

Evaluating Learning Management System (LMS)-facilitated Delivery of
Universal Design for Learning (UDL)

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF EDUCATION

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April, 2012

Acknowledgements

This dissertation owes much to a core group of brilliant and caring mentors and scholars. My advisers, Joyce Strand and Trudie Hughes, motivated, supported, and nurtured this dissertation (as well as its author) from start to finish. Dr. Strand led me to a topic that was ideally suited to my background, and her consistent and strong advocacy gave me confidence in difficult times. Dr. Hughes was there for me day-in and day-out with her expertise and affinity for instructional approaches that support diverse learners; I recall our presentation at a UDL workshop, and thank her for her generous ability to support and foster the presentation and leadership skills of those she mentors.

As instructors of the first cohort of this Ed.D. program, Frank Guldbrandsen, Julia Williams, Lynn Brice, Jean Stevenson, and Tom Peacock all had a powerful effect on my scholarship and my desire to apply the privileges of education to the benefit of others. Dr. Williams also served as a member of my committee, and her questions challenged me to think deeply about my research design and processes throughout this study.

Committee member Chery Takkunen provided encouragement and support often at the cost of her own convenience. I thank Dr. Takkunen for her insights and her deep engagement in the ideas and questions explored in this study.

Diana Johnson was involved in the instructional design and intervention aspects of this research, and the benefits of her expertise are manifested throughout this project.

Finally, thanks go to my employer, Lynne Hamre. As Chief Information Officer of the college where this study took place, Dr. Hamre continually demonstrates her support of research to inform the implementation and use of instructional technology.

Dedication

This is dedicated to my husband, Ron, and my children, Bryan, Greg, Jay, and Lee. Thank you for your never-ending love and inspiration.

Abstract

This quantitative study involved 157 students in two sections of an undergraduate class in general biology, as well as one instructor who taught both sections of the course. It used resources from the Center for Applied Special Technologies (CAST) to evaluate the viability of a Learning Management System (LMS) to provide Universal Design for Learning (UDL). It also measured and tracked the instructor's level of efficacy in sustaining UDL approaches throughout the semester. In an effort to identify the UDL's specific outcomes or benefits to students, this study used a pre- and post- test to identify the treatment's impact on student engagement. Findings indicated that the LMS could be designed to comply with UDL guidelines, and the instructor was able to establish a high level of efficacy in maintaining that UDL design. However, based on the statistical analysis of pre- and post-test responses from control vs. treatment groups of students, the treatment was seen to have no significant effect in the area of student engagement. Overall, the study added to the literature by suggesting (a) the viability of the LMS as a means of providing UDL approaches, (b) the promise of the LMS as a tool faculty can use to deliver UDL with a high level of efficacy, and (c) the design's lack of effect in the area of student engagement. The fact that this study was limited to a single brand of LMS (Blackboard), a single instructor, and a single group of students underscores the need for further research.

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Chapter 1. Introduction

Universal Design for Learning (UDL) holds promise as an approach that anticipates and supports the full range of learners, including those with special needs. Empowered by digital media, informed by brain-based research, acknowledged by recent legislation, and intended to meet the learning needs of diverse students, UDL has drawn attention at the postsecondary level (Getzel, 2008; Izzo, Murray, & Novak, 2008; Orr & Bachman Hammig, 2009; Rose, Harbour, Johnston, Daley, & Abarbanell, 2006).

Edyburn (2010) suggests UDL can be challenging to define and deploy. Faculty members may find it difficult to implement technology-based and UDL approaches (Getzel, 2008). However, an electronic and Internet-based technology known as the Learning Management System (LMS) is specifically designed to be used by instructors. Thus, the LMS was considered a potential tool with which to organize and deliver UDL's flexible, interactive, and multimedia-rich approaches.

Blackboard, Moodle, and other LMSs are common in postsecondary education. These systems utilize a diverse palette of tools and features that support the inclusion of varied resources such as asynchronous discussion boards, online chatrooms, interactive games, and video. For this reason, the LMS represents a potential solution for faculty members seeking to establish and use a range of tools to organize, extend, or supplement resources provided during the face-to-face classroom session.

Templates in some software programs and also in the LMS can be established to provide users with a consistent interface or dashboard of services and features. In establishing a template or initial design, different tools may be selected and applied based

on instructor preference and curriculum need. Baldwin (2009) speaks of the power of templates and describes software programs an educator can use to create his or her own customized environment and learning activities. In Baldwin's (2009) application, the templates were designed and used as part of an educational software program to support students with special learning needs.

Additional templates tap the established accessibility and design features of an LMS to support students with disabilities (Gerrard, 2007; Sapp, 2009). Sapp (2009) describes how the Universal eLearner represents an LMS specifically developed and explored as a means of providing UDL benefits. Gerrard (2007) discusses how a university in the United Kingdom investigated the level of engagement experienced by students with disabilities when their instruction was supplemented using the Blackboard LMS. Both studies emphasized outcomes among students with special needs as opposed to the full range of learners.

One intent of this study was to evaluate whether a template in the LMS could be established and used to support all 31 elements listed on the UDL checklist and also whether an instructor could effectively maintain an LMS-facilitated implementation of UDL. The intervention's impact in the area of student engagement was also explored.

Background and Context

Description of UDL. Universal Design for Learning expands upon the construct of Universal Design in architecture and product design, and was established by Rose and Meyer (2002) following the 1997 reauthorization of the Individuals with Disabilities Education Act ([IDEA], Edyburn, 2010). The term Universal Design was mentioned by name in the IDEA of 2004, and until recently was applied most extensively in the K-12

educational setting. UDL provides a curriculum design that is accessible on a cognitive as well as on a physical level. It supports inclusion at a time when our general population is becoming more diverse (H.R. 1350, 2004).

“The technologies of the future will be more, not less, diverse, and they will engage many kinds of learners” (Rose & Meyer, 2000, p. 6). In addressing the needs of the individual learner, UDL is not suggesting universality in the sense of a generic one-size-fits-all approach, but rather an initial design that considers and supports a wide range of learners by offering a diverse menu of choices, experiences, and supports. UDL’s flexible approaches were first intended to support learners with special needs and talents, but they are ultimately more effective for all kinds of students (Rose & Meyer, 2000).

Educators take more notice of the ‘unusual’ strengths of individuals with disabilities – e.g. the prodigious feats of visual memory in the autistic child, or the extraordinary capacity to recognize facial expression in aphasics. In the same context, myriad differences emerge between learners formerly classified in the category of ‘normal’ learners. Against this backdrop, individuals with disabilities fall along a spectrum of difference and the convention of the ‘regular’ student disappears as a normative model. (Rose & Meyer, 2000, p. 4)

With the endorsement of the Council for Exceptional Children, UDL’s founding organization — The Center for Applied Special Technology — dedicates itself to applying and promoting UDL in an effort to extend learning opportunities for all individuals, especially those with disabilities (Center for Applied Special Technology [CAST], 2010b). UDL expands upon the physical metaphor of ramps and curbcuts as it builds upon brain research to increase accessibility in cognitive as well as physical ways

(Rose & Meyer, 2002). UDL and its tenets interconnect with brain research as it highlights:

1. Learning is distributed across three interconnected networks:
 - the *recognition* networks are specialized to receive and analyze information (the “what” of learning);
 - the *strategic* networks are specialized to plan and execute actions (the “how” of learning); and
 - the *affective* networks are specialized to evaluate and set priorities (the “why” of learning).
2. Learners cannot be reduced to simple categories such as “disabled” or “bright.” They differ within and across all three brain networks, showing shades of strength and weakness that make each of them unique. (Rose & Meyer, 2002, p. 11)

Digital media supports the goal of multiple means of representation, and holds great promise in its potential to meet the differing needs of learners. “As the interactive multimedia technologies of the digital world replace the static technologies of print, a far richer palette opens up for instructional designs, and especially for designs that are flexible enough to meet the challenge of individual differences” (Rose & Dalton, 2009, p. 75).

Digital media. Digital approaches are highly compatible with UDL (CAST, 2010; Rose & Meyer, 2002). In its book, *Universal Design for Learning: A Guide for Teachers and Educational Professionals* (2005), the Council for Exceptional Children emphasizes

that teachers who use digital multimedia find this an effective way of supporting the special needs of diverse learners.

The International Society for Technology in Education (ISTE) includes a standard that educational administrators “create, promote, and sustain a dynamic digital-age learning culture that provides a rigorous, relevant, and engaging education for all students” (ISTE, 2010, n.p.). Pointing to the specific value of multimedia tools, Pisha and Coyne (2001) emphasize the use of digital media such as video, audio, and other visual formats as a means of supporting students and providing content in alternative and nontextual formats.

Edyburn (2010), a leading practitioner and researcher in the area of accessibility and assistive technology, considers technology essential for implementing UDL. Edyburn (2010) notes digital technology is highly flexible and printed or paper-based materials cannot rival the level of support that is possible when using digital media.

In earlier works (Rose & Meyer, 2002) as well as a subsequent book describing classroom implementation of UDL, Rose, Meyer, and Hitchcock (2006) emphasize the advantages of digital media:

Digital media offers tremendous flexibility that enables teachers to differentiate their approaches in a way that is simply not feasible when restricted to traditional media such as print, speech, and images. With digital media, one piece of a curriculum can be designed with built in customization features so that it can be adapted to suit many different students. (p. 19)

UDL is considered to be an effective approach to curriculum design that can be applied to pre-kindergarten through college and graduate education. By offering

appropriate challenges through multiple means of representation, action/expression, and engagement (CAST, 2012), it intends to meet needs of the full range of learners.

Significance of student engagement. Based on extensive research on the topic of student engagement, faculty and students define student engagement in similar ways.

When asked what student engagement meant to them, common responses included (a) getting more involved in learning, (b) becoming active learners, (c) feeling motivated, (d) being challenged, and (e) being excited about new concepts and experiences (Barkley, 2010).

In his book entitled *Qualities of Effective Teachers*, Stronge (2007) emphasizes the value of student engagement, stating the time students spend on task or engaged in the teaching and learning activity is an important contributor to academic success. Stronge (2007) goes on to describe other researchers' insights on the topic of supporting student engagement in learning and suggests effective teachers support student engagement by varying their own instructional strategies as well as the types of assignments and activities given to students. The use of multiple formats in the presentation of content is in keeping with the American Psychological Association's call for increased learner participation and engagement in the learning process (Orr & Bachman Hammig, 2009).

Case (2008) considers engagement to be the presence of a connection or a relationship that exists outside or even inside of oneself. Haworth and Conrad's Engagement Theory emphasizes that student engagement on the graduate level is manifested through student investment of time and effort. Haworth and Conrad (1997) suggest engagement is evident in high quality programs in which teachers and learners

devote time and effort to a learning environment and experience that is mutually supportive.

At a time when postsecondary classrooms are becoming increasingly more diverse, the provision of multiple means of engagement, such as online discussions and resource links, increased student engagement and satisfaction among students who used an LMS on a supplemental basis (Gerrard, 2007; Rose, Harbour et al., 2006). These findings are consistent with CAST's research that identifies an affective network/domain of the brain and emphasizes the importance of providing learners with multiple means of engagement (CAST, 2010b; Rose, Harbour et al., 2006; Rose & Meyer, 2002). In the research described, the affective domain of the brain is more likely to be stimulated when a learner has the opportunity to select an option or approach most appealing to them.

The National Survey of Student Engagement (NSSE, 2009) establishes benchmarks for measuring student engagement among college undergraduates in terms of their overall college experience. Measures include appropriate challenges, active learning, student-faculty interaction, enriching experience, and supportive campus environment (Barkley, 2010; Center for Postsecondary Research, 2009). The NSSE measures the broad picture of student engagement with attention paid to many aspects of the undergraduate experience.

On the individual course level, however, the Student Course Engagement Questionnaire (SCEQ) (Handelsman, Briggs, Sullivan, & Towler, 2005) is a tool that has been tested with positive results when seeking to evaluate undergraduate student engagement on the individual course level. The SCEQ is consistent with definitions of student engagement in its effort to quantify the level of engagement based on behavioral,

emotional, and motivational measures (Barkley, 2010; Case, 2008; Center for Postsecondary Research, 2009; Handelsman et al., 2005; Haworth & Conrad, 1997).

Due to its history of success as a valid measure and to the fact that this was designed specifically to measure student engagement at the course level, this instrument holds promise as a means of evaluating student engagement in this study. The survey is described as short and easy to administer (Handelsman et al., 2005).

Significance of instructor efficacy with instructional approaches. UDL places a strong emphasis on the use of digital technologies as a means of building flexibility and interactivity into the curriculum. In considering the sustainable implementation of UDL approaches, it is essential that individuals and institutions seeking to promote the use of UDL develop and apply technology tools and approaches that can be effectively used by the faculty members who are called upon to apply them (Getzel, 2008).

Faculty members are known to hold diverging attitudes and aptitudes toward the integration and use of academic technologies in teaching and learning (Kuhlenschmidt, 2010). These variations have been identified and described in Rogers' (2003) response to innovation model that categorizes instructors according to five groups: (a) innovator, (b) early adopter, (c) early majority, (d) late majority, and (e) laggard.

In order to address the needs of this wide-ranging universe of faculty members, faculty developers emphasize the importance of selecting appropriate technology tools and approaches. This task is not considered to be overwhelming. The process needs to be productive, and the tool itself needs to be easy to learn and use and adaptable to different goals (Kuhlenschmidt, 2010).

UDL has the potential to reach all students through the use of various technology tools and through the delivery of information and instruction in a variety of ways (Getzel, 2008; Rose & Meyer, 2002; Rose, Meyer et al., 2006). However, faculty members benefit from support structures, frameworks, guidelines, and training to ensure their satisfaction and success (Baldwin, 2009; Burgstahler, 2006; Edyburn, 2010; Getzel, 2008). In addition to UDL guidelines (CAST, 2010c), Burgstahler (2006) suggests instructors and designers using “development tools, such as Blackboard and WebCT, can employ product accessibility tools to create accessible courses” (p. 5).

Instructor confidence is essential to the implementation and sustainability of UDL at the postsecondary level. As a technology-based approach, the design and application of UDL will need to be reliable, easy to learn and use, and adaptable to different goals (Kuhlenschmidt, 2010). Approaches are needed to provide instructors with the knowledge and skills necessary to integrate instructional technology and UDL (Messinger-Willman & Marino, 2010).

