Exploring the Impact of Universal Design for Learning Supports in an Online Higher Education Course

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The significant increase in online learning, particularly in higher education, has raised questions about the methods instructional designers (IDs) consider to maximize learners' cognitive functioning and abilities. The literature suggests that Universal Design for Learning (UDL) offers students enhanced opportunities for engagement, expression, and academic performance. However, there is limited research measuring student perceptions on learning following the integration of UDL practices and subsequent course delivery modifications. This article discusses the integration of specific checkpoints within the three domains identified by the UDL framework. The exploratory case study identifies supports perceived to be instrumental in building students' capacity towards self-regulation, comprehension, and executive functions in an online learning environment.

Introduction

Online learning is growing more rapidly than any other innovation in higher education today (Duesbery et al., 2015). For students who are suitably skilled in reading and possess the necessary organizational abilities, these courses present the opportunity for students to study at their convenience. However, online courses have traditionally relied on asynchronous, text-heavy use of online readings, discussions, written assignments, and tests or quizzes, which are often problematic for students with learning differences (Andrews et al., 2015; Hollins & Foley, 2013).

As online learning platforms increase in popularity, the student population in higher education is becoming increasingly diverse. For example, there is a growing number of students reporting disabilities in addition to the rising number of students enrolling with minority, part-time, and non-traditional student statuses (Roberts et al., 2011). Therefore, the importance of proactive instructional design to reduce barriers, rather than incorporating accommodations after the fact, may be worth exploring (Hollins & Foley, 2013; Kumar & Wideman, 2014; McGuire & Scott, 2006).

To address barriers to student learning, researchers applied the principles of Universal Design from the world of architecture and developed Universal Design for Instruction (UDI), Universal Instructional Design (UID), and Universal Design for Learning (UDL) (Roberts et al., 2011). UDI was derived from the seven principles of Universal Design with the addition of two education-specific principles, "a community of learners," and "instructional climate." The focus of UDI is instructional and classroom environment and design. Thus, UID is used synonymously with UDI. In contrast, UDL was developed to address the variability between learners using principles based in neuroscience to alleviate barriers to learning (Meyer et al., 2014).

Literature Review

UDL

UDL was inspired by advances in cognitive neuroscience research, and its framework integrates "what we know about the learning brain" and "inform[s] the design of environments that support all learners" (Center for Applied Special Technology (CAST), 2018b). Tobin (2014) suggests the tenets of UDL are not exclusively for students with disabilities; thus, UDL gives all students equal opportunities to learn and offers online course designers with an effective means to enhance connections with all students. Therefore, the more education professionals and learners understand about the complexities, neuroscience, and predictable variability in learning, the more proficient they will be to advance toward expert learner status (CAST, 2018b; Martinez, 2010).

The Center for Applied Special Technology (CAST)

(2018b) describes the UDL Guidelines as a tool, based on scientific insights into how humans learn, for implementing the UDL framework. Thus, the guidelines are designed to be used by educators, researchers, curriculum developers, and anyone interested in optimizing teaching and learning for all people. The UDL Guidelines offer a set of concrete suggestions outlining multiple means of engagement, representation, and expression with the ultimate goal of cultivating expert learners who are (a) purposeful and motivated, (b) resourceful and knowledgeable, and (c) strategic and goal directed (CAST, 2018b).

Attention

The UDL framework acknowledges the diversity of learning and the value of empowering learners to focus on areas of challenge to drive their own learning experiences (CAST, 2018a). Thus, researchers have become increasingly interested in the phenomenon of attention (Kirk et al., 2017; Ratey, 2001; Sarter et al., 2006). Seminal author William James (1890) described attention as "withdrawal from some things in order to deal effectively with others" and implied focalization and concentration of consciousness are the essence of attention (p. 404). According to Ratey (2001), attention is more than observing incoming stimuli; it involves a number of processes including (a) filtering out perceptions, (b) balancing multiple perceptions, and (c) attaching emotional importance to these perceptions. Similarly, from a neural perspective, Penner (1984) describes attention as receptive and cognitive processes that bring awareness to stimuli entering consciousness. Therefore, when attention is insufficient or inappropriate, learning is negatively affected (Eastwood et al., 2012).

