5.2). Moreover, none of these was statistically significant in relationship to one another.

Table 5.2 Efficiency Index Scores

Lesson	M	SD
Expository 1	-0.015	1.106
Expository 2	0.0001	1.0408
Narrative Simulation	-0.0001	1.0422

Because efficiency is computed using z-scores of reported cognitive load and test score, it centered around zero; performance z-score is subtracted from the reported cognitive load (RTLX) z-score to arrive at an efficiency index score. Therefore, a negative score indicates more efficiency and a positive score indicates less efficiency.

Again, while no statistically significant differences were observed, in terms of interpreting the mean efficiency scores as an index, scores suggest Expository One is the most efficient lesson, followed by the Narrative Simulation, then Expository Two.

However, the observed differences are slight which therefore suggests within this context, instructors should select an instructional approach to teaching dyslexia awareness that meets their own goals and objectives, keeping their learner audience in mind.

One possible reason there were no observed significant differences among the lessons in terms of efficiency is that prior knowledge derived from the first lesson might have informed participants in subsequent lessons. As there were no reported significant differences in cognitive load among the lessons, as indicated in Hypothesis #1, a counterbalancing effect may have mitigated any potential deficit in the transmission of knowledge in subsequent lessons.

Comparison of Assessment Scores and Number of Attempts to Pass

Hypothesis #3 states *significant differences exists between NS and Expository sequence groups regarding other argued measures of efficiency which are initial test scores on each of the content assessments and number of attempts required to pass the test*. This was tested by comparing each group's respective attempted score on the first lesson they received, comparing each group's ProveIt! scores related to the three different lessons, and the number of attempts required to achieve a minimum passing score of 82.

Score comparisons. Mean score comparisons for respective first attempts, Expository Lesson One, and expository lesson two resulted in no statistically significant differences. However, in the narrative simulation lesson, a statistically significant difference was observed in that the expository group achieved a higher score than the NS sequence group (Table 5.3).

Table 5.3 Narrative Simulation Lesson Performance (ProveIt!) Score

Sequence Group	N	Mean	SD	SE Mean
Expository	57	82.4	13.8	1.8
NS	55	76.4	13.0	1.8

While hypothesis #3 was accepted, aspects of the implementation were likely to have influenced the outcome of this test result. The expository sequence group received two lessons consisting of around sixteen slides as well as all eleven content questions before they received the narrative simulation lesson. One could conclude prior exposure to the dyslexia content followed by the benefit of a realistic, relevant story resulted in a markedly higher score. It is also possible that several students who took the narrative simulation lesson first became preoccupied with the prior activities of the story and simply lost focus or were distracted.

Number of attempts to pass. Chi square tests of independence were performed to determine if there was a relationship between sequence group and the number of attempts required to achieve a passing score. There were no observed statistically significant differences between the two groups. However, a total of eleven participants in the expository group did not achieve passing scores compared with two in the NS group. Additionally, as an observation, Expository Lesson One had a larger first try pass rate than Expository Two or the Narrative Simulation lesson.

One possible explanation for the above factors could be attributed not only to the design, but also to the nature of the content. Expository One is more straightforward and the graphics supporting the lesson are both additive and complimentary. The narrative simulation is comprised of a series of in-story questions that served as multiple thought activities within the lesson. It also contained an assessment which had the entire eleven question set, whereas those eleven questions were divided among Expository One and Two.

There was no statistically significant difference in the number of attempts required to pass a given lesson. Possible explanations include the following:

1. The features of the NS lesson may have mitigated the supposed increased workload.
2. A pretraining effect from Expository One may have offset the presumed additional difficulty of Expository Two.

3. Participants might have been accustomed to the DDL interface and content structure such that little imposition on efficiency was observed.

Participant Feedback

At the end of each module concluding with the NASA Task Load Index, participants responded to following questions:

1. How would you describe your experience in reviewing this module?
2. Do you have any additional comments?

The majority of responses were positive on each of the three modules (Table 5.4).

Table 5.4 *Positive/Negative Participant Feedback Comments*

	Comment Type				
	Negative	Positive	Neutral	No Comments	Total
Group					
Expository	1	33	11	18	63
NS	1	34	2	19	56
All	2	67	13	37	119

A clear preference for one module versus another was not observed. However, there were a few useful comment trends among a limited number of participants.

Desire for video. A few participants requested the presence of instructional videos in place of text.

Information density. Participants mentioned that the modules were "dense" regarding the amount of text. However, this trend need not be considered negative. One participant wrote, "The module was information-dense and it will be very helpful when I am able to move from the written presentation into actual field observation and application."

Professional relevance. A few comments indicated a desire for these modules to demonstrate a more direct relationship to practical application in the field, while others expressed the information contained in these modules will be of use. One participant wrote, “Overall - this module gave a good example of what reading delays and student contexts may occur during teaching - making the content of this module useful to returning or beginning teachers. While I still feel the module can benefit from more depth in-context and better written module assessments; the information is useful and relevant to the classroom.”

Facts lost in the narrative. Multiple comments indicated some of the material facts upon which the ProveIt! was based on were not readily apparent in the narrative simulation lesson. One participant remarked, “I was a little frustrated when I couldn't find some of the information in the case study that was asked for in the assessment. But - overall it was a good experience.” However, other participants stated the story was beneficial and preferred it over the expository lessons.

Summary

Based on solicited feedback, most participants responded positively to the design experience and lesson content. Light trends suggested addition of video content, greater emphasis on material facts directly related to the ProveIt! (assessment) questions, and clearer linkages to praxis or field experience would be beneficial if refinements in these lessons were indicated by other circumstances. No obvious majority preference for expository versus narrative simulation lesson was observed.

Limitations and Suggestions for Future Research

This study suffered from multiple limitations. Literacy experts at a large research institution provided the content related to the three lessons in the study. This researcher then assisted with some of the essential elements of the design process and making suggestions relative to the pacing, sequencing, and grouping of individuals into their respective sequence groups. These suggestions were implemented by the Digital Drivers License (DDL) administrator. After the lessons were reviewed by subject matter experts, instructors of record required their students to complete each of the lessons with a passing score.

Ex post facto design

First, this assessment and analysis was a form of ex post facto design, a methodology generally bound by unique constraints when compared to quasi-experimental or experimental design (Salkind, 2010). The DDL administrator provided de-identified data for the purposes of the research. A unique identifier and session ID were provided as a means of tracking individual performance and response across the three lessons. Due to system and time constraints, there was no opportunity to make any changes in the lessons, or add independent variables based on newly discovered information or needs. Additionally, there was no means of following up with participants to ask them to finish the lesson or to inquire about other factors, such as why they dropped out of participation. Furthermore, the results of this study may well be generalizable to the current population of pre-service teachers, but further study and the ability to obtain more information and seek participation at other institutions would be useful in generalizing the result to other populations and situations.

Effect of repetition within a short period

This study did not make an explicit attempt to consider the effect of repeating very similar lessons within a relatively short time frame. While participants could take these lessons at their own pace, even waiting many days between lessons, it is unlikely this occurred in most instances, as the length of each was relatively short in duration, and the entire module could be completed in under an hour.

No observable differences were noted in test scores or measures of mental effort except in one instance. However, requiring participants to perform only one of the lessons in a given session, waiting a significant period of time, and then completing another lesson may have revealed appreciable differences in cognitive load or test performance.