Statement of the Problem

Teachers at the postsecondary level face challenges in effectively instructing and engaging an increasingly diverse population of students. As more English language learners (ELL) and students with special needs enter postsecondary education, the need for expanded interventions and support becomes evident. During the transition to a time when colleges and universities will need to support a more diverse student population, institutions of higher learning run the risk of leaving learning needs unmet as they struggle to forge new strategies and operating procedures that are reliable and consistent. Meanwhile, thanks to innovations in instructional technology and a generation of

millennium students who can avail themselves of (and even expect) technology-delivered instruction and support, the climate is right for a technologically-driven delivery of UDL.

UDL is considered a “scientifically valid” approach for instructors at the higher education level (GovTrack.us, 2008; H.R. 1350, 2004). UDL is endorsed as an inclusive approach and a means of improving the student experience, yet there is a lack of research clarifying UDL’s outcomes (Edyburn, 2010). UDL has been emphasized in both the National Educational Technology Plan (2010) and the Higher Education Opportunity Act ([HEOA], GovTrack.us, 2008). However, there is a need for more student outcome data as well as for practical strategies that will allow instructors to implement UDL in their own practice (Edyburn, 2010; Getzel, 2008; Izzo et al., 2008).

Purpose Statement

As UDL becomes an instructional design approach of choice (GovTrack.us, 2008; H.R. 1350, 2004), there is a need for more research in the areas of whether UDL truly leads to student engagement (Rose, Harbour et al., 2006). Teachers, academic leaders, and researchers working across levels are conducting their own research with a call for more information on strategies and outcomes relating to the implementation of UDL (McPherson, 2009; Messinger-Willman & Marino, 2010; Rose, Harbour et al., 2006, 2008).

With the exception of faculty in the School of Education, most postsecondary-level instructors have never received training in the area of curriculum design and instruction. For that reason, educators and experts in the area of teaching and learning need to establish, test, refine, and disseminate UDL approaches that can be replicated and

systematically applied by the generality of postsecondary instructors, regardless of whether they have had training as educators, technologists, or instructional designers.

The use of digital tools has been emphasized (CAST, 2010b; Edyburn, 2010; Kvavick, 2005; Prensky, 2005; Rose & Meyer, 2002) and the UDL implementation supports in the form of UDL guidelines and a discretionary checklist have provided useful guidance for instructors seeking to implement UDL (Rose, Harbour et al., 2006, 2008). Instructors need satisfactory approaches (training and resources) to providing UDL. This research utilized an LMS to provide elements and supports described in CAST's UDL model (Rose, Harbour et al., 2006, 2008). In designing the curriculum, the instructor and investigator also referred to the UDL guidelines and the discretionary checklist provided by CAST (2010c).

The goal was to build upon previous studies that used an LMS with an emphasis on the benefits to students with special needs alone (Gerrard, 2007; Sapp, 2010). The study was based on the accurate implementation of UDL as described by the UDL guidelines and checklist from CAST. The study explored the viability of an LMS-facilitated approach to providing UDL to undergraduate students enrolled in a face-to-face course. It also established the instructor's level of efficacy in the ongoing application of UDL approaches. In exploring benefits to students, the study measured the impact of this approach on student engagement. If deemed successful based on this study, the design would provide a rationale and a foundation for a larger scale inquiry into this LMS-facilitated approach.

Significance of the Study

UDL has been delivered at the PK-12 grade level with positive results, and the term Universal Design was mentioned by name in the IDEA of 2004 as a suggested strategy for supporting inclusion at a time when our general population is becoming more diverse (H. R. 1350, 2004). As of its reauthorization in 2008, the HEOA (GovTrack.us, 2008) provided increased impetus for UDL's implementation in postsecondary settings. According to CAST researcher Schlichtman, CAST is "definitely getting more into higher education now that the Higher Education Act was passed with UDL explicitly mentioned" (G. Schlichtman, personal communication, March 8, 2010).

Meanwhile, despite the challenges of finding consistent ways to apply and deliver UDL, higher education is unique in that most students expect the convenience, interactivity, and control provided through online technologies (Kvavick, 2005; Prensky, 2005). This expectation is realizable via the ubiquitous availability of computers and through an infrastructure that has made the LMS generally available at the higher education level (Center for Applied Research, 2003, 2008a, 2008b).

Twigg (2003), in her research for the Pew Foundation and other efforts, verified the benefits of the LMS in delivering supplemental resources to large lecture classes in colleges and universities. Additional research conducted on a smaller scale provides further evidence it may be possible to deliver UDL in a consistent manner using specific tools and enhancements from an LMS such as Blackboard (Gerrard, 2007; Rose et al., 2008; Sapp, 2009).

Could the use of an LMS represent a practical and consistent strategy to facilitate faculty implementation of UDL? By investigating the effectiveness of UDL

implementation using an LMS on a supplemental basis, a replicable approach was developed. Because the postsecondary setting has attributes and resources that may not be prevalent in PK-12 education, participants face a new set of opportunities and challenges when it comes to implementation of UDL. It seems clear that, given the new prescriptions from the HEOA reauthorized in 2008 and the numerous groups advocating for its use, instructors need one or more models that will allow them to more easily apply UDL.

The study explored uncharted territory and contributed to the literature based on the following three factors:

1. The HEOA's emphasis on UDL in the context of an increasingly diverse body of students means there are legislative as well as demographic and student-oriented reasons to implement UDL,

2. The LMS has become a readily available tool in higher education, and millennial or net generation undergraduates are familiar with technological approaches. Other (nontraditional) learners may also find the predictability of an LMS supportive, and

3. The lack of foundational information both in terms of effective UDL delivery methods and in the availability of data that verify UDL's advantages and outcomes in the area of undergraduate student engagement.

UDL's emphasis on multiple means of engagement suggests this approach will improve student engagement among a wide range of learners. Could UDL approaches — delivered through the use of an LMS — assist in this effort?

Research Questions

1. Can an instructor at a liberal arts college in Northern Minnesota deliver Universal Design for Learning (UDL) using an established set of tools and features accessible through the electronic Learning Management System (LMS)?
2. What is the level of instructor efficacy delivering UDL using the tools and features of the LMS?
3. Does the UDL treatment lead to greater student engagement?

Assumptions

Since 2004, the college where this study took place made it a practice to automatically provide an LMS site to each instructor for every course the instructor was teaching. This ubiquitous access includes self-paced and moderated training opportunities and a 24/7 Help Desk dedicated to providing LMS support service for faculty and students. Students are automatically enrolled in the LMS site associated with each of their courses regardless of whether the course is taught via a face-to-face, hybrid, or fully-online format. A number of campus directors require on-ground faculty to use this LMS site on a supplemental basis, with the assumption faculty members are able to use the built-in tools and features of the LMS.

Based on this study, the LMS-facilitated treatment would be deemed valuable through measures of its ability to comply with UDL guidelines, through a positive level of instructor efficacy using this approach, and through verification of a statistically significant improvement in student engagement. By measuring the viability and usability of the LMS as a means to facilitate UDL approaches, this study explored an instrument by which a UDL design might be applied at the postsecondary level.

Definitions of Key Terms

Accessibility – A barrier free environment that allows maximum participation by individuals with disabilities (Center for Inclusive Child Care, 2010).

Adaptations – Changes in curricular content or conceptual difficulty or changes in instructional objectives and methods (Hallahan & Kauffman, 2006).

Curriculum Access – Under the IDEA, all students, regardless of their abilities, must be given the opportunity to become involved with and progress in the general education curriculum. Every student must have access to what is being taught. Providing access, however, involves much more than supplying every student with a textbook or a computer. Teachers must ensure students are actively engaged in learning; that is, the subject matter is cognitively challenging them, regardless of their developmental level.

Students with disabilities can be blocked from this interaction by an inflexible text that may inadvertently create physical, sensory, affective, or cognitive barriers. Even though they may have the same tools as everyone else, they do not truly have equal access to the curriculum. But there are several strategies educators can employ to give these students access, including using a curriculum that has been universally designed for accessibility (Orkwis, 1999).

Differentiated Instruction – Differentiated instruction addresses teaching and learning needs of students of differing abilities in the same class. The intent of differentiating instruction is to vary and adapt instruction in relation to individual and diverse students in classrooms (Tomlinson, 2001).

Digital Media – Digital media is electronic media that might include video, audio, images, or text. It offers tremendous flexibility because it enables teachers to differentiate

their approaches in a way that is not feasible when restricted to traditional media such as print-based text or images. With digital media, one piece of a curriculum (e.g., a webpage) can be designed with built-in customization features so that it can be adapted to suit many different students (Rose, Meyer et al., 2006).

Individuals with Disabilities Education Act (IDEA) – Reauthorized in 2004, IDEA replaced PL 94-142, enacted in 1975. This federal law requires that to receive funds under the act, every school system in the nation must provide a free, appropriate public education for every child between the ages of three and 21, regardless of how seriously he or she may be disabled (Hallahan & Kauffman, 2006).

Instructional Design – Instructional design refers to the analysis of learning needs and the systemic approach to developing an online course in a manner that facilitates the transfer of knowledge and skills to the learner through the use of a variety of instructional methods, which cater to multiple learning styles, strategies, and preferences (Illinois Online Network, 2006).

Learning Management System (LMS) – An LMS is a software system specifically designed and marketed for faculty members and students to use in teaching and learning. Most Course Management Systems (CMSs) include course content organization and presentation, communication tools, student assessment tools, grade book tools, and functions to manage class materials and activities. LMSs are also referred to as CMSs or Virtual Learning Environments (VLEs). For most faculty members, CMSs have been the primary entry point into using technology for instruction. These systems are also the major vehicle for offering online courses to students in universities and colleges throughout North America and increasingly, throughout the world (EDUCAUSE, 2003).

Common LMSs used in the higher education environment are Blackboard, Moodle, Desire2Learn, and eCollege.

Millennial Learner – The millennial generation was born from 1982 to approximately 2000. A broad spectrum of technological advancements have happened during their lifetimes, which will require extra effort and communication as millennial learners move out of high school and into the workplace or higher education (Holtz, 2007).

Scaffolding – In the area of education, scaffolding supports the individual learner in his or her own construction of knowledge. It can range from doing almost the entire task for the learner to providing occasional prompts or hints as to what to do next. Using this approach, the supports are removed as the learner is able to take on more and more responsibility (Collins, Brown, & Holum, 1991).

Section 508 – “Section 508” refers to a specific portion of the 1998 amendments to the Rehabilitation Act of 1973. It applies to all governmental information technology requiring that these technologies be accessible when used by federal agencies. Section 508 has no direct authority over public, nongovernment websites and other information technology implementations. Most institutions of higher education have voluntarily adopted these standards (Blansett, 2008).

Template – A guide or framework for designers (Wiggins & McTighe, 2006).

Universal Design (UD) – The design of new buildings, tools, and instructional programs to make them usable by the widest possible population of potential users (Hallahan & Kauffman, 2006).

Universal Design for Learning (UDL) – Two features essential to UDL are (a) the built-in tools that promote access for the range of learners; and (b) concurrent with the package of accessible tools, a flexible presentation of the general curriculum that can meet the needs of individual students. Rose and Meyer (2002) define UDL as a curriculum that

- represents information in multiple formats and media,
- provides multiple pathways for students' actions and expressions, and
- provides multiple ways to engage students' interests and motivation.

In this manner, UDL provides a framework for teachers to ensure that instructional strategies, curricula, and assessment are appropriate for a variety of learners to derive benefit from the learning experience (Council for Exceptional Children, 2005).

Universal Design of Instruction (UDI) – UDI can be discussed as a process, as a set of strategies applied to specific aspects of instruction, or as a goal (Burgstahler, 2006). Nine UDI principles were developed by researchers at the Center on Postsecondary Education and Disability at the University of Connecticut. The guidelines draw from those of UD, a concept pioneered by architect Ron Mace (Scott, McGuire, & Embry, 2002).

Zone of Proximal Development (ZPD) – The ZPD is the zone of learning or rigor in which the learner can solve problems with some additional support or guidance (Vygotsky, 1978).

Summary

The LMS offers accessibility features, built-in communication and authoring tools, an online grade book, and the ability to structure and organize information. In view

of UDL's emphasis on digital approaches, the LMS has potential as a tool by which postsecondary instructors can deliver UDL approaches as they supplement and extend the face-to-face classroom experience.

To explore this possibility further, the current study used UDL guidelines and a checklist involving 31 checkpoints from CAST to determine whether the LMS used by the college could support each of the three domains and associated checkpoints. Domains supported included Recognition with 12 checkpoints, Strategic with nine checkpoints, and Affective with ten checkpoints.

The goal was to establish a foundational information as to whether the LMS was conducive to UDL design and also to determine the level of instructor efficacy maintaining UDL using the LMS-facilitated approach. Concurrently, it seemed practical to explore UDL outcomes as the literature suggested this as an area of need.

Chapter 2. Review of the Literature

Background: Universal Design for Learning (UDL)

UDL is an inclusive approach to the design and delivery of instruction to all students. It was developed following the 1997 reauthorization of the IDEA, and at a time when the need for inclusion was gaining strong momentum in the United States. “Issues associated with access to the curriculum were at the forefront of CAST’s work, and in 1999 federal grant monies were awarded to establish the National Center on Accessing the General Curriculum” (Edyburn, 2010, p. 33). Since then, and with the strong support from the National Center, CAST’s work and the initiative known as “UDL” has continued to grow more prominent as a prescribed approach to teaching and learning in higher education.

According to CAST (2012),

UDL provides a blueprint for creating flexible goals, methods, materials, and assessments that accommodate learner differences. Universal does not imply a single optimal solution for everyone. Instead, it is meant to underscore the need for multiple approaches to meet the needs of diverse learners. (para. 3)

UDL had its strongest start in the PK-12 education setting (Izzo et al., 2008). Past outreach efforts focused on educators in the PK-12 field, and CAST continued to develop accessible and universally designed products targeted to the diverse needs of the PK-12 level of learner. Wiggle Works, Thinking Reader, Science Writer, and Reading to Learn are just a few of the many technology-based products developed by CAST for the K-12 learner.

UDL is informed by the early work of Vygotsky (1978), who identified three prerequisites for learning: (a) the need to recognize patterns in perceptual information, (b) the need to apply strategies for acting on the perceived patterns, and (c) the need to be engaged by a task. UDL is also informed by more recent research on brain function made possible by neuro-imaging techniques such as PET scans (Rose & Meyer, 2002).