Attention drives learning, and when learners are paying attention to something else and are not paying attention to what is being taught, there is little chance they will learn (Wolfe, 2001). Online learning formats present an opportunity for students to identify and improve their attentional resources. For example, in a recent study by Kirk et al. (2017), data revealed intensive computerized attention training resulted in modestly improving certain untrained skills in children with intellectual and developmental disabilities. Similarly, understanding how attention impacts learning outcomes may be beneficial for online course designers to consider if they wish to strengthen online learners' cognitive skills and abilities.

Memory

Memory is essential to learning and provides the foundation for higher order thinking when existing knowledge scaffolds the integration and interpretation of new events (Preston & Eichenbaum, 2013). Thus, researchers in the areas of psychology and neuroscience have provided a rich body of literature on the various forms of memory and their development (Atkinson & Shiffrin, 1968; Paivio & Lambert, 1981). Schooling may have a profound influence on memory development, and learning environments can be viewed as vessels for providing students with opportunities to become more proficient in strategically structuring their remembering and learning (McCandliss, 2010).

Computers are similar to the human brain, and the most obvious similarity is memory (Martinez, 2010). Just as a computer's memory is vital to its functionality and power, according to Martinez, a human's memory is just as essential for maximizing learning and proficiency. Cowan (2009) describes three types of memory: (a) long-term memory, (b) short-term memory, and (c) working memory. Although confusion is common between the three types of memory, a study by Nemati (2009) reveals that teaching through memory strategies is effective, and knowledge about the brain gives educators insight to methods and designs conducive to the "mental labor" of the three types of memory (p. 21).

Multitasking and Engagement

As students process information from educational materials and digital media, they are increasingly interrupted by their surroundings and competing media (Liu & Gu, 2020). Moreover, as opportunities for online learning continue to expand, research has demonstrated that college students are commonly involved in multiple online activities when they are engaged with the Internet (Moreno et al., 2012). Therefore, the increasing prevalence of media multitasking has raised concerns among educators, and research supports that multitasking during educational activities negatively affects academic performance and learning (van der Schuur et al., 2015). Multitasking is commonly understood as synchronously engaging in two or more things or performing multiple tasks sequentially and in rapid succession (Burak, 2012). Similarly, media multitasking is typically defined as dual tasking or task switching in learning contexts (Wood & Zivcakova, 2015). According to Lepp et al. (2019), multitasking in online and face-to-face courses differs; therefore, online course designers may require different pedagogical methods to effectively minimize multitasking behaviors. For example, Miller (2014) describes the popularity of asynchronous online models which allow students flexibility to finish coursework. However, online learners also experience factors that have the potential to impact learning and student engagement such as (a) technical issues, (b) environmental distractions, and (c) social distance from instructors and peers. Therefore, pedagogical strategies for maximizing student engagement in an online environment requires forethought and savvy design choices.

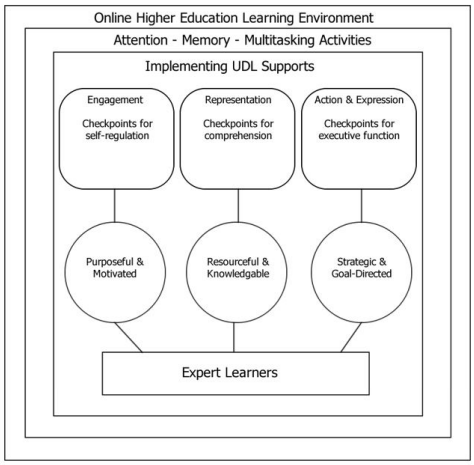
Researchers have raised questions about the quality of online education in providing students with rich and engaging learning experiences (Chen et al., 2008). In a recent study conducted by Bagriacik and Banyard (2020), literature reveals engagement has been shown to be supported or related to various variables including: (a) self-efficacy, (b) self-determined learning, (c) affect sensitive intelligent systems, (d) self-regulated learning, and (e) problem-based learning.

Overview of Conceptual Framework

According to Miles and Huberman (1994), the conceptual framework provides the researcher with the opportunity to gather constructs into themes or categories. For the purpose of this exploratory case study, the conceptual framework was developed from a review of the literature, professional experiences, and generalizations from empirical data (Baxter & Jack, 2008). The major constructs were organized in Figure 1.

Figure 1

Conceptual Framework



Note. The conceptual framework was adapted from CAST's (2018). *Universal Design for Learning Guidelines Version 2.2*.