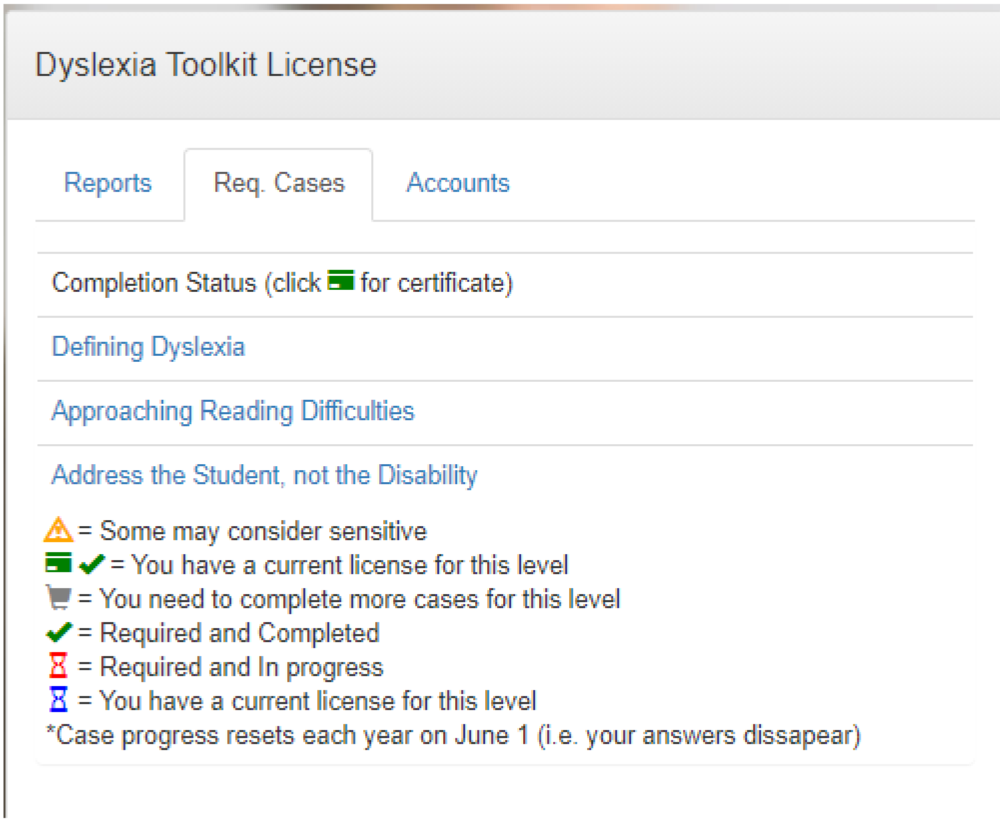
Expository One and Two are Segments

While the content between Expository Lessons One and Two is very similar to the Narrative Simulation, that content is divided between the two expository lessons where it is completely contained in the Narrative Simulation. This made direct comparison of treatments challenging, especially given advanced forms of analysis.

Participants not bound by the sequence assignment

Participants were assigned to a sequence group and given the lessons according to that sequence assigned from top to bottom. They were then instructed to complete them in that order. However, the DDL system was not configured to enforce that order (Figure 5.3). While it is assumed that most, if not all, participants followed the established order and the feedback comments appear to substantiate this, it is possible some participants followed a different order.

Figure 5.3 Dyslexia toolkit landing page. The participant in this example is assigned to the Expository Sequence Group.



Implications for future research

This study focused on evaluating two instructional methods applied to interactive online learning from the perspective of efficiency. There were observed differences relative to the sequence on the first attempted lesson for each respective group; The expository group scored higher on their first attempted test than the NS group and they reported less cognitive load on that first test. However, there were no other significant differences observed and the structure of Expository One compared to Narrative Simulation may explain those observed differences. The result suggests that within this instructional environment, performance and efficiency may not be lockstep. The weight of the perceived cognitive load may not duly impact performance, at least as the perceived mental effort was reported and measured for this first test attempt. Further study is needed to determine whether a longer test on Expository One may have influenced the perceived cognitive load or if the design of the Narrative Simulation mitigated the presumed imposition of extra workload compared to the other lessons.

Second, NSD was observed among the three different lessons. Repetition of this study in using narrative simulation within different settings would help to better generalize the results across different contexts, instructional situations, and considering different learner characteristics.

Furthermore, isolating the two instructional conditions into a true experimental design and to also incorporate the imposition of time between consumption of the instructional content and an assessment might reveal the strengths of narrative simulation over a more traditional expository treatment.

Summary

This study found no significant differences in the efficiency, test score, perceived cognitive load, or number of attempts to achieve a passing score when comparing Expository One and Expository Two. However, statistical difference was observed in the Narrative Simulation lesson when comparing the Expository and Narrative Simulation groups; The Expository group scored higher than the NS group. Additionally, significant differences from each group's respective first attempt were observed regarding cognitive load and efficiency on these first attempts. These were possibly related to the design of Expository Lesson One which was more straightforward than the Narrative Simulation and because Expository Lesson One contained fewer test questions. Moreover, offering a more straightforward presentation along with a break in content may have provided a pre-training effect that was beneficial to the Expository group, and may explain an increase in performance

Given the differences in the first attempt on each sequence group and the reported increase in NS score by the Expository group, future studies that (a) explore the impact of sequencing, (b) separate narrative simulation lessons into smaller units (chunks), and (c) conduct narrative simulation studies as true or quasi-experiments, should consider the results suggested in this study.

APPENDIX A

EXPOSITORY LESSON ONE

Case: Defining Dyslexia
Element: Case Description (1 of 12)

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How do I navigate through a case?

DEFINING DYSLEXIA

In this module, we will provide the current legal definition of dyslexia in Kentucky and break it down to its four components:

1. What causes dyslexia
2. Primary symptoms of dyslexia resulting from this cause
3. Secondary symptoms of dyslexia resulting from primary symptoms
4. Counterfactuals to rule out false positives (cases that may at first look like dyslexia but are actually something else and require a different from of instructional assistance)

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Case: Defining Dyslexia
Element: The legal definition of Dyslexia (2 of 12)

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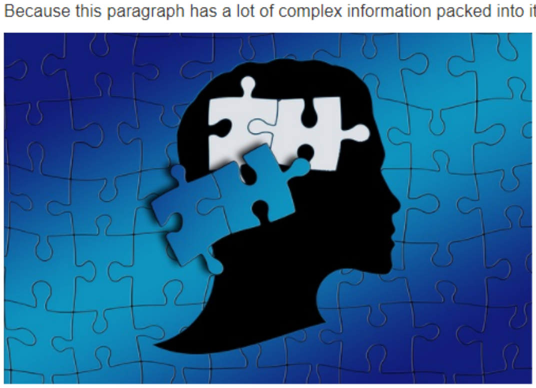
The legal definition of dyslexia in Kentucky—KRS 158.307 ss (1)(a)—is as follows:

Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.

Because this paragraph has a lot of complex information packed into it, we will unravel the definition into its four strands:



1. The **Cause** or source of dyslexic symptoms
2. **Primary Symptoms** due to the cause
3. **Secondary Symptoms** due to the primary symptoms
4. **Counterfactuals** that flag for cases of reading difficulty due to other causes than phonological processing difficulty and are not therefore dyslexia.

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Case: Defining Dyslexia
Element: Cause of Dyslexia (3 of 12)

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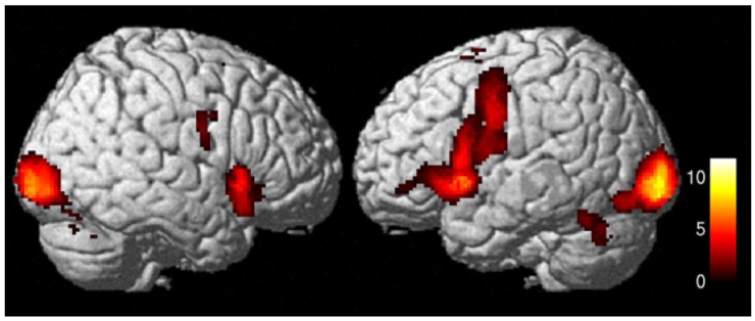
Dyslexia "*is neurobiological in origin*," and "*result[s] from a deficit in the phonological component of language*"

Dyslexia is an inherent condition due to a supposed malformation in the student's brain, possibly genetic in origin (Shaywitz, 2002). The resulting "neural glitch" makes it difficult for the student to identify language sounds quickly from letters. Sounding out a word or a pseudo-word (a letter string that can be pronounced with the basic rules of English spelling, such as "ailton") is slow and effortful for such a reader. The student's reading problem is not due to environmental conditions in the home nor from inadequate reading instruction in the school. Because of its inherent nature, dyslexia is a latent condition; that is, it cannot be observed directly, but only by way of its impact on a students' reading development. Thus, accurately identifying dyslexia before a student has had a chance to respond to effective reading instruction (e.g., first month of Kindergarten) is not feasible.

The image and quote below are from a 2006 study by Hoet et. al. using MRI scans of both dyslexic and non-dyslexic children engaged in reading tasks.