The UD movement, initiated by architect Ron Mace, sought to make the physical environment universally accessible; this was also a major influence on the development of UDL (CAST, 2010a; Rose & Meyer, 2002). However, specific to UDL is its emphasis on providing equal access to the curriculum in cognitive and pedagogical ways as well as physical accessibility measures (Rose & Meyer, 2002). UDL's three domains are expressed in a checklist developed by CAST (2010b) to assist educators in the process of developing UDL-compliant instruction. The checklist, which was researched and developed by CAST, organizes the approach to providing UDL according to the three domains of Representation, Expression, and Engagement. An array of suggestions is provided under each of the three categories (see Appendix A for the 2010 version of the UDL Checklist).

Although UDL is sometimes confused with UD, Universal Instructional Design (UID), and Universal Design for Instruction (UDI), they are separate constructs and emerged from different organizations. UD emphasizes physical access, whereas UDL, UID, and UDI specifically relate to approaches in education designed to ensure universal access to the curriculum. While physical access is an essential beginning, genuine learning requires cognitive (or intellectual) access as well (CAST, 2010a).

Extension of UD in architecture. The term Universal Design was coined by Mace, who was an architect and director at North Carolina State University (NCSU). UD in the physical environment (products and architecture) involves seven principles, and led to such widespread and usable innovations as closed captioned television, curb cuts and speaker phones (CAST, 2010a; Jimenez, Graf, & Rose, 2007). See Table 1 for an outline of the seven principles of UD.

Table 1

Seven Principles of Universal Design (UD)

1. Equitable use	The design is useful and marketable to people with diverse abilities.
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities.
3. Simple and intuitive	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue.
7. Size and space for approach	Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Note. Center for Universal Design. (2008). Retrieved from <http://www.cud.org>

Meanwhile, UDL as described on the CAST (2010a, 2010b) website seeks to provide cognitive access or access to the curriculum as it seeks to meet the needs of all students, including those with disabilities. CAST’s research describes three brain networks — Recognition, Strategic, and Affective — and how each of those networks or domains correlate with UDL principles and approaches to meet the wide-ranging needs of students. See Table 2 for an overview of each of three brain networks and the UDL principle associated with it.

Table 2

Three Cognitive Domains and Three Principles of Universal Design for Learning (UDL)

Brain Network	Associated UDL Principle
<p>Recognition networks</p> <p>Gathering facts. How we identify and categorize what we see, hear, and read. Identifying letters, words, or an author’s style are recognition tasks — the “what” of learning.</p>	<p>Multiple means of representation</p> <p>Give learners various ways of acquiring information and knowledge.</p>
<p>Strategic networks</p> <p>Planning and performing tasks. How we organize and express our ideas. Writing an essay or solving a math problem are strategic tasks — the “how” of learning.</p>	<p>Multiple means of action and expression</p> <p>Provide learners alternatives for demonstrating what they know.</p>
<p>Affective networks</p> <p>How students are engaged and motivated. How they are challenged, excited, or interested. These are affective dimensions — the “why” of learning.</p>	<p>Multiple means of engagement</p> <p>Tap into learners’ interests, challenge them appropriately, and motivate them to learn.</p>

Note. Each principle of UDL aligns with a cognitive domain as described on the CAST website: www.cast.org/research/udl/index.html

Digital Media and UDL

Inherent in UDL's design and its ability to support diversity is its emphasis on technology as a flexible and powerful means of delivery. "The flexibility of digital media and the varied resources available on the World Wide Web provide great opportunity for individualization" and makes it easier to customize teaching and learning through the provision of multiple alternatives (CAST, 2010a, para. 18). Two researchers from CAST (Rose & Dalton, 2009) suggest diverse learners benefit from the use of digital text that offers flexible features such as an audio option, variable text size and color display, and scaffolds such as the option to pursue hyperlinked definitions.

In considering traditional undergraduates, both the literature and experiential evidence affirm students are comfortable and accustomed to technology in education. Kvavick (2005) describes the landscape relating to student preference for technology in postsecondary education. Based on a survey of over 400 students, Kvavick (2005) states the majority of students prefer a moderate level of technology.

Technology has become a linker and a driver which (when accessible to all) has the potential to make education — and indeed the world — *flat* (Friedman, 2004).

Much has been made about the new generation of technology savvy students currently in and entering college. These students possess unprecedented levels of skill with information technology; they think about and use technology very differently from earlier student cohorts. They are characterized as preferring teamwork, experiential activities, and the use of technology. Prensky calls them "digital natives," referring to the fact that they have grown up with technology as opposed to "digital immigrants" who did not. (Kvavick, 2005, p. 1)

Specifically highlighting opportunities for students to learn through their interaction with digital media, one proponent for the flexibility and use of technology in education states “good video games incorporate good learning principles, principles supported by current research in cognitive science” (Gee, 2005, p. 34). Video games and similar computer-based instructional approaches can often be customized to fit the learning and playing styles, capabilities, and interests of the individual, making these digitally-based approaches consistent with the multiple means of representation, engagement, and expression that are the hallmarks of UDL (Howard, 2004; Pisha & Coyne, 2001).

Prensky (2005), who coined the terms *digital native* and *digital immigrant*, also urges educators to consider the demands, expectations, and needs of students today. Students have grown accustomed to working and playing in a digital environment where they have choices and can pursue interests or select options that most engage them. In an article entitled *Engage Me or Enrage Me*, Prensky (2005) contrasts this with traditional education, suggesting educators need to engage students with the help of flexible digital technologies or run the risk of alienating them altogether. “We have to find out how to present our curricula in ways that engage our students — not just to create new ‘lesson plans,’ not even just to put the curriculum online” (Prensky, 2005, p. 62).

From an instructor standpoint, the use of technology in teaching elicits a wide range of responses. In his *Diffusion of Innovations*, Rogers (2003) points out instructors are often at different levels in terms of their willingness and ability to embrace innovations such as the use of technology as a teaching tool. Under Rogers’ theory, categories include innovators, early adopters, early and late majorities, and laggards. The

early adopters and innovators may have high expectations for an intervention that will involve powerful and sophisticated digital technologies (Gee, 2005; Twigg, 2003).

Meanwhile, the faculty members who are considered laggards, and even some from the early and late majorities, need tools and strategies are easy to use and this is especially true if a technology-based innovation such as UDL is to achieve widespread application and sustainability (Getzel, 2008; Sapp, 2009).

Partly by virtue of the fact it employs digital approaches to teaching and learning, UDL has the potential to improve access to learning just as UD has improved access to the physical environment (Pisha & Coyne, 2001). Many instructors recognize this, and are seeking to explore the benefits of UDL (Burgstahler, 2006; Edyburn, 2010, Izzo et al., 2008). These same instructors may also be drawn to the fact that, as part of its inherent design, UDL fulfills the student appetite for digital approaches to teaching and learning (Gee, 2005; Holtz, 2007; King-Sears, 2009; Kvacick, 2005; Prensky, 2005).

Some of the digital immigrant faculty members may be coming from the baby boomer generation, known in part for the fact that their younger years involved less ubiquitous access to technology (Holtz, 2007; Prensky, 2005). Many of the over 80 million baby boomers are starting to retire (Holtz, 2007) and faculty developer Rouseff-Baker (2002) notes “a new generation is taking their place in the faculty ranks” (p. 35). Meanwhile, based on several recent studies, “many faculty members struggle with how to meet the learning needs of increasing diverse and technologically expectant students” (Izzo et al., 2008, p. 67). However, technology integration and innovation is not the domain of any one generation, and research indicates many long-time faculty members

are increasing their use of technology in an effort to meet the needs and preferences of today's students (EDUCAUSE, 2003, 2008a, 2008b; Kvavick, 2005).

UDL and Student Engagement

Student engagement is valued as an important component of the teaching and learning process and of the college experience overall. For many years, the Center for Postsecondary Research has involved colleges and universities nationwide in a survey designed to “enrich the discourse about college quality and to provide diagnostic information to support the improvement of undergraduate education” (Gonyea, 2010, p. 3). Known as the NSSE, the survey seeks to understand and establish elements and strategies for student engagement.

UDL also emphasizes the importance of student engagement, and one of its three core principles is an instructional environment that provides students with multiple means of engagement (CAST, 2010b, 2012; Rose & Meyer, 2002). In discussing student engagement, Kuh, Director of The Center for Postsecondary Research and one of the founders of the NSSE, states student engagement is measurable based on “the time and energy students devote to educationally purposeful activities” (Gonyea, 2010, p. 4).

“Teachers who create *multiple means of engagement* support affective learning by tapping into learners' interests and offering appropriate challenges to increase their motivation” (Jimenez et al., 2007, p. 45). UDL's emphasis on student engagement emerged not simply from the intuitive instincts of teachers. It also builds upon recent findings in brain research and the earlier work of Vygotsky, whose discussion of individual differences among learners, a ZPD, and three domains of learning informs and

is compatible with CAST's construct of UDL (CAST, 2010c; Pisha & Coyne, 2001; Rose, Harbor et al., 2006; Rose & Meyer, 2002).

Author and expert on student engagement techniques Barkley (2010) argues because higher education today is so “astonishingly diverse,” the elements of the dialogue on student engagement vary across institutions, classrooms, instructors, and students (p. 3). Additionally, “teachers must find ways to engage students not only in traditional face-to-face courses but also in courses taught partially or wholly online” (Barkley, 2010, p. 3).

In light of this situation in which different students and different environments may require varying and diverse means of engagement, UDL's approach has the potential to address this diversity through its emphasis on multiple means of engagement. The demand for approaches that will engage students with a wide range of interests and abilities is compatible with the inherent design of UDL (CAST, 2010b, 2010c; Rose & Meyer, 2002). Indeed, by building a diverse range of engagement strategies into the initial planning and design of a course, the UDL approach promises to avert the need for sudden adjustments or adaptations and promises to have universal yet individualized appeal from the outset (Pisha & Coyne, 2001).

Speaking of their own implementation of UDL with a class of Harvard students, Rose, Harbour, et al. (2006) suggest a need for further research on UDL's impact on student engagement, saying we “currently do not evaluate this third goal [student engagement] systematically enough” (p. 140). Suggested approaches for addressing the affective domain and the need for varied means of engagement include the delivery of

content that supplements and enriches core content, addresses variable zones of proximal development, and provides choices.

Scaffolding. The concept of scaffolding has been applied in the field of education as a means of providing temporary support for learners as they increase their mastery to the point where they outgrow their need for the original support. According to Stronge (2007), scaffolding is an effective instructional approach because it allows students to obtain needed help and to work at a pace most effective for them. Anghileri (2006) studied the use of scaffolding in a universally designed college-level mathematics course and states this approach helps the learner to develop a sound foundation with increasing independence as understanding becomes more secure.

In a discussion on how to promote student engagement in learning, Stronge (2007) mentions the value of guided practice, step-by-step instructions, and self-regulation. Shernoff, Csikszentmihalyi, Schneider, and Shernoff (2003), who were also referenced by Stronge (2007), investigated the conditions under which high school students reported being engaged. “Participants experienced increased engagement when the perceived challenge of the task and their own skills were high and in balance” (Shernoff et al., 2003, p. 158). Zepke and Leach (2010) state, in the higher education setting, engagement is one indicator of student success.

“For learning to take place, the material must be challenging enough to engage students’ interest, but not so challenging that they become frustrated and give up” (Howard, 2004, p. 26). Instruction that provides scaffolding to support a range of learners is consistent with the emphasis on student engagement.

Differentiated instruction. Differentiated instruction is an instructional process that has excellent potential to positively impact learning by offering teachers a means to provide instruction to a range of students in today's classroom situations (Hall, Strangman, & Meyer, 2010). Differentiation is grounded in the work of Vygotsky (1978) and the ZPD. It endorses flexible responses to student differences in readiness, interests, and learning needs.

Differentiated instruction emphasizes the importance of student engagement and encourages teachers to develop lessons that will engage and motivate a diverse classroom of students. This model advocates a shared foundation or core of knowledge and then uses flexible groupings in which students interact and work together to develop knowledge of new content. Described by Tomlinson (2001), groupings are not fixed but instead the grouping and re-grouping process needs to be a dynamic process that changes with the project, content, and ongoing evaluations. As part of the instruction itself, tasks should be varied. For example, a session should not consist of all drill and practice or any single activity.

In discussing the convergence between UDL and differentiation, Hall et al. (2010) emphasize the complementary nature of the two constructs stating, "when combined with the practices and principles of UDL, differentiated instruction can provide teachers with both theory and practice to appropriately challenge the broad scope of students in classrooms today" (p. 20).

Inclusion and Government Endorsement of UDL

The Americans with Disabilities Act (ADA) is considered to be one legislative force that helped drive the development of UD in the built environment. More recently,

legislation continues to evolve with the idea of a least restrictive environment (LRE), widespread access to the general classroom and more recently, strategies that promote universal access to the cognitive domain of the curriculum itself as distinct from the types of physical access associated with ramps, curb cuts, and other types of structural accommodations.

Today, it is unimaginable that any public building would be built without multiple means of access incorporated in the design; new buildings are smarter than old buildings. What has been done in the physical world of architecture can also be accomplished in the more abstract world of knowledge. (Pisha & Coyne, 2001, p. 203)

On a legislative level, this vision of UD for learners who seek to access the general curriculum had its early roots in P.L. 94-142 (Education of All Handicapped Children Act), which was established in 1977 and specified the provision of a LRE to ensure that, to the maximum extent appropriate, children with disabilities would be educated with those who did not have disabilities.

In 1997, the protections initiated in the 1975 Education of All Handicapped Children Act were strengthened and reauthorized through the establishment of the IDEA. The law continued to contain strong language intended to guarantee student access to the general curriculum and the 2004 IDEA calls for students with disabilities to have access to the general education curriculum within general education classrooms as the most appropriate method of providing special services within the least restrictive environment. However, in their article on the promise of UDL, Jimenez et al. (2007) cite the assertions of Artiles (2003) and Wehmeyer (2006), who suggested, “merely providing students with

disabilities access to general education programs does not ensure their full acceptance within these settings or guarantee meaningful participation or comparable outcomes” (p. 43).

“Now more than previously, IDEA calls for students with disabilities to have access to general education curriculum within general education classrooms” (Jimenez et al., 2007, p. 43). Jimenez et al. also note the 2001 No Child Left Behind Act ([NCLB], U.S. Department of Education, 2003) required all children, including those with disabilities, attain proficiency on state standards and assessments. Such legislation has resulted in the increased inclusion of students with disabilities in the general education setting, and an average classroom environment that has become more diverse than ever before (Jimenez et al., 2007).