The UDL framework is a set of guidelines organized into three domains. Each domain offers checkpoints for creating expert learners who internalize self-regulation, comprehension, and executive function. It is a framework for teaching and learning that offers guidelines for designing instruction that addresses known learner variability and removes learning barriers. UDL provides a framework for course design that will increase access, participation, and success for all learners. The Higher Education Opportunity Act of 2008 defines and endorses UDL implementation for postsecondary instruction (Meyer et al., 2013; Novak & Thibodeau, 2016).

The checkpoints identified by the UDL framework for the engagement, representation, and action and expression domains contributed to the conceptual framework for this research project. Attention, memory, and multitasking activities were selected because these areas of cognition aligned well with the guidelines on which the UDL framework was developed (Miller et al., 2020; Miller, 2014).

Checkpoints for self-regulation are guidelines for the affective network of the learning brain, within the engagement domain of the UDL framework. These checkpoints include offering students opportunities that promote expectations and beliefs that optimize motivation and facilitating students' personal coping skills and strategies. These checkpoints were selected for this project because they address the power of learner variability on attention and engagement. For example, Miller (2014) describes that "in face-to-face teaching, you can ensure that some bare minimum of time is devoted to classwork (by policing attendance)," and classes can be scheduled "when students are likely to be fresh (i.e., not in the middle of the night). Neither of these basic strategies for ensuring maximal engagement is easy to do online" (p. 40). Because engagement is so essential to learning, these checkpoints offer online instructional designers (IDs) guidance focused on the real goal of education--developing learner expertise. Learners who are able to self-regulate their attention and memory can set difficult goals for themselves and sustain their efforts to achieve, even when conditions for engagement vary (Meyer et al., 2014; Pintrich, & Schunk, 1996).

Checkpoints for comprehension are guidelines for the recognition network of the learning brain, within the representation domain of the UDL framework. These checkpoints include activating student background knowledge. This checkpoint was selected for this project because it offers a research-based scaffolding technique that addresses learner variability. Learners differ greatly in their ability to construct meaning based on their prior knowledge and experiences. There are also barriers for learners who have the necessary background knowledge but might not know it is relevant. The importance of attention, memory, and multitasking to learning is more likely to be important to students when the information is significant to them.

Checkpoints for executive function are guidelines for the strategic network of the learning brain within the action and expression domain of the UDL framework. These checkpoints include helping students choose appropriate goal setting, supporting students' planning and strategy development, and facilitating students managing information and resources. Thus, this checkpoint was

selected for this project because it is critically important for students and IDs to understand that executive functions have very limited capacity due to working memory limitations. If working memory is not constructed as relevant within a learning activity, students have to understand how to keep information organized in a way that works for them. Learners also have to develop the skill of effective goal setting. Once a goal is set, effective learners plan a strategy, including the tools they will use, for reaching that goal (CAST, 2018b; Meyer et al., 2014; Novak & Thibodeau, 2016).

The checkpoints within the three domains defined by the UDL framework were the basis for using the data collection instruments and collecting data to examine and identify the elements that contribute to students' perceptions of using specific learning activities on attention, memory, and multitasking to develop as expert learners. After data collection, the UDL framework also served as the basis for data analysis. This framework added structure to data collection and coding during data analysis but did not restrain the nature of qualitative research. In summary, the UDLframework is what provided the constructs for the conceptual framework guiding this research.

Purpose

The purpose of this study was to explore how students perceive the use of specific learning activities on attention, memory, and multitasking to help them develop as "expert learners" who are, each in his or her own way, resourceful and knowledgeable, strategic and goal-directed, purposeful and motivated. This research also sought to identify lessons that can be learned by IDs who would like to implement UDL supports in an online higher education course.

Research Questions

The following central questions directed this qualitative case study research:

1. How do students perceive the use of specific learning activities on attention, memory, and multitasking to help them develop as "expert learners" who are, each in his or her own way, resourceful and knowledgeable, strategic and goal-directed, purposeful and motivated?
2. What lessons can be learned by IDs who would like to implement UDL supports in an online higher education course to support student success?

Method

Data were collected from a convenience sample of 169 students attending a public university in the southeastern United States. The participants included 121 female undergraduate students and 53 male undergraduate students (N = 6 unreported gender). The participants were enrolled in six separate undergraduate level university courses. Study participants were asked to complete brief online survey responses following individual learning activities designed to elicit perceptions about attention, memory, and multitasking. Responses were analyzed and interpreted using the suggested steps for conducting qualitative data analysis and interpretation (Creswell & Guetterman, 2019).