"We conducted a functional magnetic resonance imaging study, with a rhyme judgment task, in which we compared dyslexic children with two control groups:

1. Age-matched children
2. Reading-matched children (younger normal readers equated for reading ability or scanner-performance to the dyslexic children).

Dyslexic children exhibited reduced activation relative to both age-matched and reading-matched children in the left parietotemporal cortex and five other regions, including the right parietotemporal cortex.

The dyslexic children also exhibited reduced activation bilaterally in the parietotemporal cortex when compared with children equated for task performance during scanning.

Nine of the ten dyslexic children exhibited reduced left parietotemporal activation compared with their individually selected age-matched or reading-matched control children.

Additionally, normal reading fifth graders showed more activation in the same bilateral parietotemporal regions than normal-reading third graders.

These findings indicate that the activation differences seen in the dyslexic children cannot be accounted for by either current reading level or scanner task performance, but instead represent a distinct developmental atypicality in the neural systems that support learning to read."

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Case: Defining Dyslexia

Element: Primary Symptom: Phonics (4 of 12)

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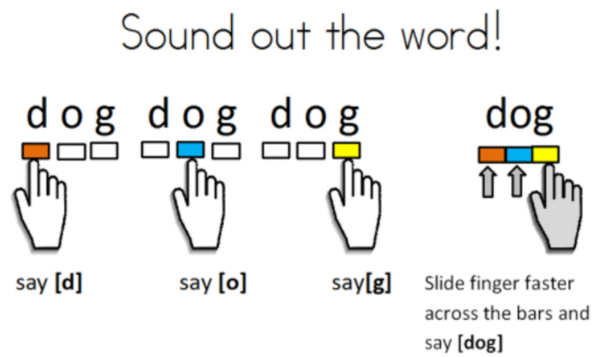
Dyslexia "*is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities.*"

Good decoding ability requires efficient and accurate matching of language sounds to alphabet symbols; these are the phonological abilities in which dyslexics suffer a developmental impediment (see Cause).

Because dyslexic students cannot match letters and sounds quickly and accurately, they are often also poor spellers as well as slow and inaccurate at sounding out words. They have difficulty with phonics (early reading instruction that teaches children to sound out letters and blend the sounds and employ pronunciation rules quickly and accurately to arrive at identifiable *auditory word forms*, that is, accurately pronounced words). However, there are other reasons why a student might be poor at sounding out or spelling, such as inadequate education, developmental delay, visual impairment, or general cognitive difficulty, among others. Students with primary symptoms should be tested to rule out these other possible causes before being labeled at-risk for dyslexia.



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Case: Defining Dyslexia

Element: Primary Symptom: Sight word recognition (5 of 12)

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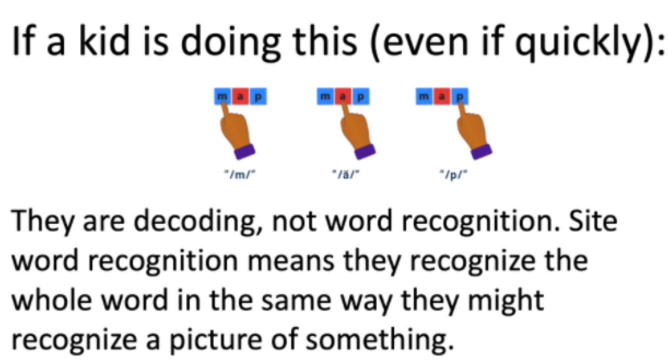
Most words in typical texts read by literate adults are sight words, which is why reading seems so effortless for them. However, automatic sight word recognition is ***not*** the sounding out of letters so quickly a reader does not know she is doing it. Rather, sight word recognition is the result of a deep, over-learned familiarity with the spelling patterns of the printed language allowing the reader to recognize *visual word forms* (common letter sequences). This comes from extensive practice sounding out words. Because dyslexics have difficulty with sounding out letters in texts, it takes them longer to overlearn the orthographic regularities (spelling patterns) of English, and as a result they have difficulty developing easy and rapid sight word recognition.



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Case: Defining Dyslexia

Element: Secondary Symptoms: Comprehension (6 of 12)

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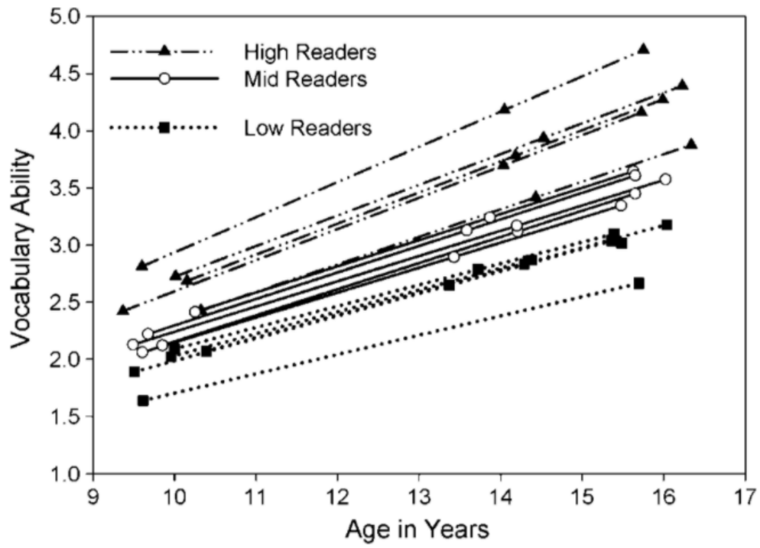
"Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge."

For most readers, it is hard to comprehend a text if they cannot sound out the words to recognizable word forms. Because language conveys meaning through words and their grammatical relationship, a reader who cannot decode a text to recognize the words it contains, cannot easily comprehend the language encoded in the text. This is true even if they have good oral language comprehension. A reader cannot understand word forms they cannot "see" (recognize) or "hear."

Because so much vocabulary and background knowledge are learned during the school years and beyond through reading, the inability to read for understanding constrains the development of crucial content knowledge. Therefore, students who are dyslexic can often fall behind in content knowledge and vocabulary development if their difficulty is not addressed.

However, there are other possible reasons for poor comprehension (or for poor content and vocabulary learning). Most of these are far more likely than dyslexia. Poor comprehension by itself does not constitute evidence for dyslexia.

Happily, thanks to technological advances in non-print media and assistive technology, there are other ways for slower and less proficient decoders to learn content and expand their vocabulary while learning to read better.



Linear growth functions for random samples of readers for readers in high (80th percentile and above), medium (40th-60th percentile range), and low (20th percentile or below) skill groups for word reading in fourth grade. (Duff, Dawna & Tomblin, J. & Catts, Hugh. (2015). The Influence of Reading on Vocabulary Growth: A Case for a Matthew Effect. Journal of speech, language, and hearing research : JSLHR. 58. 10.1044/2015_JSLHR-L-13-0310)

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Automatic sight word recognition is not as difficult to develop as it might seem for most students. After all, there are only 26 letters in the alphabet, and only 44 phonemes (language sounds) in English to match them to. Some letter-sounds are more common than others (vowels tend to be more common than most consonants and when not accented they are often pronounced similarly as a schwa; over 12% of the letters on a page written in English will be the letter "e," although it can be pronounced in several different ways, and so on). Some letters follow others more commonly than do others (for instance, "t" is more likely to be followed by "h" than by "a,"), and some sequences are more common than others (for instance, "ing" is more common than "som") and so there are only about 150-200 common spelling "rules" or patterns in written English. Readers quickly become accustomed to spotting these common relationships and anticipating them when they read.

Deep over-learning of these orthographic patterns is best accomplished for most students through painstaking (but hopefully not painful) practice at sounding out each and every letter and word in their practice texts until they begin to pick up the patterns, something which should also be accelerated by explicit instruction in common patterns and words. In this way, students learn the spelling patterns of common letter groups, syllables, morphemes, short words, and word families. This learned ability will eventually help them bypass the effortful phonological processing required in early reading instruction with phonics. Most students master the shift from letter sounding to sight word reading within about 18 months, some earlier or more quickly, some less so.