More recently, and of specific relevance to postsecondary institutions, the HEOA — reauthorized in 2008 — also recommends UDL as a valid approach. The law specifically mentions UDL as opposed to other constructs in education. It provides financial incentives for implementation by tying Pell grants and other forms of federal funding to UDL. The HEOA includes the following description in its reauthorization:

Universal Design for Learning – The term ‘universal design for learning’ means a scientifically valid framework for guiding educational practice that –

(A) Provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways in which students are engaged; and

(B) Reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement

expectations for all students, including students with disabilities and students who are limited English proficient. (GovTrack.us, 2008, n.p.)

“Universal Design for Learning has finally made center stage in the national world of education” (Jimenez et al., 2007, p. 46). However, as Edyburn (2010) notes, the educators themselves may not be ready to learn and teach using this new approach.

UDL in Higher Education

In considering UDL at the higher education level, Getzel (2008) states, “Students benefit when faculty incorporate concepts of universal design into their instruction and curriculum” (p. 207), but notes it is often challenging for faculty members to know how or where to begin. Instructors, administrators, and disabilities services professionals may also have difficulties recognizing and defining UDL, and many educators wonder how they can implement it in their own practice (Edyburn, 2010).

Academic deans, department chairs, program directors, those who manage centers for teaching and learning, and academic technology coordinators may seek to encourage and promote the adoption of UDL. However, if UDL concepts are not explained and supported, it may be difficult to ensure this inclusive and digitally-based approach can be applied and sustained in K-12 or higher education settings (Edyburn, 2010).

Implementation Challenges

While the need for implementing and evaluating UDL in the higher education setting has been emphasized (Burgstahler, 2008; Edyburn, 2010, Getzel, 2008; Izzo et al., 2008; King-Sears, 2009; Rose, Harbour et al., 2006), the front line of faculty members who would implement it may be entirely unaware of this suggested approach. If they are aware of it, they may not know how or where to begin (Edyburn, 2010; Izzo et al., 2008).

Citing the benefits of new technologies and teaching strategies, Getzel (2008) states, “One of the promising practices for effective teaching and accessibility of instruction at the college level is the application of universal design methods” (p. 213). However, at the same time, Getzel emphasizes faculty members’ need for support in implementing technology-enhanced instruction. “As greater numbers of students enter college with diverse learning and support needs and as new technologies and teaching strategies emerge, there is a need to continue building and expanding professional development on instructional strategies for faculty” (Getzel, 2008, p. 213).

It has been noted postsecondary instructors often feel untrained and unprepared to meet the challenges of instructional design. “Higher education is an interesting field in that many individuals within the academy are prepared for only some of their day-to-day responsibilities” (Zakrajsek, 2010, p. 83). Indeed, in the area of teaching and learning many faculty members may have only made intuitive use of instructional design, and others may be unfamiliar with the term or the concept of UDL (Edyburn, 2010).

Edyburn (2010) stresses the potential pitfalls and frustration that may occur in the effort to translate UDL theory into practice, saying, “I am concerned about the ability of the profession to implement a construct that it cannot define” (p. 33). In the effort to address this challenge and provide faculty members with satisfying approaches to implementing UDL in their own instruction, Izzo et al. (2008) note, “Additional research is needed to validate the impact of the UDL approach and strategies on student learning outcomes and to determine the most efficient and effective means of providing this information to faculty” (p. 69).

Special educator Baldwin (2009) describes a template as a software-based program that allows the instructor to adjust and adapt material in such a way that it matches the needs of a specific individual's curriculum. Baldwin speaks of the power of templates as a means to allow educators to easily create customizable instructional activities.

Gerrard (2007) and Sapp (2009) describe projects in which the LMS with its digital environment, toolset, and features was applied to support students with special needs. The hybrid prototype described by Sapp (2009) specifically seeks to generate a learning environment that is consistent with UDL: "The Universal eLearner is an online integrated learning module, under development, that incorporates accessible technology universal design for learning, and best practices for online education" (p. 495). Sapp (2009) notes the Universal eLearner is not a finished product but rather the outcome of a grant-funded project conducted by Bridge Multimedia and the American Foundation for the Blind. The grant was funded through the National Institute on Disability and Rehabilitation Research, U.S. Department of Education. In her United Kingdom-based study, Gerrard (2007) explains recent Special Educational Needs and Disability Act (SENDA) legislation led to the consideration of how the University of Paisley's use of an LMS might support students with special needs and promote compliance with national laws.

In 2002, the university adopted the Blackboard VLE, and it was realized that the use of this technology could go some way towards meeting the demands of SENDA. VLE software companies such as Blackboard, WebCT, First Class, have accessibility policies to ensure that their products are in compliance with

international legislation such as SENDA in the United Kingdom and the Disability Services Act in Australia. (Gerrard, 2007, p. 201)

In order to ensure the success of UDL on the postsecondary level, faculty developers, academic technology coordinators, instructional designers, and instructors may need to devise approaches that can streamline faculty implementation efforts and improve the likelihood of instructor efficacy and associated plans for continued implementation of this federally-mandated intervention (Edyburn, 2010; Getzel, 2008; Rouseff-Baker, 2002).

UDL Approaches Using a Learning Management System (LMS)

An LMS is generally designed to provide faculty members with powerful features, and the ability to select from a wide array of organizational tools (e.g., calendar, syllabus, instructor contact page) and teaching and learning options (online discussions, journals, wikis, web meetings, instructional videos). In keeping with Section 508, the 1998 amendment of the Rehabilitation Act requires federal agencies to make their electronic and information technology accessible to people with disabilities (Section 508.gov, 2010). Specifically, Blackboard has designed and tested its LMS in an ongoing effort to maintain system accessibility. In establishing and measuring the LMS design, Blackboard refers to Section 508 of the Rehabilitation Act and also the Web Accessibility Initiative from W3C (Blackboard, 2012). The elements provided by Blackboard seemed to promote the ability to establish and maintain of a UDL-compliant intervention using the LMS.

Some instructors may express an initial hesitance to use these LMS tools and environments. However, the intent of those who develop LMS technology is to make

these systems as intuitive and easy-to-use as possible. The increasing use of these systems may provide some evidence of their utility (EDUCAUSE, 2008a, 2008b).

As secure, electronic websites are accessible via the Internet, the LMS provides a digital framework consistent and compatible with many flexible and technologically-based UDL tools and venues (Gerrard, 2007; Rose & Meyer, 2002; Sapp, 2009). Built-in features support the option for student-instructor communication, the posting of course content and multimedia resources, support for the development and distribution of online tests and surveys, and the option to provide individual grade information to students.

LMSs in general have become a standard and readily available technology tool at the postsecondary level. LMSs (sometimes called VLEs or CMSs) are a practical solution postsecondary instructors can use to supplement their courses because they are built to have flexible features, secure access, and ease-of-use.

The LMS or website has also been explored specifically as a means of delivering UDL in higher education classrooms. Rose et al. (2008) describe a project that made extensive use of a supplemental website to support UDL-delivery of a graduate course in education, and Sapp (2009) reviews data describing the Universal eLearner, the prototype developed as part of a government-funded project to develop, implement, and evaluate a specially constructed hybrid LMS that may be used as an accessible/UDL delivery tool. The specialized LMS was originally used with PK-postsecondary learners. It was funded by the National Institute on Disability, and involved collaboration between the American Foundation for the Blind and Bridge Multimedia (Sapp, 2009).

Commercial LMSs are common in the higher education setting (EDUCAUSE, 2008a, 2008b; Twigg, 2003), and these two intensive projects described by Rose et al.

(2006, 2008) and Sapp (2009) suggest the possible value of using a commercial LMS, such as Moodle or Blackboard, to assist college faculty in efforts to improve student engagement and satisfaction through the provision of UDL. The two approaches and outcomes are described below, and include:

1. Delivery of UDL through a course website developed and used at Harvard University;
2. A preliminary description of a grant funded project involving the design of a hybrid LMS to deliver UDL benefits to PK-postsecondary learners.

Delivery of UDL through a course website developed and used at Harvard University. In a 2008 article, “Universal Design for Learning in Postsecondary Education,” Rose et al. (2008) describe a UDL project involving T-560, a large, lecture-based, graduate-level course taught at Harvard University. The writers acknowledge research and application have lagged behind theory with regard to the implementation of UDL in higher education. However, UDL principles associated with the design of T-560 were practical in their use of readily-available digital technologies to address multiple means of representation, expression, and engagement. In prefacing their description of the project, the authors state:

Despite recent attention to universal design in higher education research by the Association on Higher Education and Disability (AHEAD, a professional organization for disability services providers), there has been a general lack of interdisciplinary attention on the part of postsecondary faculty. (Rose et al., 2008, p. 138)

In implementing their design and expanding on all the aspects of learning, the lecture, readings, and other media and activities associated with T-560 were included on a blog-based course website. This allowed instructors the use of a predictable set of tools as well as the development of a resource that was available to support students around the clock and on an ongoing basis.

According to the researchers' (Rose et al., 2008) description of the project, specific features of the UDL design of this course addressed the three domains or principles of UDL. For example, content was delivered through face-to-face lecture, as well as posted notes and videos. Students had several options for representing their knowledge, and their means of engagement with the material was likewise varied.

The article describing Harvard's implementation of a UDL design for T-560 does not include any mention of research that measured outcomes such as perceived student learning, engagement, or the ease of use from a faculty perspective. However, the authors (Rose et al., 2006, 2008) did provide observations and anecdotes relating to the most effective features and innovations of the course, including online discussions, posted notes from students, and video recordings of class sessions available online for review.

In a longer article describing the same project (Rose, Harbour et al., 2006), the authors provided visual examples of UDL principles in action via the variety of lecture notes that were shared by students with different means of representation, expression, and engagement. Both the 2008 book chapter (Rose et al., 2008) and the 2006 article in the *Journal of Postsecondary Education and Disability* (Rose, Harbour et al., 2006) conclude with an affirmation of UD as it relates to both cognitive and physical access to the

curriculum, suggesting UDL has the potential to benefit the full range of students regardless of whether they have a disability or not.

Delivery of UDL via a hybrid LMS for PK-postsecondary learners. Separate from the efforts of Rose et al. (2006, 2008) in their use of an online website or blog, Sapp (2009) describes the Universal eLearner as “an online integrated learning module, under development, that incorporates accessible technology, UDL, and best practices for online education” (p. 495). Thus far, this specially-designed LMS had been developed and field tested with students’ visual impairments as well as those with learning and orthopedic disabilities.

The intent behind the design of this grant-funded system is to support the inclusion of students with disabilities who may have difficulties accessing the content and media that is employed in most general education classrooms. The prototype version of this specialized LMS was field tested with fifth graders, and centered on a social studies unit that used educational content and materials from Pearson Digital Learning.

Sapp (2009) emphasizes the importance of both access and comprehension, and cites Rose and Meyer (2002) with the observation that most applications of UD in such materials have focused on providing access through design features that work with screen readers or additional options, such as captioning. With the Universal eLearner, multiple levels of captioning as well as audio descriptions are included and the content is crafted by a publisher to ensure the inclusion of educational videos that conclude with end-of-chapter summaries designed to help students organize their knowledge and boost comprehension.

In verifying the basic programming and accessibility features are in place, Sapp (2009) concludes her evaluation of the Universal eLearner LMS saying, “The next step in the development of this product is to evaluate whether the new accessibility features to enhance comprehension are effective” (p. 499). In keeping with the concept of UD, the issue of physical access has been addressed through the assistive technology features of this product, leaving the developers with the need to address cognitive or intellectual access to the curriculum.

Summary

Postsecondary faculty members are often busy with both long-range and day-to-day obligations, and they may be left with little discretionary time. In an article on how to support college faculty members throughout their career, Austin (2010) states faculty members often experience work-life balance issues, saying, “While time management was a challenge during the early career, time pressures can become even greater at mid-career” (p. 372). Along with the ongoing teaching and learning they orchestrate, it may be a challenge for instructors to devote the time required to identify, master and implement effective approaches to UDL.

UDL offers an effective approach to teaching and learning, and promises to promote a high level of engagement among all learners, including — but not limited to — those with special needs (CAST, 2010b; Pisha & Coyne, 2001; Rose, Harbour et al., 2006, 2008; Rose & Meyer, 2002). By tapping the benefits of digital media and UDL’s flexible and accessible design, instructional environments can be supportive at the outset, and can diminish the need to respond reactively as each new need is discovered.

In two separate investigations, researchers Gerrard (2007) and Sapp (2009) studied and described how an LMS may be used to provide UDL benefits to students. However, these studies limited themselves to those with special needs and did not seek to systematically explore instructor efficacy with the approach or outcomes of UDL in terms of student engagement or some other benefit to students. The charge to implement UDL in higher education has been sounded (Jimenez et al., 2007); those who seek to implement UDL with entire classrooms of students need practical approaches that will be satisfying and effective (Edyburn, 2010; Getzel, 2008; Izzo et al., 2008).

This research explores whether the LMS can be used to provide UDL approaches and to determine the instructor's level of efficacy in applying and maintaining the UDL treatment throughout the semester. Additionally, the study sought to determine whether the treatment led to greater student engagement.

Despite pressure from the HEOA and evidence that students need UDL approaches due to their increasing diversity, postsecondary instructors may not be able to find the time or have the expertise to implement UDL solutions. A strategy involving the use of the UDL checklist as well as the use of tools and features available through an accessible LMS may offer a solution to this challenge.

Chapter 3. Methodology

Introduction

This study contributed to the research clarifying UDL's outcomes in terms of its benefits to learners. At the same time, it tested whether an LMS could serve as a successful conduit for UDL approaches as described by CAST (2012). As part of this process, it also sought input from the professor by asking her to evaluate and track her level of efficacy using the LMS to provide UDL throughout the fall 2011 semester.

The purpose of this chapter is to describe the rationale, method, design, and procedures used in this quantitative research.

Statement of the Problem

Teachers at the postsecondary level face challenges in effectively instructing and engaging an increasingly diverse population of students. As more ELL and students with special needs enter postsecondary education, the need for expanded interventions and support becomes evident. During the transition to a time when colleges and universities will need to support a more diverse student population, institutions of higher learning run the risk of leaving learning needs unmet as they struggle to forge new strategies and operating procedures that are reliable and consistent. Meanwhile, thanks to innovations in instructional technology and a generation of millennium students who can avail themselves of (and even expect) technology-delivered instruction and support, the climate is right for a technologically-facilitated delivery of UDL.