The data analysis conducted for this qualitative case study exploring how students perceive the use of specific learning activities on attention, memory, and multitasking was performed using qualitative case study methods for its data collection and analysis (Yin, 2011). Data collected from the online learning activities were analyzed in a three-step qualitative analysis procedure. The steps are as follows: 1. Open coding of responses and reflections of each online activity creating labels in conceptual chunks, 2. Grouping open codes into categories for preliminary axial coding; and 3. Comparing the open and axial codes to arrive at composite themes. Through each phase of the study, the researchers met to check for potential bias and to build objectivity to the study (Creswell & Guetterman, 2019). Stake (1995) suggests "there are multiple perspectives or views of the case that need to be represented, but there is no way to establish, beyond contention, the best view" (p. 108). Thus, case study design methods were the most adequate tools to realize both the practical and theoretical aims and to ensure the credibility of the data and findings of the research.

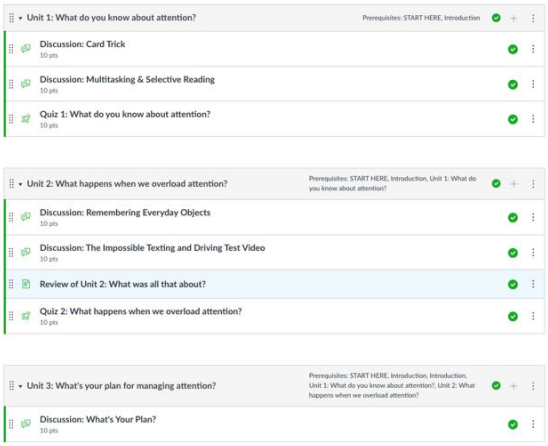
The researchers received permission to conduct the study from the institution's Institutional Review Board (IRB), and the study participants were asked to sign a consent and were informed that their participation in this study was voluntary. The participants were also advised that they could withdraw from the study at any time and that their responses would remain confidential.The learning activities, called "Attention Matters!," designed by Miller et al. (2020) to address growing concerns about distraction and learning, were integrated into the *Canvas* learning management system throughout weekly course modules. The activities were organized into three separate units. The units, titled respectively, are as follows:

- "What do you know about attention?"
- "What happens when you overload attention?"
- "What's your plan?"

Each of the three units was designed to have similar structure and sequence of learning materials and a discussion. The first two content units included a short description of the unit's content, followed by between one and two demonstrations and/or videos, a one-page explanation of the phenomena that were shown in the demonstrations and videos, and a discussion forum. The module design emphasized interactive demonstrations or multimedia (e.g., engaging short video clips), instead of more traditional materials such as slide decks or assigned readings. The discussion prompts emphasized personalization, encouraging students to talk about whether the activities could apply to their own experiences. The third unit asked students to describe what they would do in the future to better manage attention, memory, and multitasking in situations that require executive functioning skills, such as when they were tempted to text during class. Figure 2 shows the structure of the "Attention Matters!" student activities in the "Modules" page of the *Canvas* course.

Figure 2

"Attention Matters!" Student Activities in Canvas



Note. The Attention Matters! modules and activities in Canvas were adapted from Miller, M. (2014).

The "What do you know about attention?" unit included activities to demonstrate phenomena related to attention and distractions. These activities integrated change blindness and the Stroop effect (1935). Change blindness is a phenomenon that involves changes in visual scenes that take place across some type of interruption such as a brief flicker of a gray field across the scene (Miller et al., 2020). Miller suggests that change blindness is an attentional phenomenon that is unlikely to occur when it is known what the scene is about or what important action is taking place. Change blindness was used to start the discussion about the limitations of attention and how information can be difficult to discern when it is focused elsewhere. This activity used a 2 minute and 43 second *YouTube* video, "Colour Changing Card Trick" (Quirkology, 2012), which uses misdirection and cuts to distract viewers from major changes taking place in the scene, and then replays the video with the changes pointed out. This unit also included an activity to demonstrate the complexity of distractions, using the Stroop effect (Stroop, 1935). Participants were asked to name the color of a series of words, printed in different colors, which conflict with the color names spelled out by the word (e.g., the word "blue" is printed in red ink, the word "yellow" printed in purple ink, and so forth).

The "What happens when you overload attention?" unit included an activity to demonstrate phenomena related to memory. The activity was adapted from Nickerson and Adam's (1979) coin drawing task that illustrates memory for details of highly familiar objects can be strikingly inaccurate. Students were asked to draw a one-cent coin on paper and then check it for inaccuracies. They also had the option to upload a photo of their drawings to the discussion forum.