Sequence	Frequency (per 10,000 chars)
th	330
he	302
an	181
in	179
er	169
nd	146
re	133
ed	126
es	115
ou	115
to	115
ha	114
en	111
ea	110
st	109
nt	106
on	106
at	104
hi	97
as	95
it	93
ng	92
is	86
or	84
et	83
of	80
ti	76

Sequence	Frequency (per 10,000 chars)
ar	75
te	75
se	74
me	68
sa	67
ne	66
wa	66
ve	65
le	64
no	60
ta	59
al	57
de	57
ot	57
so	57
dt	56
ll	56
tt	56
el	55
ro	55
ad	52
di	50
ew	50
ra	50
ri	50
sh	50

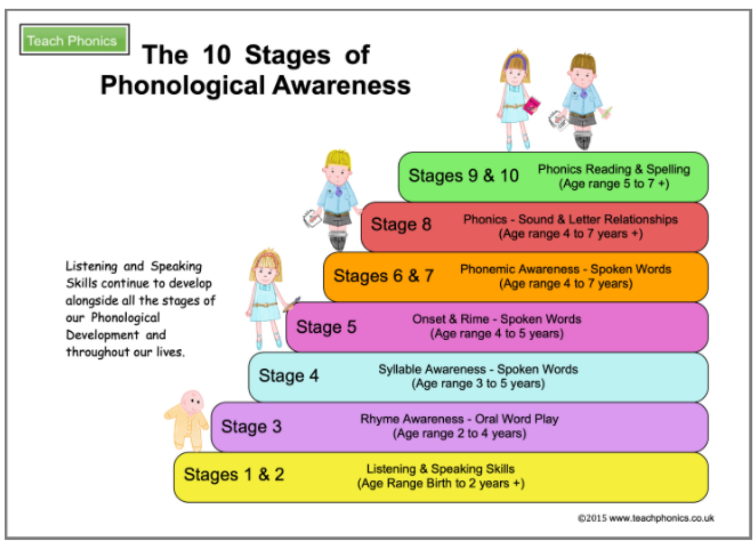
Prev | Next

What students are most likely to struggle from when learning to read will depend in part on their grade level. At the earliest grades (K-1), where students are just beginning to master their alphabet, phonemic awareness, beginning phonics, and so on, many students will struggle simply because these skills are unfamiliar to them and will require time and effort, plus much practice, to develop. Some will struggle more than others. Some will require more time and effort than others, and some will require more time before they are ready to start learning these skills, and more time before they master them to proficiency. These students do not have dyslexia, they are just new to reading.

By first-grade, phonemic awareness will cease to predict a student's achievement on a reading test, and by first and second-grade, decoding skills and language comprehension will predict the outcome of a reading test with equal probability. At that point, students who struggle inordinately with sounding out words or letter sequences may be at risk for dyslexia. But such difficulty is often temporary, and in those cases, the student does not have dyslexia. A competent reading specialist who can provide effective interventions for a student's persistent developmental delay in reading is effective in helping that student catch up to expected decoding speed and accuracy.

By the later primary grades (grade 2-3), children are typically in the full alphabetic phase or the consolidated alphabetic phase of learning to read words. Thus, instruction in word recognition in grades 2 and 3 usually focuses the student on processing text as multi-letter chunks rather than focusing on individual letters and learning to use knowledge of rimes (common word endings such as "an" as found in "pan," "man," "ran," etc.) and affixes (prefixes and suffixes; standard meaningful word units such as "-ing," or "-ed," or "-s") and to recognize larger units in words. These skills should become easier for students with time.

By 4^{th}grade, decoding skills (automatic recognition of auditory and visual word forms) will cease to predict the variance on end-of-year reading comprehension tests because most students will have essentially mastered these abilities. For students at this grade level and beyond, language ability, basic reasoning skills, prior knowledge, and motivation to read, among other issues, will be the major challenges to their success on a reading test. If it turns out, however, that they are still slow and inaccurate at sounding out words, even though they have had effective reading instruction, they may be at-risk for dyslexia.



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Case: Defining Dyslexia

Element: Reading difficulties does not equal dyslexia (9 of 12)

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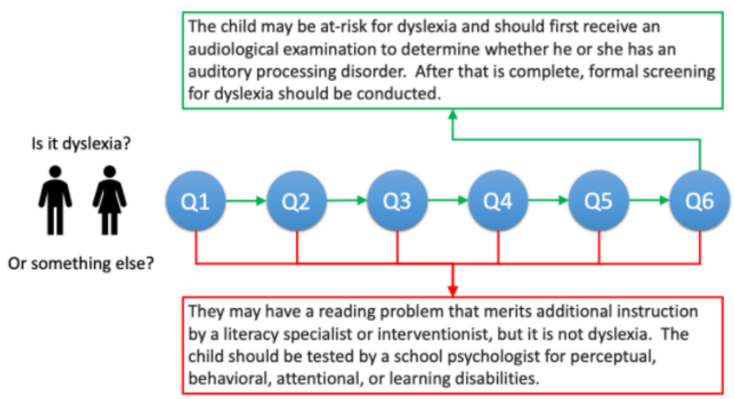
We can use the formal definition of dyslexia to determine whether a student is at-risk of dyslexia or whether they suffer from other reading difficulties. For instance, we know, by definition, that students who are dyslexic have a phonological processing difficulty that appears when they try to sound out words. As a result, students who sound out words slowly and make lots of mistakes, even though they have had effective reading instruction and lots of opportunity and support to practice those skills, are likely candidates for being at-risk of dyslexia.

However, kindergarten and first-grade students who are new to reading instruction will typically read slowly and make mistakes, too. Some students will naturally need more time to develop their decoding skills, and some will need more time before they are ready to begin developing those skills. Needless to say, children who have not had access to effective reading instruction may be expected to struggle with reading. These are all cases of reading difficulty, but none of them qualify as cases of a student with a neurobiological disability that specifically impairs their phonological processing, and thus they are not likely candidates for a label of dyslexia. With instructional support and practice, most students improve. Those students are not likely to be dyslexic and it is not helpful or efficient to label them as such.

You should see if your reading specialist has a decision tree or set of hueristics that you can decide what has to be done. For example, if the answer to ANY of these questions is NO, then the child should be tested by a school psychologist for perceptual, behavioral, attentional, or learning disabilities. A "no" on items 1 or 2 means there is no apparent reading problem. A "no" on any of the other items suggests the child has difficulties for reasons other than dyslexia. The difficulties may either be language comprehension related (items 3, 4, & 6) or cognitively related (items 4 & 5, maybe on 6), or something else. In these cases, they need a specialist to determine the nature of the problem. It does not mean they do not deserve reading assistance, it just means they are not dyslexic.

1. Is the child in the second year of their schooling or beyond (1st grade and up if they started at K, or 2ndgrade and up if they started at 1st)?
2. Does the child score poorly on a standardized reading test or screener (bottom 20%, 20th percentile, Below Basic, Novice, or similar designation)?
3. Does the child demonstrate slow and effortful sounding out of words when reading aloud relative to same grade peers in the same class?
4. Does the child have average or better language skills, vocabulary, expression, responsiveness to verbal cues?
5. Does the child demonstrate typical ability attending to common classroom protocols, writing letters and numbers, or keeping track of details or being organized?
6. Does the child demonstrate symptoms of unexpected phonological processing difficulty on a diagnostic assessment such as the QRI-6 or DRA3?



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Case: Defining Dyslexia
Element: Things to consider (10 of 12)

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Because students who struggle to learn to read do so for a variety of reasons, accurate determination of the causes of a student's reading difficulties is crucial for their effective intervention. Most children who struggle to learn to read will not meet the definition of dyslexia. Therefore, one of the best ways to approach accurate identification of those at-risk for dyslexia, is to **avoid mis-identification**. As the medical profession would remind us (and commit to in their Hippocratic Oath): **Above all else, Do No Harm!** Educators should remember that they have neither the training nor the credentials to diagnose a student as actually being dyslexic. Therefore, we refer to students who show signs of being "at-risk for dyslexia."

See the questions below.

If the answer to ANY of these questions is NO, then the problem is likely inadequate school or district policies (or their implementation) for students with reading difficulties.

If the answer to ALL of these questions is YES, and the child's difficulty with reading is persistent, then the child may be at risk for dyslexia. The severity, likelihood, and prognosis for instructional intervention ought to be determined by a certified reading specialist.