UDL is considered a *scientifically valid* approach for instructors at the higher education level (GovTrack.us, 2008; H.R. 1350, 2004). UDL is endorsed as an inclusive

approach and a means of improving the student experience, yet there is a lack of research clarifying UDL's outcomes (Edyburn, 2010). UDL has been emphasized in both the National Educational Technology Plan (ISTE, 2010) and the HEOA (GovTrack.us, 2008). However, there is a need for more student outcome data as well as for practical strategies that will allow instructors to implement UDL in their own practice (Edyburn, 2010; Getzel, 2008; Izzo et al., 2008).

Research Questions

The current study explored the following research questions:

1. Can an instructor at a liberal arts college in Northern Minnesota deliver Universal Design for Learning (UDL) using an established set of tools and features through the electronic Learning Management System (LMS)?
2. What is the level of instructor-efficacy delivering UDL using the tools and features of the LMS?
3. Does the UDL treatment lead to greater student engagement?

Research Methodology

This study sought to generate objective information relating to whether or not the supplementary use of the LMS can provide traditional undergraduates with UDL approaches, what level of efficacy is experienced by the instructor implementing this approach, and whether the level of student engagement seems to change over time based on the presence or lack of a UDL supplement in the LMS.

When crafting studies that seek to establish causality such as whether a UDL treatment suggests an increase in student engagement, Fitzpatrick, Sanders, and Worthen (2011) indicate, "A quantitative approach might be used to determine if, in fact, the

causal mechanisms or effects hypothesized by the theory actually did occur” (p. 118).

Other data generated as part of this study involve the application of authoritative guidelines (CAST, 2012), expert validation, and self-reports that are quantified through the use of a 1- to 5-point scale.

A randomized design is widely considered the best way to select samples for a given study. However, at most colleges and universities, students register by selecting their preferred section of a given course. For that reason, it was not practical to conduct a randomized experimental study. Therefore, a quasi-experimental approach involving two sections of like groups (undergraduates taking BIO 1110 in Section 001 and those in Section 002) was used to provide control and treatment groups. The need to compare like groups, identify their responses to different experiences, and generate data indicated the value of a comparison group design (Fitzpatrick et al., 2011).

As part of this study, an independent evaluator was involved to provide inter-rater reliability. This independent evaluator has a Ph.D. in Instructional Design and is extremely knowledgeable in LMS-design. She evaluated UDL approaches of the instructor’s previous LMS design as well as of the design that was established after UDL training and resources. Then, throughout this 16-week course in general biology, the instructor monitored her own efficacy in implementing UDL approaches, using a self-report to express her level of efficacy with UDL on a scale of 1-5. Instructor efficacy was documented using the Instructor Response Form (see Appendix B) which also provided a listing of all UDL domains, guidelines, and checkpoints.

To ensure the treatment site was consistent with UDL, the site was validated six times by the investigator and an independent Instructional Design consultant using the

UDL Validation Form (see Appendix C). During those times, the instructor's self-report was also reviewed and assertions made by the instructor on the Instructor Response Form were confirmed. Observations can be qualitative or quantitative in nature, and are essential to almost all evaluations. (Fitzpatrick et al., 2011). In the current study, quantitative observations were used and involved the application of a UDL checklist from CAST as well as the use of numeric rating scales combined with expert validation.

Research Design

The study took place at a liberal arts college in Northern Minnesota in fall 2011. Participants included the instructor of two sections of Biology 1110: General Biology and 157 students enrolled in those two sections. The instructor had five years' experience teaching at the college, and had used the LMS as a supplement during each of those five years.

Section 001 included 77 students and provided the control. This section met in the Science Auditorium at 8:00 a.m. every Monday, Wednesday, and Friday for lecture-based instruction involving slide presentations and the use of digital ink annotations to emphasize key points in a visual way. As part of their experience, the control group had access to a supplemental LMS site based on the site previously developed and used by the instructor. The LMS control site was not consistent with UDL approaches.

Section 002 included 80 students and provided the treatment. Class for this section met in the Science Auditorium at 10:15 a.m. every Monday, Wednesday, and Friday, and the lecture-based instruction was identical to that provided in Section 001. The LMS site for students enrolled in the treatment group was designed to meet all aspects of the UDL guidelines and checklist from CAST. UDL's 31 checkpoints were

spread across three domains – Representation (12), Strategic (nine), and Affective (ten) – and the UDL treatment site met all 31 of these checkpoints.

Differences between the experiences of students in the two sections centered on the instructor's variable design of the two LMS sites. All BIO 1110 students were able to log into Blackboard to access the LMS site associated with their section. However, the main difference centered on whether they were enrolled in Section 001 (control) or Section 002 (treatment). The in-class lectures as well as all lab experiences were consistent with one another. Students were not prevented from attending the alternate lecture session, and due to a separate registration for lab sections, BIO 1110 students in Section 001 and Section 002 were co-mingled throughout eight lab sections.

At the liberal arts college where the study was conducted, LMS sites are automatically generated for every course listed by the Registrar. As a result, traditional faculty sometimes use the system to supplement their face-to-face courses. The instructor involved in this project had taught BIO 1110 for several years, and had used the LMS as a supplement for several years prior to the study. In addition to the student treatment group's responses to the UDL intervention, the ability to establish a UDL-compliant site in the LMS and the level of efficacy experienced by the implementing instructor were topics of inquiry during the study. The LMS sites were configured as follows for control versus treatment:

Table 3

Configuration of LMS Sites

Blackboard LMS Site used to Supplement BIO 1110: General Biology	
Section 001: Control	Section 002: Treatment
Course Content (including lecture slides, instructor annotations, sample quizzes, and a link to textbook website)	Announcements
In-Course Messages	Course Information
Student Grades	Calendar
	Course Content (including lecture slides, instructor notes, sample quizzes, multimedia resources from textbook, and broken out by unit)
	Virtual Office
	Student Collaboration Room (learning games, meeting/discussion area)
	Send Email
	Glossary
	Enriching Resources (videos, websites, journals)
	Student Grades

In Section 001, the instructor used the LMS to supplement her course as she had done in the past. The Section 002 LMS site used UDL approaches. The instructor received resources and training in UDL from the investigator, and had ongoing access to materials provided by CAST.

The control site was similar to the supplemental approach used by the instructor in previous years. Prior to the beginning of the semester, the control site was evaluated using the UDL Validation Form (see Appendix C), and found to lack multiple means of representation, action/expression, and engagement and to thus be inconsistent with UDL approaches. Using CAST's (2012) guidelines and checklists to guide its design, the LMS

site for the treatment group was established and verified as consistent with UDL approaches. Initially and as the course proceeded, the instructor ranked her level of efficacy on a 1-5 scale and specified her application of UDL using a form describing specific UDL approaches. The fidelity of the design was also evaluated by the investigator as well as by an independent instructional designer.

The ability to establish an LMS site consistent with UDL was evaluated through a comparison of the LMS control site the instructor created prior to the UDL training and access to resources from CAST. Instructor efficacy was measured by the instructor using the Instructor Response Form (see Appendix B) which includes a level of efficacy (self-report) scale of 1-5. Each time the form was completed by the instructor; the UDL strategies noted by the instructor were also validated by the investigator. To ensure inter-rater reliability as well as fidelity of the UDL design, the UDL Validation Form (see Appendix C) was completed initially by an independent Instructional Design Consultant, a few changes were made to the site, and the form was used to guide site reviews for an additional five times throughout the study.

A pre- post- design using the validated SCEQ was used to measure student engagement (see Appendix D). Students in both the control and the treatment groups completed the SCEQ in-class during the first full week of classes and again at the end of the semester. Results were analyzed using a non-directional t-test at .05 significance.

Participants and Sampling Procedure

In keeping with the literature's emphasis on how digital approaches are readily adopted and used by younger students, the research was conducted in an undergraduate-level course in general biology. This sampling approach helped focus the study on a

population of traditional students who grew up with technology and their reaction to the UDL intervention.

The college where the intervention took place had a limited number of instructors teaching two sections of the same large undergraduate course. Therefore, the selection of the course and the instructor, also a subject of the study, was based on convenience. An analysis of the course catalog revealed several courses that represented a likely enrollment of over 40 students per section. To ensure the strongest design possible, the researcher first approached the instructor of BIO 1110 because it represented the largest course meeting the study's criteria. The professor agreed to participate with her fall 2011 course in general biology. The professor evaluated the use of the LMS as a means of organizing and distributing resources according to UDL. She also agreed to provide ongoing updates in the LMS and to evaluate her own level of efficacy with UDL as part of the process. The instructor had taught general biology for several years, and throughout that time she had optionally used the LMS to supplement her teaching. In agreeing to participate in the study, she noted the need for approaches that would increase engagement among her students. The study itself aimed to identify whether an LMS-facilitated UDL approach would suggest higher levels of student engagement when compared to a standard or non-UDL control.

For the LMS design, the instructor's initial site was used to demonstrate the baseline or pre-intervention level of compliance with UDL, and the site was evaluated to determine its compliance with CAST's UDL guidelines.

Sampling and evaluation of the instructor's level of efficacy and the site's consistency with UDL involved the use of a specific checklist and self-rating scale for the

instructor. Sampling dates were pre-established and documented on a data collection timeline (see Appendix E).

In terms of the population and sampling procedure to measure the intervention's impact on student engagement, a convenience sample was used. The 16-week course in general biology was selected due to its demographic composition of undergraduate students, its relatively large size, and the fact the same instructor taught both sections. When determining that the sample size would be sufficient for the purposes of this study, Lenth (2011) indicated for a paired t-test, even a conservative estimate of student participation should provide a design with sufficient power to detect an effect.

Although the course was expected to have an enrollment of at least 80 students per section, it was likely not all of the 80 students in those two sections would opt to participate by completing the pre- and post-test survey. It was also anticipated that errors and other factors, such as students dropping the course or being absent during the administration of the pre- or post-test on student engagement had considerable potential to reduce the number of paired pre- and post-responses. Student Engagement Surveys were coded by the students to assure anonymity. However, mistakes in the coding, absences, and other factors were concerns as the research required that both pre- and post-measures could only be viable if they came from the same population of students. A best case/worst case analysis indicated even if 50% of students completed both pre- and post-tests, the design would still be strong enough to reveal an effect.

Assuming a two-tailed t-test at an alpha of .05, preliminary power analyses indicated a paired t-test involving pre- and post-responses from as few as 60 or 40

students per section would represent a good chance of detecting an effect if one existed. This assumption provided confidence the research design would be suitably strong.

Instrumentation

Various instruments were needed to measure the following:

- whether an LMS with an established set of tools and features could provide a UDL approach,
- the level of instructor-efficacy in implementing the LMS-facilitated UDL design, and
- whether the UDL treatment led to greater student engagement.

Because UDL involves a specific set of guidelines established by its founding organization (CAST), the instrumentation used in this study was in close alignment with the UDL guidelines and checklist (CAST, 2012). The Instructor Response Form shown in Appendix B asked the instructor to specify her level of efficacy with UDL using a scale of 1-5 (5 being most). The intent for seeking specific examples from the instructor was to provide the evaluators (the investigator and design consultant) an opportunity to confirm the instructor's observation, intervention, and claims made regarding efficacy level were accurate. In addition to confirmation of the Instructor Response, the validation process covered overall compliance of the treatment site itself. The UDL Validation Form is shown in Appendix C and included all CAST checkpoints to ensure the treatment site was consistent with UDL approaches. The UDL Validation Form was completed in detail at the outset of the intervention and was then used as a tool with which to review the overall site as the intervention proceeded. Please see the Data Collection Timeline (Appendix E) for details.

The study also tracked pre- and post-levels of student engagement, and the instrument used for that evaluation was a survey completed by students known as the SCEQ. The SCEQ involves 23 questions, and is a validated tool to identify student engagement at the course level (Handelsman et al., 2005). Responses would be evaluated on an overall basis with more detailed information available using the following four student engagement subscales: (a) Skills, (b) Emotional, (c) Participation/Interaction, and (d) Performance. Appendix F and Appendix G include the SCEQ survey and SCEQ Student Engagement Scoring Form. Informed consent and the anonymity of pre/post student data was assured by having students provide the last four digits of their cell phone numbers on the consent form and also on the SCEQ survey forms distributed pre and post.

Validity

A number of measures were built into the study's design to ensure valid results. The comparison group design, involving a control and treatment provided a site in the LMS for each of the two sections, control and treatment. The ability to compare the two groups – one with a standard LMS supplement and the other with a UDL-based LMS supplement – guarded against the possibility students were simply responding to the existence or lack of a site with supplemental resources in the LMS.

Usage of the LMS site was required in order to make the intervention meaningful. To increase usage of both control and treatment sites, the instructor posted student grades online for both control and treatment groups. Student tracking data were used to confirm usage of the site, and the post-SCEQ test included a scale-based usage question that

allowed the investigator to filter out the results of students who made little or no use of the LMS site.

It was important to rule out the possibility that varying levels of student engagement between the control and treatment groups were the result of the instruction itself. For that reason, both control and treatment sections of the course were taught by the same instructor.

At the early stages of this project, it was determined that in order to accurately measure the impact of a UDL supplement on student engagement, the control and treatment sites in the LMS must be designed and validated – initially and throughout the intervention – to ensure that they either lack (e.g., control) or possess (e.g., treatment) UDL attributes. To ensure inter-rater reliability, the evaluator used a checklist to evaluate instructor self-reports and the UDL-compliance of the treatment site six times throughout the project. To ensure a strong research design throughout the intervention, the evaluator also reviewed the control site during the fifth verification check and confirmed the control was significantly lacking in UDL approaches.

Aside from the questions of whether an LMS site could be designed in accordance with UDL and whether students' level of engagement changed based on the use of that site, a third variable explored instructor efficacy in applying UDL approaches. As part of the design, the instructor periodically responded to a 1-5 scale in which she self-reported on her level of efficacy. However, to ensure her perceived and stated level-of-efficacy was matched by her understanding and application of UDL, additional validity measures were established through the design of an Instructor Response Form (see Appendix B). The form requested the instructor to provide specific examples of UDL application. Each

example given by the instructor was verified by both the investigator and the consultant. Through these devices, the validity of the instructor's numeric and scale-based self-report was improved through the ability of investigator and consultant to verify the self-report accurately cited UDL approaches and was consistent with the manifested level of insight and application.

Reliability

In accordance with prevailing guidelines regarding the protection of human subjects, a request for review was submitted to the Institutional Review Boards of the colleges involved in this study. Approval was granted by both institutions, and the approved research plan was followed closely throughout the study.

In planning for a study that would yield reliable results, the investigator sought the largest class possible, and one that had the desired demographic composition of traditional undergraduates aged 18-21. Based on the configuration of BIO 1110 with its relatively large population of students, it was expected the study would detect an effect if one existed.