Lastly, the third unit "What's your plan?" unit included a discussion asking students to share their plans for managing attention, memory, and distractions to help them be more successful with their own learning.

Overall, this case study addresses the three UDL framework domains relevant to building learners' self-regulation, comprehension, and executive function in an online higher education course. Six checkpoints within these three domains contributed to the conceptual framework used as a foundation to facilitate reliability of this research.

Results

A qualitative analysis of the data revealed four central themes related to integrating UDL supports into an online higher education course: supported students' attention; helped eliminate distraction roadblocks; provided relevance to learning; changed students' beliefs about attention, memory, and multitasking. These four themes emerged from the qualitative data analysis and represent the major ideas in the database. They are infused throughout the three domains and corresponding checkpoints used as the framework for this research. These four themes were intertwined throughout the domains. Table 1 provides an overview of the findings by theme within the UDL framework domains and related checkpoints.

Table 1

Overview of Findings by Theme within the UDL Domains and Related Checkpoints

Theme	Engagement Domain	Representation Domain	Action & Expression Domain
	Self-regulation checkpoints:	**Comprehension checkpoints:**	**Executive function checkpoints:**
	Promote students' expectations and beliefs that optimize motivation Facilitate students' personal coping skills and strategies	Activate student background knowledge	Guide appropriate goal setting Support students' planning and strategy development Facilitate students management of information and resources
Guidance on what information is important supports students' attention	"We are better able to pay attention when we are told and are aware of what we are looking for and what we should be focusing on."	"Distractions cause confusion and loss of focus which results in more time necessary to complete tasks."	"In order to manage distractions I think [I] need to know what [my] main distractions are and create a manageable plan."
Distractions cause roadblocks to learning.	"I have limited my own potential."	"We focus on what we find important."	"From now on, I will never go on my phone in class unless it is an absolute emergency."
Relevance is valuable to students' learning.	"I do not pay attention to small details."	"It is challenging/difficult to pay attention (focus)to more than one thing at a time."	"I'm definitely going to be doing things a lot differently in all of my classes."
Students' beliefs about attention, memory, and multitasking can be changed.	" …I want to change, I want to do things differently…"	"I am now aware of how my attention can affect not only myself, but also the people around me."	"Overall, the Attention Matters module has been one of the most impactful lessons I have ever learned from."

Attention drives learning, and the concept of attention skill gathering is important for students' academic success and social relations (Yildirim Doğru, 2015). In the current study, students indicate "managing distractions during work, school, and meetings is beneficial to truly pay attention in those settings." Similarly, a study by Cheong et al. (2016) investigated instructor concerns about how to fulfill pedagogical goals and communicate their authority in the classroom amongst mounting digital distractions. Thus, providing opportunities that raise students' awareness that attention is adversely affected by distractions in the classroom, and as study participants remarked, "affects not only myself, but also the people around me" is valuable information for improving student engagement, improving students' social relations (i.e., expressed care and concern for others around them), and improving expert learning. Students perceived the learning activities "showed [them] how paying attention makes a difference".

When planning for instruction, educators must have an awareness of their students' interests, their preferences, their strengths and challenges, and their readiness to learn (Kieran & Anderson, 2019). This case study indicated that the checkpoints within the three domains defined by the UDL framework contributed to changing students' perceptions of memory, attention, and multitasking as they develop as expert learners. Also, participants of this study expressed an interest in managing distractions during classes and study time by, for example, "turning my phone off" or "putting away my Apple watch" to maximize in and out of class engagement and productivity. Thus, intertwining modules into an online platform curriculum that explicitly focuses on individual student barriers to learning, and having conversations about strategies for eliminating these barriers, may support students' readiness to learn in both online and traditional classrooms.

Supporting educators' understanding of how teaching models and learning designs must be reconfigured to meet the needs of 21st century learners is needed to support student success (Awadhiya & Miglani, 2016). This study changed the learning design of six university courses by introducing various online modules into the curriculum, and the results revealed a change in students' beliefs about attention, memory, and multitasking. For example, one student explained the following:

When I first started this class, I sometimes texted while I was going through the assignments, but not anymore. By completing the activities in ["Attention Matters!,"] I learned just how distracting cell phones can be in class and when trying to pay attention in general. Furthermore, I think that turning off my phone before class will improve my academic performance in general.