1. Has the child been tested by a school psychologist for, and found not to have, any cognitive, perceptual, behavioral, or attentional impairments?
2. Has the child had instruction from demonstrably effective teachers of reading (teachers fully certified to teach, and have at least two years of full-time classroom teaching experience at this grade?
3. Is the school using an evidence-based approach to teaching reading and especially decoding skills (e.g., phonemic awareness, phonics, fluency)?
4. Has the student been evaluated by a certified reading specialist and provided typical reading assistance or consultation as needed, yet the reading difficulty persists?

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APPENDIX B

EXPOSITORY ONE CONTENT ASSESSMENT (PROVEIT!)

Case: Defining Dyslexia

Element: Module Assessment Part 1 - Required (11 of 12)

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Below there are some questions to check that you got the most important points of the material presented in this module (passing score is 80%). After finishing this, there is a quick set of questions that deal with the desing of this module. Both this and the feedback module are required to complete the module, although there are no correct answers for the feedback qustions.

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Element Questions: Module Assessment Part 1 (This assessment is required to complete the case)

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True / False	**Question 1:** Most educators have the ability to diagnose the cause of a student's reading difficulty.
True / False	**Question 2:** Delayed neurological development might contribute to reading deficiencies instead of dyslexia.
True / False	**Question 3:** Individuals with dyslexia have difficulty developing easy and rapid sight word recognition.
True / False	**Question 4:** Students with dyslexia do not often fall behind in content knowledge.
True / False	**Question 5:** Inability to to accurately recognize words is mainly attributable to dyslexia.
True / False	**Question 6:** By grades 1-2, children who struggle inordinately with sounding out words or letter sequences may be at risk for dyslexia?

Question 7: Describe what you learned about dyslexia and reading delays that you did not know prior to completing this module.(This is an unscored question.)

Question 8: Do you have any additional comments?

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APPENDIX C

EXPOSITORY LESSON TWO

Case: Approaching Reading Difficulties
Element: Case Description (1 of 8)

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How do I navigate through a case?

APPROACHING READING DIFFICULTIES

Because students who struggle to learn to read do so for a variety of reasons, accurate determination of the causes of a student's reading difficulties is crucial for their effective intervention. Most children who struggle to learn to read will not meet the definition of dyslexia. Therefore, one of the best ways to approach accurate identification of those at-risk for dyslexia, is to **avoid mis-identification**. As the medical profession would remind us (and commit to in their Hippocratic Oath): **Above all else, Do No Harm!** Educators should remember that they have neither the training nor the credentials to diagnose a student as actually being dyslexic. Therefore, we refer to students who show signs of being "at-risk for dyslexia."

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Case: Approaching Reading Difficulties
Element: Universal Screeners and Dyslexia (2 of 8)

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UNIVERSAL SCREENERS

The call for universal screening of all students has led to the unfortunate but cost-effective use of general tests of reading ability, such as the MAP reading test, or the end of year K-PREP state reading test, as a benchmark or screening test for reading ability, with low performing students presumed to be at-risk of dyslexia. The problem is that those tests only tell us which students are weak at reading relative to average student ability at that grade level. They do not tell us why. Only a small percentage of students scoring poorly for their grade level on a standardized reading comprehension test will be at-risk for dyslexia.

Using such tests in a pinch for diagnosing dyslexia risk is an unfortunate choice because reading comprehension tests have not been designed for, and therefore do not serve, diagnostic purposes. Such reading tests cannot tell us why a student with a lower than average reading score is doing poorly. For that we need a diagnostic measure such as an informal reading inventory (e.g., Leslie and Caldwell's Qualitative Reading Inventory [QRI-6], or Beaver and Carter's Developmental Reading Assessment [DRA3]). A diagnostic inventory will provide a student's reading profile of strengths and weaknesses to help determine the best approach to address the students' reading difficulties. A qualified (well trained and credentialed) reading specialist will know how to administer such an inventory, and it should be an integral part of any Response to Intervention approach in assisting students with reading difficulties.

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Case: Approaching Reading Difficulties
Element: What are Screeners? (3 of 8)

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UNIVERSAL SCREENERS

A screener is a quick assessment given to students to determine if they are at-risk for particular reading problems. A universal screener is an assessment given to all students to determine their placement in a program or curriculum. Screeners tend to be quick to administer (because they have relatively few test items). But for that reason, they are not very accurate or reliable as a diagnostic assessment. Therefore, screeners should never be used as a definite assessment for remediation placement.

Some screeners are individually administered, some are group administered, some are given by instructors or specialists, some by computer, and some are self-assessments. Repeated use of screeners as progress monitors or unit summation is not advised. (Anyone who has ever tried to lose weight knows that daily use of a bathroom scale is more frustrating than helpful; and as any farmer can tell you, time spent weighing a chicken is not time spent feeding it).

There are many new screening assessments for dyslexia on the market today, and it is possible that your school or district may require that you use one. As of this writing, none of these screeners have been independently tested for reliability or validity, which means we do not know if they are dependable or accurate as indicators of dyslexia risk. For that reason, a screener should never be the final judgment on the nature of a student's reading difficulty. It may, however, be used as a preliminary assessment before assigning the student to a reading specialist for administration of a proper diagnostic assessment (see next subsection).

Although there are no *dyslexia screeners*that have been independently tested for reliability and validity, there are many *reading screeners* and diagnostic instruments that have been tested extensively. A list of tested reading screeners is available at the American Institute of Research from the Center on Response to Intervention. (Be sure to select the grade level and subject at the drop downs on top to narrow your search.)

When reviewing this index of assessments, bear in mind the "Area" to which it applies (found described in the second column of the chart). For instance, *DIBELS Next* is the first screener on the list to show strong reliability and validity, but it only applies to accuracy in reading fluency. If this is what an educator wishes to measure, it may be a good choice, but it may not have much relevance for predicting how a student will do on a standardized reading comprehension test.

Promising screeners commonly used include such screeners as PALS, FAST, and Predictive Assessment of Reading.

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Case: Approaching Reading Difficulties

Element: What are Diagnostic Instruments? (4 of 8)

⬅ Prev | Next ➡

DIAGNOSTIC INSTRUMENTS

A diagnostic assessment is designed to inform an educator about a student's reading profile (overall range of reading abilities), and to alert the instructor to aspects of a reader's development to which they should be attentive. Diagnostic assessments for students demonstrating reading difficulty are useful for identifying a reader's relative strengths and weaknesses. A diagnostic test can assist in determining a student's word reading accuracy, vocabulary level, or oral comprehension ability, for instance. However, students in need of support may struggle with several interrelated issues.

It is not effective to use a diagnostic assessment to identify precise instructional targets. In other words, if you find that a student has difficulty with multisyllable words, that does not mean you should limit instruction to drilling the student on multisyllable words; there may be more fundamental reasons for the difficulty (e.g., phonological skill, working memory, language development), but comprehensive reading instruction with an eye to the issue should be sufficient to support the reading of multisyllabic words.

Students at-risk for dyslexia could be expected to show lower than grade-level speed and accuracy with word sounding. But, again, this may be a matter of developmental variation. Using a diagnostic test for formative purposes (to inform instruction, and then to take into account the result of that instruction over time to re-interpret assessment data) is a high-level educational skill requiring extensive professional training as a reading specialist.

Recommended Reading: (*The State of Learning Disabilities*; NCLD, 2014), or, for advanced students, Lipson & Wixson (2013) *Assessment of Reading and Writing Difficulties: An Interactive Approach*(5th ed.).

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Case: Approaching Reading Difficulties

Element: Evidence based interventions (5 of 8)

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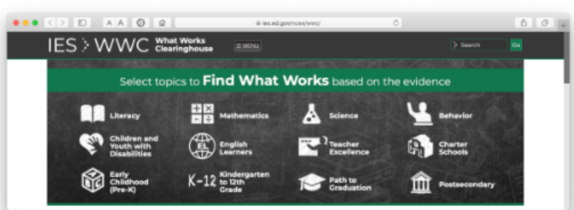

KRS 164.304 requires that post-secondary teacher education programs include instruction in "Evidence-based interventions and accommodations for dyslexia and other disorders defined in KRS158.305 and related literacy and learning challenges." "Evidence-based" is defined in KRS 158.307 as having the same definition as in U.S.C. sec. 7801(21).