Limitations

The study was limited to one college, one professor, one brand of LMS (Blackboard), and two sets of students; a larger study would be beneficial in determining the effect of an LMS-facilitated approach to UDL via an expanded range of institutions, professors, students, and subject matter. For example, the instructor was comfortable with technology-enriched approaches and the student population consisted almost entirely of students who grew up with the familiarity and expectation of technology-enriched experiences. This means any positive results from the study cannot necessarily be

generalized and applied to non-traditional students who may be uncomfortable or even disengaged with the UDL approaches through the LMS.

Another significant limitation was the fact the instructor was not able to monitor or prevent students from the treatment and control groups to attend the alternate lecture session, and students from both sections were dispersed across the eight different lab sessions. Some students may have become aware of the differences between the control and treatment sites, and students in the control section may have had some exposure to the UDL supplement. Students still had access to only one site when they logged into Blackboard, but the awareness of a difference in supplemental site design is a concern that should inform future research.

Other limitations exist based on the fact that students from both sections may have occasionally attended lecture together. Specifically, this co-mingling of students inhibited the instructor's ability to emphasize the UDL treatment and draw student-attention to the interactive features and array of options it contained. For ethical reasons, it was also not possible to exclude the control section from certain forms of content our UDL evaluation brought to light as desirable features. For example, the instructor had not initially posted specific objectives for each unit. However, our UDL evaluation made it evident this was a needed aspect of the Strategic Domain. Due to the clear value this resource would provide, it was decided to include the Unit Objectives in the LMS site created for both the control and treatment groups of students.

Summary

This project made efficient use of existing LMS and digital resources as it explored questions that were inter-related and intrinsic to the hypotheses and research

questions explored in this study. The question of whether students would experience increased levels of engagement based on a UDL supplement delivered exclusively through the LMS required first that a UDL-compliant supplement be established. Secondly, it was important that the instructor would be capable of developing and maintaining a high level of efficacy in implementing the LMS-based approach to UDL throughout every unit of the course. The experimental approach to exploring potential variations in student engagement level relied on two highly compatible contingencies: (a) the ability to establish an initial UDL design in the LMS, and (b) instructor efficacy or ability to maintain the UDL design throughout the course. Thus, the trio of research questions were synergistic and served to support one another.

Careful attention to student demographics as well as class size, and a single instructor across two sections of the same class strengthened the study and were hallmarks of its experimental design. Efforts to ensure validity and reliability included IRB-approved procedures in the administration of pre- and post- surveys, coding of survey responses and third-party administration of the informed consent. Additionally, self-report data and instructional designs were verified and validated by an independent evaluator to ensure inter-rater reliability.

The methodology used in this project results from expert advisement, thoughtful selection of subjects, advance planning, and a research-based design that is strong and sensitive. Limitations exist, but the methodology has been crafted with due diligence, and with an open mind as to its outcome.

Chapter 4. Findings

This study was set in a large, undergraduate, lecture-style course in General Biology. It explored the use of an LMS site to enrich a large lecture-format course and (a) to verify the ability to establish and facilitate an initial UDL design via a site in the LMS, (b) to identify levels of instructor efficacy in implementing UDL using the LMS, and (c) to identify any variations in student engagement that may have resulted from the UDL treatment. This chapter starts with a summary of the study design and the data collected. Following that discussion is a detailed presentation of results associated with each of the three research questions. A summary of main findings follows each section.

Three Key Areas Explored

At a time when UDL is being mentioned by name in U.S. law, the literature emphasizes many areas of interest, including three that aligned with the research questions of this study. First, it is evident instructors at the postsecondary level need to identify practical options for organizing and providing UDL approaches. Second, in order to implement UDL on a small- or large-scale basis, it is important to confirm instructors can be effective in their efforts to apply UDL approaches using established guidelines and checklists provided by CAST. Third, the scope and depth of UDL's benefits are promising and the HEOA refers to UDL as a scientifically valid approach. However, verification of specific advantages continue to be called for. This study sought to explore UDL's benefits to learners by measuring its impact on student engagement.

Viability of LMS to deliver UDL approaches. Instructors seeking to implement UDL may benefit from a strategy that can help organize and implement this technology-

compatible approach (Edyburn, 2010; Getzel, 2008; Izzo et al., 2008). The LMS with its academically-oriented features and its availability at the higher education level seems a promising and flexible tool. To determine the viability of an LMS-based approach, the CAST guidelines were used to guide the construction of a UDL treatment site in the LMS. The instructor, the investigator, and an instructional design consultant documented their evaluation of the completed LMS site using the UDL guidelines and checklist from CAST (see Appendix H). For the purposes of establishing the quasi-experimental design, the control site was also evaluated using the same UDL guidelines and checklist, and those results are included in Appendix I.

Instructor efficacy in LMS-based implementation of UDL. The LMS is designed to be used by instructors seeking to provide supplemental resources as well as those who teach hybrid or fully online courses. Using the UDL treatment site established in the LMS, the study monitored the cooperating professor's level of efficacy in continuing and maintaining the UDL approaches provided to the UDL treatment group. This level-of-efficacy was tracked using a self-report scale of 1-5, with verification measures involving additional review by a researcher and evaluator built into the design.

Student outcomes based on the UDL design. From the perspective of verifying how UDL impacts learners, this research question explored UDL outcomes among traditional undergraduates in the higher education setting. UDL may be challenging to apply and – while it is endorsed as scientifically valid (GovTrack.us, 2008) – designers, instructors, and policy makers may be motivated to use it if they are provided tangible evidence that UDL represents a fruitful means of improving teaching, learning, and the student experience overall.

In exploring the nature and scope of benefits derived from this UDL treatment, the study used a quasi-experimental pre/post-test design to track student engagement to see whether a validated UDL design in the LMS affected the level of engagement experienced by students in the LMS treatment course versus the LMS control course.

Characteristics of Participants, Study Design, and Data Collected

Study participants included (a) two sections of predominantly undergraduate college freshmen aged 18-21 and (b) an instructor teaching two sections of a large lecture-format course (taught by the same instructor) in general biology. The instructor had five years experience teaching at the college where the study took place, and made voluntary use of supplemental sites in the LMS throughout that time. When first agreeing to take part in the study, she noted that she hoped to stimulate student engagement through her participation in the project.

A total of 157 students in Section 001 and Section 002 completed the fall 2011 course in General Biology. Ninety-nine (63%) of those students completed both pre- and post-surveys administered in the large lecture setting.

In the final analysis, 49 students in Section 001 (control) and 50 students in Section 002 (treatment) provided both pre- and post-survey responses, and those data sets allowed for tracking and comparison of student engagement based on the differing LMS resources provided to students throughout the course.

Description of the Data

This section includes figures and descriptions of data collected and used to answer the three research questions associated with this study.

UDL guidelines were used in an expert review of LMS. Figure 1 addresses the following research question:

Can an instructor at a liberal arts college in Northern Minnesota deliver Universal Design for Learning (UDL) using an established set of tools and features through the electronic Learning Management System (LMS)?

Figure 1 displays a chart describing three UDL domains or networks (Recognition, Strategic, and Affective). Because each domain carries with it a certain set of criteria identified using a total of 31 checkpoints, it was possible to look at the different domains and use the CAST checklist to look at the number of checkpoints possible compared to the number of checkpoints attained for each of the three domains.

UDL Treatment Site in LMS complied with all 31 checkpoints across three domains

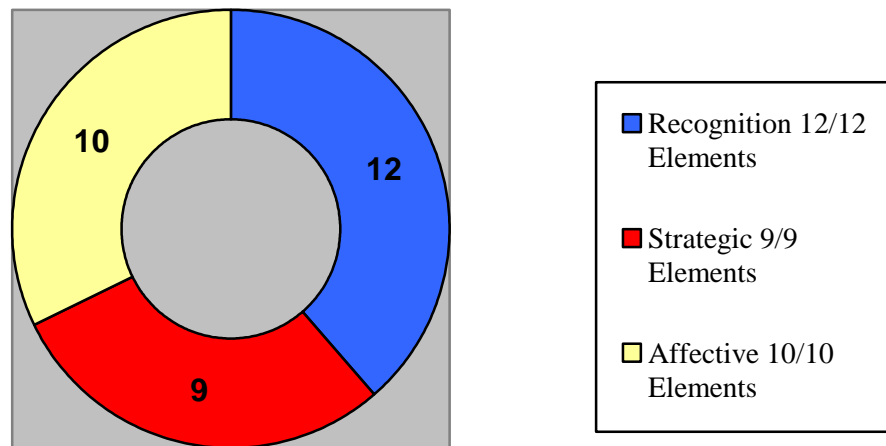


Figure 1. The LMS treatment site was compliant with all UDL domains, involving 31 checkpoint/elements (12 for Recognition, 9 for Strategic, and 10 for Affective).

The Recognition Domain is associated with 12 checkpoints relating to (a) options for perception, (b) options for language and symbols, and (c) options for comprehension. Here, the site review confirmed compliance with all aspects of this domain. Examples of attributes documented were numerous and noted in Appendix H. Highlights of elements detected include ability to re-size text, the incorporation of auditory and visual components, glossaries, study games, and textbook interactivities as well as opportunities to participate in online meetings and discussions.

The Strategic Domain is associated with nine checkpoints relating to options for checkpoints relating to (a) options for physical action, (b) options for expression and communication, and (c) options for executive function. The review of the treatment site in the LMS confirmed all nine of the elements associated with this domain were addressed. Examples noted during the review included options for email, online discussion posts, meetings in a virtual collaboration space, ability to present user display, detailed menu, direct access to textbook functions, and overviews of each unit.

The Affective Domain is associated with ten checkpoints relating to (a) options for recruiting interest, (b) options for sustaining effort, and (c) options for self-regulation. As with the other two UDL domains, the LMS site was validated by the instructor, the instructional design consultant, and the researcher who met prior to the start of class to review and evaluate the Blackboard sites. Again, after a few preliminary adjustments such as the inclusion of learning objectives, all ten of the ten checkpoints were met. Elements identified in the completed LMS treatment site included collaboration areas, student-generated learning games, a modular display of the different course units,

learning objectives, online communication options, and practice tests with built-in feedback, textbook interactions, and a schedule of virtual meeting times.

Individually and as a whole – the attainment of elements associated with these three domains (Representation, Strategic, and Affective) was emphasized in the LMS design. Figure 1 depicts how fully those domains were met in the UDL treatment. The treatment site was evaluated by the investigator, the instructor, and an instructional design consultant using the CAST guidelines/checklist. The completed UDL checklist for the treatment is shown in Appendix H. Appendix I shows the UDL checklist completed for the control site. For the instructional design consultant's summary report of these evaluations see Appendix J.

Instructor efficacy levels were tracked throughout the course. Tables 4, 5, 6, and 7 address the following research question:

What is the level of instructor-efficacy delivering UDL using the tools and features of the LMS?

These figures illustrate the instructor's ongoing level of efficacy in using the LMS to provide UDL approaches. To generate this information, the instructor completed the UDL Instructor Response Form (see Appendix B) on five separate occasions as the course progressed. The instructor evaluated each of UDL's three domains (Recognition, Strategic, and Affective) using a numeric scale which she supplemented with examples of her implementation. Those self-reports as well as the UDL compliance of the treatment site were verified each time in order to provide inter-rater reliability and also to ensure fidelity of the UDL design was maintained. During the fourth of five evaluations, the control site was reviewed using the CAST UDL checklist. It was determined that no elements had been added that would have increased that site's compliance with UDL.

The first section of the UDL Instructor Response Form called upon the instructor to rate her efficacy with the *Recognition Domain*, which emphasizes multiple means of representing concepts and information. As shown in Table 4, she consistently rated her own efficacy at the highest possible level during each of the five self-reports that she completed throughout the semester. She also provided examples of her implementation, and these examples were verified by both the researcher and the independent consultant. Taken together, these results showed that the instructor's stated level of efficacy was consistent with her implementation. This rating process and verification were consistently 5/5 during each of the five self-reports completed throughout the semester.

Table 4

Instructor Efficacy Self-report: Recognition Domain

Recognition Domain: Provide Multiple Means of Representation				
Date	Self-reported Efficacy Level (1-5)	UDL Area Identified by Instructor	Instructor Comments	Verified
9/15/11	5/5	<ul style="list-style-type: none"> • Alternatives for visual information • Illustrate through multiple media • Highlight patterns, critical features, big ideas, and relationships 	Provided publisher created videos, graphics that help ESL students or those with language related disabilities; LMS is organized by unit.	Yes
9/24/11	5/5	<ul style="list-style-type: none"> • Alternatives for visual information • Clarify vocabulary and symbols • Highlight patterns, critical features, big ideas, and relationships 	Animations, extra videos, glossary, outcomes for each exam.	Yes
10/21/11	5/5	<ul style="list-style-type: none"> • Alternatives for visual information • Clarify vocabulary and symbols • Highlight patterns, critical features, big ideas, and relationships 	Animations, extra videos, glossary, outcomes for each exam.	Yes
11/19/11	5/5	<ul style="list-style-type: none"> • Alternatives for visual information • Clarify vocabulary and symbols • Guide information processing, visualization, and manipulation 	Images, videos, materials from textbook, glossary for both Mac and PC, direct access to current unit logging into LMS.	Yes
12/10/11	5/5	<ul style="list-style-type: none"> • Alternatives for visual information • Illustrate through multiple media • Activate or supply background knowledge. 	Animations, videos from textbook, alternative ways to learn information, video and exercises give relationships between key concepts.	Yes

Table 5 shows the instructor's responses to the second section of the UDL Instructor Response Form which asked her to rate her efficacy level with the *Strategic Domain*, which emphasizes multiple means of action and expression.

The self-rating of 4/5 indicated that the instructor was initially more challenged in implementing the *Strategic Domain*, but by the time the second self-evaluation was called for she reported her efficacy at a 5/5 for this domain. This optimal level was maintained for the remainder of the semester.

Again, the Instructor Response Form requested specific examples of her implementation, and these examples were verified by both the researcher and the independent consultant.