Another student described, "[a]t the beginning of the ["Attention Matters!,"] my answers were far from correct. Before reviewing the module, I never truly realized how important it is for students to pay attention in the classroom." After the study, participating students indicated that their "communication with other people has increased," and they have "noticeably found [themselves] understanding so much more in class because the professor has [their] full attention."

Therefore, the online modules equipped students, in a practical way, to address their counterproductive beliefs related to attention, memory, and multitasking.

This study revealed that students perceived that the use of specific learning activities on attention, memory, and multitasking helped "change [their] view[s]" and develop an awareness of their ability to "take different actions" to develop as "expert learners" who are, each in his or her own way, resourceful and knowledgeable, strategic and goal-directed, purposeful and motivated.

Discussion

As the impact of the use of ubiquitous technologies like smartphones, laptops, and tablets remains widely unknown, and despite the spirited conversations of the drawbacks digital and media multitasking, multitasking with devices remains a common practice amongst 21st century learners (Miller et al., 2020). The results of the current study indicate that integrating the UDL framework into an online higher education course supported students' attention, helped eliminate distraction roadblocks, provided relevance to learning, and changed students' beliefs about attention, memory, and multitasking.

Chief academic officers consistently rate online education learning outcomes "as good as or better" than the learning outcomes for face-to-face instruction. However, a consistent minority continue to consider online education as inferior with one of the outcome barriers reported by faculty as "the need for more discipline on the part of online students" (Allen & Seaman, 2013, p. 6). Therefore, IDs who explore the lessons learned through the implementation of UDL in an online higher education course, presents opportunities to support students' "discipline" and students' success. For example, several participants in this study expressed awareness that they "need to pay close attention" and "need to manage distractions," and they also perceived "managing distractions is a very important life skill" and that "everyone's distractions are different so [everyone has] to figure out what works for [him or her]." The data indicates participants' readiness to self-regulate their multitasking and off-task behaviors in an effort to support their journeys toward expert learning.

Higher education faculty can expect a wide range of learners in online learning platforms, which according to a study based on responses from more than 2,800 colleges and universities conducted by the Online Learning Consortium, 6.7 million learners have enrolled in at least one online course, and approximately 32 percent of all postsecondary education learners now register in at least one online class during their educational careers (Allen & Seaman, 2013; Houston, 2018). Similarly, the global Covid-19 pandemic led to profound changes in social interaction and organization in the educational sector, and many institutions have instituted new eLearning protocols (Murphy, 2020). As a result, the benefits of implementing the UDL supports in instructional design for a growing number of online learners is becoming increasingly valuable and relevant.

This study adds to the body of research related to learners' attention, memory, and multitasking behaviors. Our findings also contribute to the literature on what learners believe and understand about attention, memory, and multitasking. Thus, learning opportunities and conversations about distractions and attention may improve an instructor's ability to manage digital class distractions and more effectively engage online and traditional classroom students. However, the researchers acknowledge limitations of the study. For example, the participants in this study were enrolled in academic courses and were aware of the concepts the modules targeted. Therefore, self-reported responses may be subject to unconscious bias. Future research could explore the impact of participation in brief online experiences like "Attention Matters!" through an examination of long-term impact on beliefs and behaviors. Also, the convenience sample was limited to students attending one public university in southwest Florida. Future research could investigate similarities or differences in student perceptions in varying demographics and how perceptions related to these concepts have the potential to contribute to the development of "expert learners" who are, each in his or her own way, resourceful and knowledgeable, strategic and goal-directed, purposeful and motivated.

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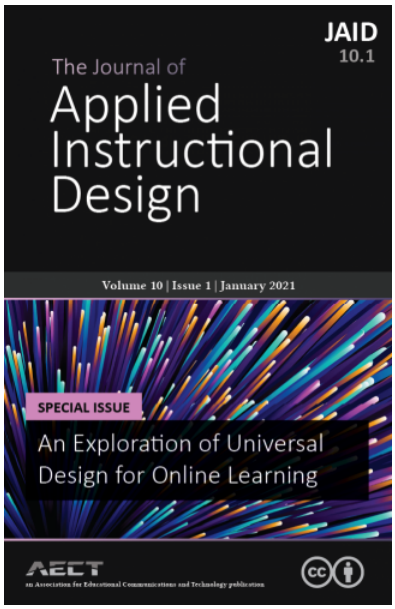

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