This is the same definition employed by the Institute of Educational Sciences at the US Department of Education on their What Works Clearinghouse Site, where they review studies of instructional programs and assessments. Therefore, it will be quick work to review the intervention and accommodations for dyslexia that are "evidence-based," because according to this criteria there are none.

⬅ Prev | Next ➡

Case: Approaching Reading Difficulties

Element: There is no [Dyslexia Intervention] Spoon (6 of 8)

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Of the 106 dyslexia remediation studies reviewed by the Institute of Educational Sciences (IES) through 9 different meta-analyses (8 on particular branded programs, 1 on non-branded approaches), the majority of studies did not rise to the level of "evidence-based" research (as provided in 20 U.S.C. sec. 7801(21) and required by KRS 158.307). Of those few studies that did meet the definition of "evidence-based," with or without IES's expressed reservations, none demonstrated any evidence of a significant positive effect on students' reading ability.

In other words, by the definition of "evidence-based" written into Kentucky regulatory statute, **there are no evidence-based interventions and accommodations specifically for dyslexia**. For that reason, the following advisement is based on more general understandings of effective instruction for students exhibiting temporary or longer-standing reading difficulties. However, it is not meant to take the place of coursework on the teaching of reading to elementary school children.

Reading instruction for students in need of intervention should **always be focused on the student,** not on the disability or disorder presumed to be the cause. Although a student at-risk for dyslexia may require extensive support for decoding skills instruction, that does not mean that decoding instruction alone is sufficient to make the student a good reader.

Students who struggle to learn to read do so for a variety of reasons, and those reasons exhibit a range of intensity and duration. Most are temporary. Students at-risk for dyslexia demonstrate ongoing difficulty. Students whose dyslexia risk disappears or is outgrown were probably never truly dyslexic in the first place.

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APPENDIX D

EXPOSITORY TWO CONTENT ASSESSMENT (PROVEIT!)

Case: Approaching Reading Difficulties

Element: Module Assessment Part 1 - Required (7 of 8)

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Below there are some questions to check that you got the most important points of the material presented in this module (passing score is 80%). After finishing this, there is a quick set of questions that deal with the desing of this module. Both this and the feedback module are required to complete the module, although there are no correct answers for the feedback qustions.

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Element Questions: Module Assessment Part 1 (This assessment is required to complete the case)

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True / False — **Question 1:** Most educators have the ability to diagnose the cause of a student's reading difficulty.

True / False — **Question 2:** Standardized reading tests such as the K-PREP help determine who might have dyslexia.

True / False — **Question 3:** Teachers should use screeners to determine student placement in a particular reading group or for certain dyslexia interventions.

True / False — **Question 4:** Determining whether a student has dyslexia is a complex process and teachers who are untrained/unqualified frequently misdiagnose students.

True / False — **Question 5:** Encouraging students to read for fun so that they are eager to learn does not help those with dyslexia.

True / False — **Question 6:** Teachers should assume students who perform poorly on reading assessments have dyslexia until proven otherwise.

Question 7: Describe what you learned about dyslexia and reading delays that you did not know prior to completing this module. (This is an unscored question.)

Question 8: Do you have any additional comments?

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APPENDIX E

NARRATIVE SIMULATION LESSON

Case: Address the Student, not the Disability

Element: Case Description (1 of 9)

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How do I navigate through a case?

ADDRESS THE STUDENT NOT THE DISABILITY

Students not only differ in reading abilities compared with a benchmark, average score, or other students; they also differ when compared to themselves over time. The result is their developmental trajectory as a reader. Ideally, the student comes to a sense of being an eager and capable reader because they are (or at least well on their way). Unfortunately, some approaches to and polices for addressing reading difficulties result in readers who hate to read, are demotivated, fail to practice their skills, and never develop good reading ability. Some children also grow to success in spite of their educational environments. In this module, we will consider Wilhelmina's story.

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Case: Address the Student, not the Disability

Element: Meet Wilhelmina (2 of 9)

← Prev | Next →

Wilhelmina (a pseudonym) was a second-grader. She initially attended a Title I public school in another state for kindergarten and first grade. Her kindergarten teacher was a first-year novice who did not receive preparation in early reading instruction, as that state just shifted early reading instruction from first grade to kindergarten.

Wilhelmina's first-grade teacher was a three-year veteran. However, she was not certified to teach, as she had never entered a teacher preparation program.

Over 60% of the students at Wilhelmina's old school were English language learners, but the teacher was not trained in English as a Second Language (ESL) and did not speak any language other than English. Neither did Wilhelmina.

← Prev | Next →

Element Questions: Formative: Meet Wilhelmina

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True
False

Question 1: Having a non-certified teacher contributed to Wilhelmina's dyslexia.

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Element Questions: Formative: Meet Wilhelmina

Hey College of Education! You have completed this assessment with **1 correct out of 1 scored items (100%).**

If you want to retake this (it's really meant to practice and learn, but we love persistence), you can reset this assessment by clicking here.

correct **Question 1:**
Having a non-certified teacher contributed to Wilhelmina's dyslexia.

Your Response:
F

Ans/Feedback:
The correct answer is false. First, we aren't yet certain Wilhelmina has dyslexia. Second, dyslexia is a neurological condition. It is possible Wilhelmina did not benefit from outstanding instruction, but there may be other factors at play besides her teacher's certification status.

Case: Address the Student, not the Disability
Element: A New School for Wilhemina (3 of 9)

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Wilhelmina is now a newly-arrived second-grader in one of Kentucky's best performing elementary schools, located in an affluent area (Wilhelmina's parents rented in the district). Most of the students at the school read well above average with over 60% proficient or above in second grade reading. The school employs veteran teachers and generally provides ample specialist support. The curriculum tracks ahead of most other schools.

← Prev | Next →

Case: Address the Student, not the Disability
Element: Initial Impressions of Wilhemina (4 of 9)

← Prev | Next →

Please consider and answer the questions below before moving on to the next slide.

After the first MAP test for the year, the school called an IEP with Wilhelmina's parents. Wilhelmina was in the first percentile in reading, meaning 99% of the students who took the test did better on it than she did. During the IEP meeting, teachers, without any screening or diagnostic testing, suggested that Wilhelmina might have dyslexia. She was assigned a reading specialist for Tier Two support, as per Kentucky's System of Intervention (KSI—Kentucky's RtI framework).

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Element Questions: Formative: Initial Impressions of Wilhemina

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True / False	**Question 1:** The experienced teacher in this exceptional school is easily able to diagnose Wilhelmina's dyslexia.
True / False	**Question 2:** Quick screening tools can easily confirm the cause of Wilhelmina's reading trouble.
True / False	**Question 3:** The IEP made the right decision in following the law and assigning Wilhelmina to a reading specialist for further evaluation and remediation.

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Element Questions: Formative: Initial Impressions of Wilhemina

Hey College of Education! You have completed this assessment with **3 correct out of 3 scored items (100%).**

If you want to retake this (it's really meant to practice and learn, but we love persistence), you can reset this assessment by clicking here.

correct **Question 1:**
The experienced teacher in this exceptional school is easily able to diagnose Wilhelmina's dyslexia.

Your Response:
F

Ans/Feedback:
The correct answer is false. This question makes two incorrect assumptions. 1) Wilhelmina's teacher may not have the proper training to diagnose the cause of Wilhelmina's trouble. 2) We do not know that Wilhelmina has dyslexia.

correct **Question 2:**
Quick screening tools can easily confirm the cause of Wilhelmina's reading trouble.

Your Response:
F

Ans/Feedback:
False is the corrct answer. Screeners are not sufficient to make a dyslexia diagnosis.

correct **Question 3:**
The IEP made the right decision in following the law and assigning Wilhelmina to a reading specialist for further evaluation and remediation.

Your Response:
T

Ans/Feedback:
True is correct. Reading specialists are trained to provide proper support to those with reading deficiences, which may attributed to many factors and conditions.

Case: Address the Student, not the Disability

Element: A Crucial Point for Wilhelmina (5 of 9)

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Please consider and answer the questions below before moving on to the next slide.

Wilhelmina took the midyear MAP test in January and scored in the third percentile. Because of scheduling difficulties, IEP personnel did not hold the follow-up meeting until late March. Although there had been no testing for dyslexia per se, school personnel told Wilhelmina's parents she was very definitely dyslexic and that she ought to be moved back a grade-level.