Table 5

Instructor Efficacy Self-report: Strategic Domain

Strategic Domain: Provide Multiple Means of Action & Expression				
Date	Self-reported Efficacy Level (1-5)	UDL Area Identified by Instructor	Instructor Comments	Verified
9/15/11	4/5	<ul style="list-style-type: none"> • Optimize access to tools and assistive technologies • Use multiple media for communication • Enhance capacity for monitoring progress 	Blackboard display options & keyboard alternatives, online office hour supports student questions as well as audio and visual tools, lab assignments offer rubrics, 24/7 access to grade information.	Yes
9/24/11	5/5	<ul style="list-style-type: none"> • Optimize access to tools and assistive technologies • Use multiple media for communication • Enhance capacity for monitoring progress 	Blackboard display options & keyboard alternatives, online office hour supports speech or text, rubrics are used, students monitor progress using online gradebook.	Yes
10/21/11	5/5	<ul style="list-style-type: none"> • Optimize access to tools and assistive technologies • Use multiple tools for construction and composition • Enhance capacity for monitoring progress 	Blackboard supports alternative keyboards, slides are posted in PDF and PowerPoint formats, advanced posting of slides for notetaking, online grade information.	Yes
12/10/11	5/5	<ul style="list-style-type: none"> • Optimize individual choice and autonomy • Use multiple media for communication • Guide appropriate goal-setting 	Online office hour option (VOIP or call in via cellphone), interactive games and student collaboration/chat room available, learning objectives/guidance.	Yes

The third and final section of the UDL Instructor Response Form called upon the instructor to rate her level of efficacy with the *Affective Domain*, which emphasizes multiple means of engagement. As shown in Table 6, she consistently rated her own efficacy at the highest possible level during each of the five self-reports that she completed throughout the semester. She also provided examples of her implementation, and these examples were verified by both the researcher and the independent consultant. Taken together, these results showed that the instructor's stated level of efficacy was consistent with her implementation. This rating was consistently 5/5 for all of the five self-reports completed throughout the semester.

Table 6

Instructor Efficacy Self-report: Affective Domain

Affective Domain: Provide Multiple Means of Engagement				
Date	Self-reported Efficacy Level (1-5)	UDL Area Identified by Instructor	Instructor Comments	Verified
9/15/11	5/5	<ul style="list-style-type: none"> • Optimize individual choice and autonomy • Foster collaboration and community • Promote expectations and beliefs that optimize motivation 	Many ways to reinforce information, animations, flashcards, word games, online meetings, collaboratively created learning games, student mentor.	Yes
9/24/11	5/5	<ul style="list-style-type: none"> • Minimize threats and distractions • Foster collaboration and community • Promote expectations and beliefs that optimize motivation 	Established structure, calendar in LMS, collaboration area with chatroom in Blackboard, information and advice from student.	Yes

Table 6, continued.

Affective Domain: Provide Multiple Means of Engagement				
Date	Self-reported Efficacy Level (1-5)	UDL Area Identified by Instructor	Instructor Comments	Verified
10/21/11	5/5	<ul style="list-style-type: none"> • Minimize threats and distractions • Foster collaboration and community • Promote expectations and beliefs that optimize motivation 	Established structure, calendar in LMS, collaboration area with chatroom in Blackboard, information and advice from student.	Yes
11/19/11	5/5	<ul style="list-style-type: none"> • Minimize threats and distractions • Foster collaboration and community • Develop self-assessment and reflection 	Announcements deadlines posted on calendar in LMS, optional collaborative learning games, interactive video and animations.	Yes
12/10/11	5/5	<ul style="list-style-type: none"> • Optimize individual choice and autonomy • Foster collaboration and community • Develop self-assessment and reflection. 	Supplemental materials in treatment LMS address issues students encounter (e.g., cancer, genomics, biotechnology, etc.), interactive games, discussion forum, quizzes and interactive animations.	Yes

The above tables summarize the instructor responses. Please see Appendix K for detailed information obtained using the UDL Instructor Response Form as well as the validation activity and comments.

Table 7 provides an overview of the instructor's self-reported the level of efficacy for each UDL domain (Recognition, Strategic, and Affective) as noted on the response form completed by the instructor five times throughout the semester.

Table 7

Overview of Instructor Self-reported Level of Efficacy With UDL

	Representation	Action & Expression	Engagement
9/15/11	5	4	5
9/24/11	5	5	5
10/21/11	5	5	5
11/19/11	5	5	5
12/10/11	5	5	5

Note. 1=low, 5=high

Student engagement was measured using pre- and post-surveys. Tables 8-16 are based on SPSS analyses that compared and contrasted student engagement levels among students experiencing the control versus the treatment. The comparative analyses of student engagement levels were made possible using scores from a Student Course Engagement Questionnaire (SCEQ) administered to both control and treatment groups at the beginning of the semester in September, and then again at the end of the 16-week course in December. These tables address the following research question:

Does the UDL treatment lead to greater student engagement?

These tables provide SPSS reports based on the descriptive statistics and pre/post results from the control and treatment groups. The data presented in Tables 8-16 include t-tests revealing comparative responses (control versus treatment) in student engagement as measured by the SCEQ, which is a validated survey/instrument used to measure student engagement on the course level (Handelsman et al., 2005). Tables 17-18 show similar comparisons using only the responses of students who identified themselves as high LMS users.

As shown in Table 8 below, the full Section 001 (control) group started the course with a mean SCEQ score of 87.4. The mean SCEQ score was 79.9 when the post-test was later administered in December. The t-test produced a t of 5.340 and indicates a significant decline in student engagement, $p=.0001$.

Table 8

Control Group (Section 001): Longitudinal (pre- to post-test) SPSS Analysis of Student Course Engagement Questionnaires (SCEQ)

Section 001 Control Group: Paired Samples Descriptive Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Section 001	SCEQ Pre	87.4184	49	10.02255	1.43179
	SCEQ Post	79.9796	49	11.76062	1.68009

Table 9

Control Group (Section 001): Paired Samples Test Results

Paired Samples Test			
	Paired Differences		
	Mean	Std. Deviation	Std. Error Mean
SCEQ Pre/Post	7.43878	9.75194	1.39313

Table 10

Control Group (Section 001): Paired Samples Test Results

Paired Samples Test					
Paired Differences					
95% Confidence Interval of the Difference					
	Lower	Upper	t	df	Sig. (2-tailed)
SCEQ Pre/Post	4.63769	10.23986	5.340	48	.000

Tables 11-13 show results for Section 002 (treatment) group. The mean scores of 89.0 for the pre-test versus 79.8 for the post-test was similar to the control group in that results showed a decline in SCEQ scores. The t-test produced a t of 6.111 which was again a significant decline in student engagement scores, $p=.0001$.

Table 11

Treatment Group (Section 002): Longitudinal (pre- to post-test) SPSS Analysis of Student Course Engagement Questionnaires (SCEQ)

Section 002 Treatment Group: Paired Samples Descriptive Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Section 002	SCEQ Pre	89.0200	50	9.69218	1.37068
	SCEQ Post	79.8000	50	13.13043	1.85692

Table 12

Treatment Group (Section 002): Paired Samples Test Results

Paired Samples Test			
	Paired Differences		
	Mean	Std. Deviation	Std. Error Mean
SCEQ Pre/Post	9.22000	10.66807	1.50869

Table 13

Treatment Group (Section 002): Paired Samples Test Results

Paired Samples Test					
	Paired Differences				
	95% Confidence Interval of the Difference				
	Lower	Upper	t	df	Sig. (2-tailed)
SCEQ Pre/Post	6.18817	12.25183	6.111	49	.000

These data are consistent for both the Section 001 control group and Section 002 treatment group. Both groups experienced a significant longitudinal decline in student engagement as indicated by their SCEQ scores.

Tables 14-16 show post-test means for both the control and treatment sections of the course. Post-test means between the control and treatment were not significantly different from one another.

Table 14

SPSS Analysis to Determine Difference Between the Post-test Means for the Control Versus Treatment

Group Statistics					
	Section	N	Mean	Std. Deviation	Std. Error Mean
SCEQ Post	001	49	79.9796	11.76062	1.68009
	002	50	79.8000	13.13043	1.85692

Table 15

Post-test Comparison: Results of Non-directional or 2-tailed t-test

Independent Samples Test					
		t-test for Equality of Means			
		t	df	Sig. (2-tailed)	Mean Difference
SCEQ Post	Equal variances assumed	.072	97	.943	.17959
	Equal variances not assumed	.072	96.230	.943	.17959

Table 16

Post-test Comparison: Results of Non-directional or 2-tailed t-test

		Independent Samples Test		
		t-test for Equality of Means		
		Std. Error Difference	95% Confidence Interval of the Difference	
			Lower	Upper
SCEQ Post	Equal variances assumed	2.50697	-4.79606	5.15524
	Equal variances not assumed	2.50417	-4.79099	5.15017

Overall, the data indicate the control (M=87.4184) and treatment (M=89.0200) groups started out with similar mean average scores in the area of student engagement as measured by the SCEQ. The post-test analysis reveals that the similarity between the two groups remained in effect as the semester proceeded; while student engagement showed an overall decline, the declines were comparable. In other words, the UDL treatment had no impact in student engagement based on pre- and post- SCEQ scores.

To ensure that the students completing the student engagement surveys made actual use of the LMS sites, a usage question was added at the end of the post- survey (Appendix F). This asked students to rate their level of use of the LMS on a scale of 1-5 (5=high). As shown in Table 17, high or frequent users included 37 students from Section 001 (control) and 38 students from Section 002 (treatment). Students who rated themselves a 4/5 or 5/5 were used in this comparison.

Table 17

Comparison of Post-SCEQ Scores in the Control and Treatment Groups among Students who Identified Themselves as High Users of the LMS Site

Group Statistics					
	Section	N	Mean	Std. Deviation	Std. Error Mean
SCEQ Post	001	37	80.7568	11.78843	1.93801
	002	38	79.4211	13.86934	2.24990

Table 18 shows results of the comparison of high LMS users. High LMS users of the control versus treatment groups were compared, with the SPSS evaluation revealing no significant differences in SCEQ engagement results between the frequent users of the control site versus the frequent users of the treatment site. This verified the lack of the treatment's effect by ensuring that students being compared (control vs. treatment) had indeed made heavy use of the LMS site provided.

Table 18

Comparison of High LMS Users

		Independent Samples Test			
		t-test for Equality of Means			
		t	df	Sig. (2-tailed)	Mean Difference
SCEQ Post	Equal variances assumed	.449	73	.655	1.33570
	Equal variances not assumed	.450	71.704	.654	1.33570
		95% Confidence Interval of the Difference			
		Std. Error Difference	Lower	Upper	
SCEQ Post	Equal variances assumed	2.97597	-4.59540	7.26681	
	Equal variances not assumed	2.96950	-4.58430	7.25571	

As a whole, the SPSS analysis of the pre- and post- survey results revealed two similar groups that both experienced a similar and significant decline in engagement as measured by the SCEQ. Based on these results, the treatment had no measurable impact on student engagement.

Summary of Research Question 1: Using an LMS to Provide UDL Approaches

Using the example of a single course and instructor at a college in Northern Minnesota, the first question asked was: Is it possible to deliver Universal Design for Learning (UDL) using an established set of tools and features accessible through the electronic Learning Management System (LMS)?

For this question, it was necessary to apply CAST's UDL guidelines while constructing an online site that would provide foundational UDL elements and also

promote UDL approaches by the instructor. Based on the recruitment of interactive and content-rich resources from the textbook publisher as well as the inclusion of virtual meeting rooms, video integration, online office hours, and other features facilitated by the LMS, an initial site was designed to be practical and appealing to the instructor.

The treatment site was evaluated using CAST's UDL guidelines and checkpoints which included linkage to external examples and explanations. Each of the 31 elements or checkpoints was evaluated.

Analysis procedures. Two weeks prior to the start of classes, the instructional design consultant, the instructor, and the investigator met to review both control and treatment sites. Each used the UDL checklist (see Appendix A), the UDL Instructor Response Form (see Appendix B), and UDL Design Validation Form (see Appendix C) to review each site checkpoint-by-checkpoint and document the presence or lack of UDL elements. Each of the 31 checkpoints was evaluated.

Summary conclusions of Research Question 1. Results for this research question explored whether a site in the LMS could be used to deliver UDL approaches, and were based on the use of CAST's UDL guidelines and checklists to review the control versus the treatment site in the LMS. The investigator, the instructional design consultant, and the instructor reached consensus on each element for each of the two sites. In conclusion, the control site was lacking in UDL elements while the treatment site was generally compliant with UDL approaches with a minor adjustment suggested. The treatment was brought into full compliance with UDL after the instructor posted objectives for the course. The treatment site then fulfilled all CAST checkpoints relating to UDL, whereas the control site was lacking in elements needed to fully meet UDL

guidelines. See Appendix H and Appendix I for the completed CAST checklists with notes and Appendix J for the control versus treatment site consultant's evaluation report.

Summary of Research Question 2: Determining the Level of Efficacy With Which an Instructor Can Maintain the UDL Design in the Learning Management System

The second question explored the level of instructor-efficacy delivering UDL using the tools and features of the LMS.

Analysis procedures. A five-point rating scale was used to track the level of efficacy experienced by the instructor as she used the LMS site to provide students in the treatment section with UDL approaches. At key points throughout the semester, the instructor was asked to complete a scale-based self-report for each of the three UDL domains (Representation, Action and Expression, and Engagement). Evaluations were timed to occur before the beginning of each new unit.

Because self-reported rating scales are subjective by nature, the instructor was also asked to document specific examples of her UDL application. The examples were then verified by both instructional design consultant and investigator, with the plan being to intervene if needed with suggestions and support.

Summary conclusions of Research Question 2. Based on the five samples taken throughout the semester, instructor efficacy in applying UDL approaches was optimal for the following two of the three UDL domains:

- Multiple means of representation, and
- Multiple means of engagement.

The instructor reported she was initially less efficacious in applying the remaining (strategic) domain involving multiple means of action and expression. However, her level

of efficacy rose to 5/5 for that domain by the time the next self-report was requested, and that high level was maintained throughout the remainder of the course.

Validation by the investigator and instructional design consultant involved noting the stated level of efficacy and specific examples provided by the instructor and verifying the elements existed and were as described. Over the five checkpoints included after the course was launched, the investigator and instructional design consultant verified the site design was consistently compliant with UDL approaches, and additionally the specific UDL applications noted by the instructor were indeed evident. For this research question, this study found it was possible for the instructor to establish and maintain a high level of efficacy using the LMS to provide students with UDL approaches. Details of the specific instructor self-reports and associated validation remarks may be reviewed in the spreadsheet found in Appendix K.

Summary of Research Question 3: Determining Whether and How the UDL Treatment Site in the LMS Affected Student Engagement

The third and final question in the study asked if the UDL treatment led to greater student engagement. It used a quasi-experimental design in combination with a validated survey of student engagement (pre- and post-) to explore whether the UDL treatment led to different (and possibly improved) outcomes in the area of student engagement when compared to the control group.