The parents protested that they had seen positive changes in just the past two months. Moreover, the classroom teacher agreed that she also observed improvement in Wilhelmina's reading. As it was already late March, the parents and school agreed that she could finish out the year, and possibly then retake the grade the following year, depending on her final MAP test score. She was not moved into Tier Three intervention, as the shared special educator was already over-committed, a common occurrence.

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Element Questions: Formative: A Crucial Point for Wilhelmina

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True / False	**Question 1:** The IEP team should have looked at Wilhelmina's standardized test scores to determine whether or not she had dyslexia.
True / False	**Question 2:** The IEP team should consider the input of the classroom teacher and parents in deciding if Wilhelmina should move back a grade.

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Element Questions: Formative: A Crucial Point for Wilhelmina

Hey College of Education! You have completed this assessment with **2 correct out of 2 scored items (100%).**

If you want to retake this (it's really meant to practice and learn, but we love persistence), you can reset this assessment by clicking here.

correct **Question 1:**
The IEP team should have looked at Wilhelmina's standardized test scores to determine whether or not she had dyslexia.

Your Response:
F

Ans/Feedback:
Standardized tests cannot determine or even suggest a student has dyslexia. Trained reading specialists are really the only personnel capable of making such a determination.

correct **Question 2:**
The IEP team should consider the input of the classroom teacher and parents in deciding if Wilhelmina should move back a grade.

Your Response:
T

Ans/Feedback:
They should definitely weigh both teacher and parent input, especially considering no actual cause for Wilhelmina's reading deficiency has been determined.

Case: Address the Student, not the Disability

Element: Wilhelmina Breaks Through (6 of 9)

Prev | Next

Please consider and answer the questions below before moving on to the next slide.

In early May, on the final second grade MAP test, Wilhelmina scored at the 78th percentile. In other words, within eight months, Wilhelmina went from doing worse than 99% of the students taking the test to better than three-quarters of the students taking the test. More notably, according to the MAP test data, she went from doing worse than 97% of the students to better than three-quarters in just four months!

Wilhelmina advanced to third grade, where she scored 84th percentile on her start-of-year third grade MAP reading test and continued to score in the 85th to 92nd percentile on elementary grades reading assessments after that.

Wilhelmina would continue to struggle with writing letters neatly and spelling, suggesting that she might indeed have a mild phonological impediment or general elemental acuity issue. But her solid language skills and supportive school and home environments, combined with a shift in the curricular emphasis, seemed to make the difference in her end-of-year test performance.

Prev | Next

Element Questions: Formative: Wilhelmina Breaks Through

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True / False — **Question 1:** Based on the evidence presented, Wilhelmina probably doesn't have dyslexia.

True / False — **Question 2:** Had school staff just gone ahead and treated Wilhelmina for dyslexia, she would have been much better off.

Save for Later | Submit Now

Element Questions: Formative: Wilhelmina Breaks Through

Hey College of Education! You have completed this assessment with **2 correct out of 2 scored items (100%).**

If you want to retake this (it's really meant to practice and learn, but we love persistence), you can reset this assessment by clicking here.

correct **Question 1:**
Based on the evidence presented, Wilhelmina probably doesn't have dyslexia.

Your Response:
T

Ans/Feedback:
Although we cannot be absolutely certain without more in depth screening, it would seem other factors contributed to Wilhelmina's reading delays and not dyslexia.

correct **Question 2:**
Had school staff just gone ahead and treated Wilhelmina for dyslexia, she would have been much better off.

Your Response:
F

Ans/Feedback:
Treating Wilhelmina for dyslexia would have been the wrong move, and could have done more harm than good.

Case: Address the Student, not the Disability

Element: Prologue (7 of 9)

← Prev | Next →

There are many possible reasons Wilhelmina did poorly during most of the second grade (consider, for instance, her kindergarten and first-grade classroom experiences), and many possible reasons she did so well by the end of second grade (she had good classroom teacher, reading specialist, peer support, and attentive parents). It is worth noting that her math scores also made a big jump at the end of the year (from third percentile, to fourth, percentile to 85th percentile). So, there might even have been a neurological growth spurt to factor in (kids' brains, like the rest of their bodies, do grow in fits and starts). Or she may have finally been getting the hang of how to respond appropriately to instructional protocols in a well-organized educational environment.

Still, for our purposes, it is important to observe that a too-quick judgment of her being at-risk for dyslexia would not likely have helped her. She improved without any dyslexia remediation. When asked how she did better, Wilhelmina herself suggested that it was because in the second half of the year the teacher stopped making the students do phonics exercises (which Wilhelmina found tiresome) and started teaching them to read books "for fun" (which she did eagerly).

← Prev | Next →

Element Questions: Lessons from Wilhelmina

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True / False	**Question 1:** Decoding skills must precede reading for enjoyment and/or meaning.
True / False	**Question 2:** Student eagerness to practice their reading makes a big difference in their reading development
True / False	**Question 3:** Language ability is as important on end of year reading tests as decoding
True / False	**Question 4:** There is more to reading instruction than phonics
True / False	**Question 5:** Diagnosis of the cause of reading difficulties is complex and often misattributed to dyslexia.

Save for Later | Submit Now

Element Questions: Lessons from Wilhelmina

Hey College of Education! You have completed this assessment with **5 correct out of 5 scored items (100%).**

If you want to retake this (it's really meant to practice and learn, but we love persistence), you can reset this assessment by clicking here.

correct **Question 1:**
Decoding skills must precede reading for enjoyment and/or meaning.

Your Response:
F

correct **Question 2:**
Student eagerness to practice their reading makes a big difference in their reading development

Your Response:
T

correct **Question 3:**
Language ability is as important on end of year reading tests as decoding

Your Response:
T

correct **Question 4:**
There is more to reading instruction than phonics

Your Response:
T

correct **Question 5:**
Diagnosis of the cause of reading difficulties is complex and often misattributed to dyslexia.

Your Response:
T

APPENDIX F

NARRATIVE SIMULATION CONTENT ASSESSMENT

Element Questions: Module assessment Part 1 (This assessment is required to complete the case)

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

True / False — **Question 1:** Most educators have the ability to diagnose the cause of a student's reading difficulty.

True / False — **Question 2:** Standardized reading tests such as the K-PREP help determine who might have dyslexia.

True / False — **Question 3:** Teachers should use screeners to determine student placement in a particular reading group or for certain dyslexia interventions.

True / False — **Question 4:** Determining whether a student has dyslexia is a complex process and teachers who are untrained/unqualified frequently misdiagnose students.

True / False — **Question 5:** Encouraging students to read for fun so that they are eager to learn does not help those with dyslexia.

True / False — **Question 6:** Teachers should assume students who perform poorly on reading assessments have dyslexia until proven otherwise.

True / False — **Question 7:** Delayed neurological development might contribute to reading deficiencies instead of dyslexia.

True / False — **Question 8:** Individuals with dyslexia have difficulty developing easy and rapid sight word recognition

True / False — **Question 9:** Students with dyslexia do not often fall behind in content knowledge.

True / False — **Question 10:** Inability to accurately recognize words is mainly attributable to dyslexia.

True / False — **Question 11:** By grades 1-2, children who struggle inordinately with sounding out words or letter sequences may be at risk for dyslexia.

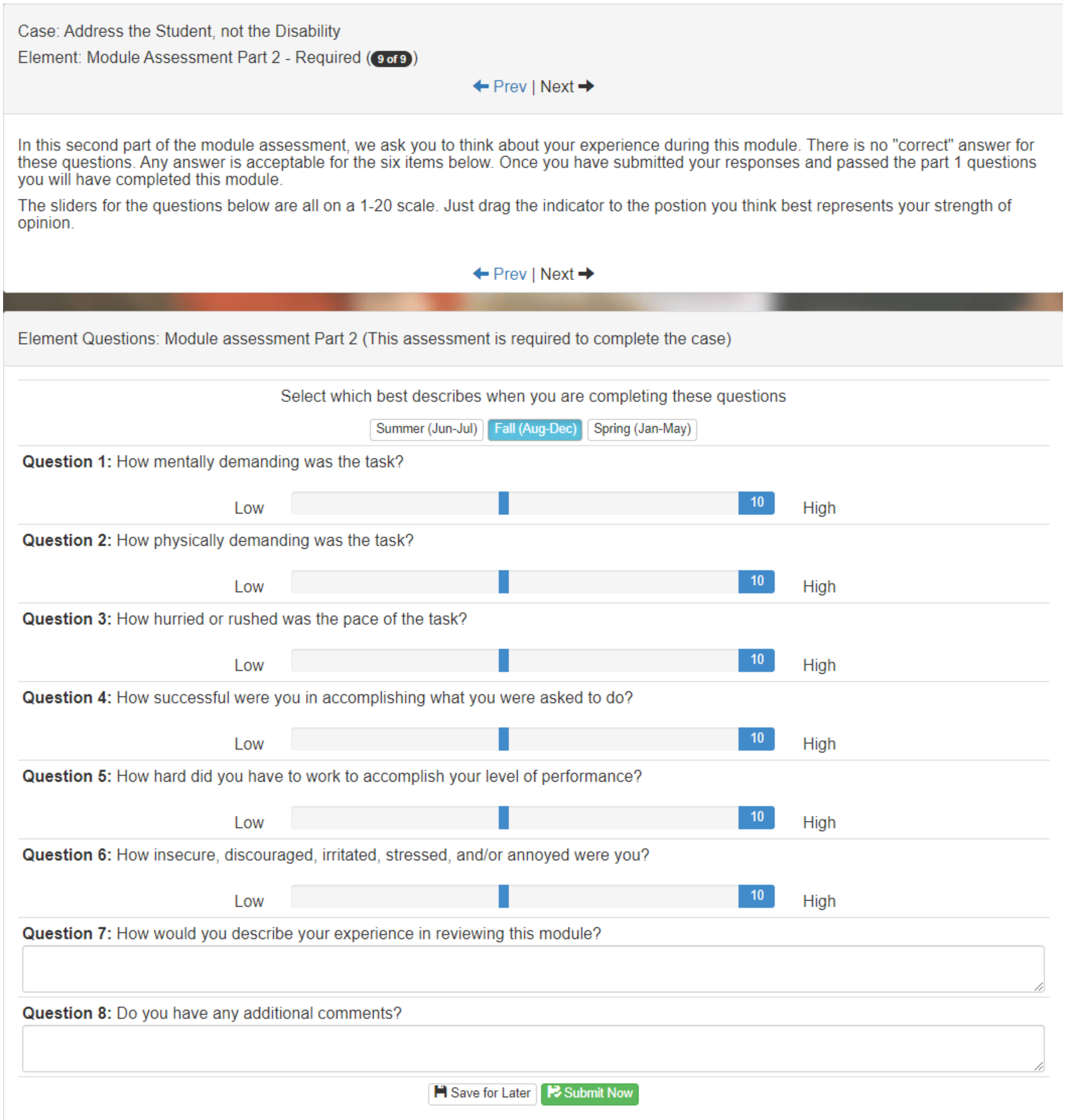
Question 12: Describe what you learned about dyslexia and reading delays that you did not know prior to completing this module. (This is an unscored question.)

Do you have any additional questions?

Save for Later | Submit Now

APPENDIX G

NASA TASK LOAD INDEX AND EXPERIENCE QUESTIONS AS PRESENTED AFTER ALL CONTENT ASSESSMENTS



Case: Address the Student, not the Disability

Element: Module Assessment Part 2 - Required (9 of 9)

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In this second part of the module assessment, we ask you to think about your experience during this module. There is no "correct" answer for these questions. Any answer is acceptable for the six items below. Once you have submitted your responses and passed the part 1 questions you will have completed this module.

The sliders for the questions below are all on a 1-20 scale. Just drag the indicator to the postion you think best represents your strength of opinion.

Prev | Next

Element Questions: Module assessment Part 2 (This assessment is required to complete the case)

Select which best describes when you are completing these questions

Summer (Jun-Jul) | Fall (Aug-Dec) | Spring (Jan-May)

Question 1: How mentally demanding was the task?

Low 10 High

Question 2: How physically demanding was the task?

Low 10 High

Question 3: How hurried or rushed was the pace of the task?

Low 10 High

Question 4: How successful were you in accomplishing what you were asked to do?

Low 10 High

Question 5: How hard did you have to work to accomplish your level of performance?

Low 10 High

Question 6: How insecure, discouraged, irritated, stressed, and/or annoyed were you?

Low 10 High

Question 7: How would you describe your experience in reviewing this module?

Question 8: Do you have any additional comments?

Save for Later | Submit Now

APPENDIX H

IRB LETTER OF APPROVAL/EXEMPTION

University of Kentucky | Office of Research Integrity
IRB, RDRC

EXEMPTION CERTIFICATION

IRB Number: 57744

TO: Christopher Daniel
College of Education
PI phone #:

PI email: chris.daniel@gmail.com

FROM: Chairperson/Vice Chairperson
Nonmedical Institutional Review Board (IRB)

SUBJECT: Approval for Exemption Certification

DATE: 9/29/2020

On 9/29/2020, it was determined that your project entitled "*Assessing Learning Efficiency in Narrative Simulation Delivered Through Interactive Multimedia*" meets federal criteria to qualify as an exempt study.

Because the study has been certified as exempt, you will not be required to complete continuation or final review reports. However, it is your responsibility to notify the IRB prior to making any changes to the study. Please note that changes made to an exempt protocol may disqualify it from exempt status and may require an expedited or full review.

The Office of Research Integrity will hold your exemption application for six years. Before the end of the sixth year, you will be notified that your file will be closed and the application destroyed. If your project is still ongoing, you will need to contact the Office of Research Integrity upon receipt of that letter and follow the instructions for completing a new exemption application. It is, therefore, important that you keep your address current with the Office of Research Integrity.

For information describing investigator responsibilities after obtaining IRB approval, download and read the document "PI Guidance to Responsibilities, Qualifications, Records and Documentation of Human Subjects Research" available in the online Office of Research Integrity's IRB Survival Handbook. Additional information regarding IRB review, federal regulations, and institutional policies may be found through ORI's web site. If you have questions, need additional information, or would like a paper copy of the above mentioned document, contact the Office of Research Integrity at 859-257-9428.

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EDUCATION

Eastern Kentucky University. Richmond, Kentucky. August 2008
Master of Public Administration

Eastern Kentucky University. Richmond, Kentucky. May 1997
Bachelor of Arts in Spanish.

PROFESSIONAL EXPERIENCE

4/2014-Present: Office of E-Campus Learning. Eastern Kentucky University.
Instructional Designer

4/2014-Present
Freelance Instructional Designer/Technologist/Trainer
Current Clients: Nationally Recognized Legal Education Services Provider
Local Private Child Psychology Services Provider
Eastern Kentucky University

1/2008-4/2014: Eastern Kentucky University
Training and Professional Development Manager, Advanced Blackboard Support

2008-2009: Eastern Kentucky University, Continuing Education Department
Computer Applications Instructor

4/2003 – 12/2007: Eastern Kentucky University, Richmond, Kentucky
Desktop Support Supervisor

SELECT AWARDS/RECOGNITION

7/29/2020: Blackboard Inc. Catalyst Award with EKU Psychiatric Mental Health Nurse Practitioner Program. Recognizes those who have adopted flexible, distance and online delivery, including using mobile technologies to positively impact the educational experience.

07/25/2019: Blackboard Inc. Austin, TX. Catalyst Award with EKU Family Nurse Practitioner Program. Recognizes those who have adopted flexible, distance and online delivery, including using mobile technologies to positively impact the educational experience.

5/2008: Janet W. Patton Award: Graduate Student of the Year. Eastern Kentucky University. Richmond, Kentucky. Recognizes one graduate student annually for outstanding scholarship in public administration and contributions to the graduate program.

SELECT PUBLICATIONS

Sweet, C., Blythe, H., Philips, B., & Daniel C. (2014) Achieving Excellence in Teaching: A Self-help Guide. New Forums Press. Stillwater, Oklahoma. ISBN: 1-58107-259-9.

Violette, J. L., Daniel, C. S., Meiners, E. B., & Fairchild, J. L. (2013). Going Out on a Limb: The Implementation of the L.E.A.F. Model of Teaching and Learning. In R. Carpenter (Ed.), Cases on Higher Education Spaces: Innovation, Collaboration, and Technology (pp. 186-205). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2673-7.ch010.