Analysis procedures. Ninety-nine (63%) of the students completed the Informed Consent forms and the pre- and post-SCEQ surveys. Pre/post data sets were collected from 49 students in Section 001 (control) and from 50 students in Section 002 (treatment). SPSS was used to generate descriptive statistics for the two sections and also

to conduct a t-test evaluation of the data. The data were evaluated using a non-directional t-test at .05 alpha level.

Student tracking data were generated by the LMS, with the intent being to enrich findings about LMS site usage between the control and treatment groups. By necessity and due to the anonymity of the participant group, the overall tracking data generated by the LMS reflected usage by all students in the course, including those who did not provide pre- and post-survey data.

In an effort to improve understanding of the intervention's impact on student engagement, the second or post-test administration of the SCEQ incorporated an additional question that used a 1-5 scale to allow students to self-report their usage level of the LMS site. Since the control and the treatment were delivered solely through the LMS, this additional/usage-level question was intended to filter out responses of those who made only moderate or infrequent use of the sites (see Appendix F for the post-test student SCEQ survey form). This additional analysis allowed for another look at whether and how actual usage of the LMS site impacted student engagement among control versus treatment groups.

Using the usage scale as a filter, it was possible to disaggregate data sets and evaluate results from respondents who identified their usage level as being a 4 or 5 on a 5-point scale. This resulted in a total of 75 participants who made frequent use of the LMS, with 37 from the control and 38 from the treatment section. These additional data were used for validation purposes in conjunction with the main data analysis.

Summary conclusions of Research Question 3. Based on SCEQ scores collected during the September pre-test, the control and treatment sections of BIO 1110

were initially similar, with both groups experiencing a significant pre- to post-test decline in engagement as measured by the SCEQ scores. The treatment did not seem to mitigate or strengthen this decline. A non-directional t-test conducted using a .05 significance-level was used to compare the post-test results between the two groups. The outcome was $t=.072$, $p=.943$. This shows no significant difference between the post-test scores of students in the control versus the treatment sections. This indicates the UDL treatment had no impact in terms of increasing or decreasing student engagement.

To track student usage of the supplemental sites over the duration of the semester, the LMS evaluation reports were generated. As shown in figure 8, these reports revealed a total of 15,396 hits recorded for the control compared to 16,091 hits recorded for the treatment over the same time period. Access of Content Areas was also tracked and the two sites showed a consistent level of usage from one group/site to another.

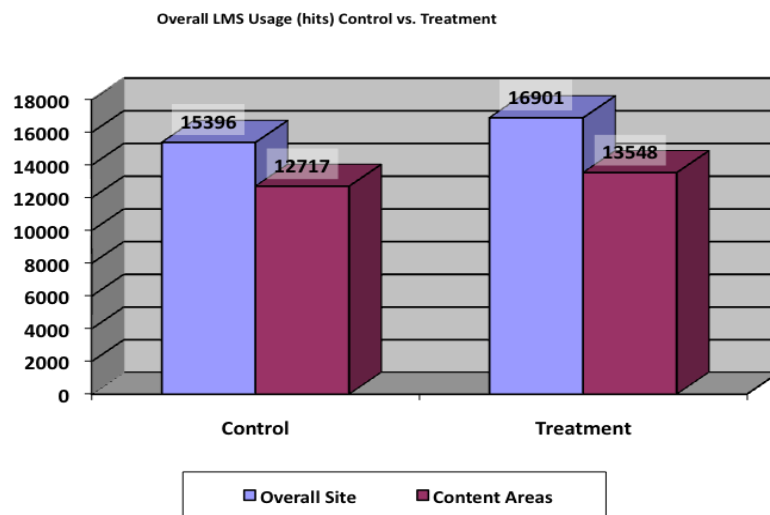


Figure 2. Tracking data from LMS control versus treatment shows hits on the site between 9/16/2011-12/9/2011.

A t-test of control/treatment data from students who made frequent usage of the LMS sites was also conducted in an effort to identify any differences among those who were more heavily exposed to the treatment versus control. This comparison of post-test engagement scores compared 37 students in the control with 38 students in the treatment who had identified themselves as high users of the LMS site. The SPSS analysis that compared these frequent users of the LMS sites revealed $t=.449$, $p=.655$, and thus further confirmed the larger findings that the UDL treatment had no significant impact on the level of student engagement as measured by the SCEQ.

Overview of the Research Findings

The data collected answered the initial questions associated with this study. However, the fact that this research focused on one course and one instructor made it clear that many other studies are needed before generalizations can be made.

The current research found it was possible to select and arrange tools, features and resources in the Blackboard LMS in a way that supports UDL approaches. It was also possible for an instructor with little or no prior experience with UDL to establish and maintain a high level of efficacy in applying and articulating UDL approaches using the LMS-facilitated design. In evaluating student outcomes in terms of how the UDL intervention impacted student engagement, the raw data indicate the UDL treatment had no effect.

These are interesting results that add to the literature. At the same time, each finding raises a new question. Below is a telescopic view of the findings and new questions that emerged. A more complete discussion is provided in Chapter 5.

Table 19

Overview of the Findings and New Questions

Finding	Associated Question
1. Using tools and features associated with the Blackboard LMS, it is possible to establish a design consistent with all elements of UDL.	Is this the case for all brands of LMS such as eCollege, Moodle, Sakai, etc.?
2. A postsecondary instructor with minimal prior exposure to UDL was able to establish and maintain a high level of efficacy using the LMS-facilitated approach.	Would other postsecondary instructors be able to establish and maintain a high level of efficacy using the LMS-facilitated approach?
3. The treatment site in the LMS (designed and maintained according to UDL guidelines) did not lead to improvements in student engagement.	In another context – such as a class not predominantly composed of first-semester freshmen or a class with a different subject or instructor – would a UDL intervention via the LMS increase student engagement?

Chapter 5. Findings, Conclusions, and Recommendations

General Discussion

This study involved a triangle of questions that addressed the practicality and outcomes associated with delivering UDL approaches via a face-to-face course that has been supplemented with a site in the LMS. The intent was to contribute to the existing research by exploring the viability of using a supplemental LMS site as a means of organizing and delivering UDL approaches to students. It also explored the efficacy level with which a faculty member might apply and maintain this LMS-facilitated approach. In terms of benefits to students, the study used a quasi-experimental design and pre- and post-test measure to explore UDL's impact on student engagement.

This chapter begins by summarizing findings from the study and discussing the viability and the outcomes of UDL when delivered through a supplemental site in the LMS. The chapter also incorporates conclusions, limitations, and recommendations for future research.

Summary of Results

The study explored practical approaches for facilitating UDL. It is not the first effort to use an LMS or web blog to organize and deliver UDL approaches, as articles by Rose, Harbour, et al. (2008) and Sapp (2009) describe instances in which similar LMS-like systems were used in similar ways. The project described by Sapp (2009) was a dedicated computer-based system for 5th graders, while Rose, Harbor, et al. (2008) used a course blog as a means of supplementing a face-to-face education course taught through the Harvard Graduate School.

Despite previous efforts to use an LMS to organize and represent UDL, the current study was a pioneer in its systematic evaluation and verification that the LMS can be designed to comply with all UDL elements. It also confirms that the instructor involved in this study was able to use the LMS to maintain UDL approaches throughout the semester. Finally, the study may be the first of its kind to objectively explore learner outcomes in the area of student engagement based on LMS-facilitated delivery of UDL.

Research questions intended to

- verify that tools and features available in the LMS could be designed in accordance with UDL principles to support student learning,
- ascertain the level of efficacy with which an instructor who was previously unfamiliar with UDL could implement and maintain this approach through the LMS site design, and
- identify whether the LMS-facilitated UDL design had a statistically significant outcome or impact on student engagement. This was measured using a validated survey completed by students.

The first research question involved the design and collaborative review of the treatment using CAST's UDL checklist (see Appendix A) to measure the LMS treatment site's fulfillment of each of 31 UDL elements or checkpoints. The design process itself took place during the summer of 2011, and the instructor, investigator, and independent consultant evaluated the treatment site in late August. It was established the control site offered very limited elements and was not generally compliant with UDL approaches. After some minor adjustments were made to the treatment site in the LMS, the collaborative review by the instructor, investigator, and instructional design consultant

established that all of the 31 UDL elements/checkpoints had been met (see Appendices F and G).

The second question asked the instructor to monitor and express her level of efficacy in using the LMS to maintain UDL approaches. This measurement was taken at five points throughout the course, and the instructor self-report was reviewed by the investigator and by an independent instructional design consultant to ensure inter-rater reliability. The instructor consulted with the investigator on occasion and using the UDL resources from CAST, her completion of the self-rating/response form monitored and established a high level of efficacy in applying UDL approaches throughout the semester.

The third question focused on how the UDL treatment affected student engagement. It involved a t-test of scores based on student completion of a validated survey (Handelsman et al., 2005) known as the SCEQ. The pre-test survey was administered during the first full week of the semester. In comparing control versus treatment sections of general biology students, the t-test established there were no initial differences in student engagement as measured by the SCEQ. The post-test also involved student completion of the same SCEQ survey intended to measure student engagement. It was identical to the pre-test but included one additional scale-based question asking students in both the control and treatment groups to identify the frequency with which they used the site.

A t-test of the post-test SCEQ scores indicated, while both groups experienced a significant decline in student engagement as a general response to the course, the treatment had no effect as it neither mitigated nor intensified this decline. Because it was possible some students made only minimal use of the LMS sites, it was desirable to

compare high level users based on self-report usage-data students provided as part of their SCEQ post-test. Through this approach, it was possible to compare only high-frequency users of the control and treatment LMS sites. The t-test displaying no effect among the larger control versus treatment group was run again. This time the t-test compared SCEQ scores of the 75 students (37 control, 38 treatment) who made frequent use of the LMS. As was the case with the larger group, the t-test comparing only the heavy users of the LMS sites revealed no significant difference in engagement between the control and treatment groups. The identification of these heavy users was based on students' self-ratings of their level of usage of the LMS. The post-SCEQ survey included a 1-5 scale asking students to identify their level of use. Students who rated their usage-level at a 4 or 5 were considered to be heavy users of the LMS.

Universal Design for Learning: Importance of Findings

UDL has captured the attention of educators and policy makers world-wide. Websites from CAST, the Council for Exceptional Children, and other organizations continually promote and support UDL, and conferences from leading higher education organizations offer sessions on such topics as *Institutionalizing Universal Design for Learning at Your University* (Hausler & Spooner, 2010) and *Effectively Engaging Teachers and Learners Through Universal Design for Learning* (Christie, 2012).

UDL has become a prevalent and much-publicized approach and – with the increasing diversity of students at all levels – UDL is an endorsed approach in higher education today. The HEOA of 2008 “establishes the expectation that [UDL] provides distinct benefits to students and requires that colleges of education that receive federal funding for teacher quality partnership grants report on the outcomes of UDL training

within their preservice preparation programs” (Edyburn, 2010, p. 33). Edyburn (2010) emphasizes that despite the widespread recognition of UDL and the endorsement of government agencies and professional organizations, it is not clear what the outcomes actually are. Other practitioners (Getzel, 2008; Izzo et al., 2008) have stated the need to identify approaches to assist faculty in efforts to implement UDL. These questions seem interdependent because instructors need to implement and sustain UDL effectively if we are to generate and evaluate outcomes associated with these UDL-compliant learning experiences.

The current study adds to the literature on LMS-facilitated delivery of UDL, and uses the UDL checklist (CAST, 2012) and structured evaluation procedures to reinforce earlier suggestions (Gerrard, 2007; Sapp, 2009) the LMS offers a potentially viable approach to the design and delivery of UDL at the postsecondary level. This study also demonstrated the potential of LMS approaches in the area of supporting instructor efficacy with UDL is encouraging.

The proven application of LMS-facilitated delivery approaches – along with the concurrent finding that UDL did not lead to higher levels of student engagement – suggests the value of additional studies. Such studies might continue to verify the value of LMS approaches and continue to explore and measure benefits to students (including student engagement) among a broader range of courses, instructors, and with different demographics of students. While this study explored UDL’s impact among the general population of students it did not seek to identify subgroups or track specific outcomes among diverse students. Thus, it is not known whether the treatment had a preferred result among ESL students or among those with special learning needs.

Conclusions

LMS-facilitated approaches to providing UDL. Although potential critics of an LMS-facilitated approach to UDL might argue that no effect was shown because the LMS-based extension or supplement was not immersive enough, additional reliability measures built into this study yielded interesting results that actually address and refute that concern. Results indicating no significant difference among the full group of participants who responded to the pre- and post-SCEQ survey were re-evaluated through an additional self-report rating scale that made it possible to compare only the heavy users of the site. Again, as with the larger group, there was no significant difference that would indicate that the validated UDL treatment led to higher levels of student engagement. Using the SCEQ tool, it was evident – even among heavy users – the treatment led to no significant increase in student engagement. This gives rise to speculation, and points to the need for more research with different students, instructors, subjects, and class status. The lack of results is especially notable due to the fact that a key component of the UDL design emphasizes the provision of multiple means of engagement, with the design and delivery of this defined according to elements on the UDL guidelines/checklist (see Appendix A).

The overall *decline* in engagement among both control and treatment sections of this predominantly freshman group brought to mind literature cited earlier in this paper (Howard, 2004; Vygotsky, 1978). In keeping with the concept of a Zone of Proximal Development (ZPD) (Vygotsky, 1978), researchers state, “In order for learning to take place the material must be challenging enough to engage students’ interest, but not so challenging that they become frustrated and give up” (Howard, 2004, p. 26). It would be

interesting to repeat this study among a more stable population of undergraduate students who are not first-semester freshmen and have had more time to adjust to social and academic demands of college life.

Other aspects of this multi-faceted study indicate – while certainly not the only approach to organizing and delivering UDL approaches – an LMS supplement to a face-to-face course continues to be a viable option to explore. It is essential that future studies using an LMS or any other delivery strategy continually monitor the fidelity of the UDL design to ensure the treatment is consistently strong and compliant with UDL guidelines and principles. In a related consideration, the current study incorporated an evaluation of the control site to ensure it consistently lacked UDL elements. This additional verification was an important aspect of the study methodology and was completed to ensure the control site did not gain UDL attributes and thus diminish the strength of the experimental design.

Instructor efficacy with LMS-facilitated UDL approaches. Although the instructor was not initially conversant with UDL, she was open-minded and eager to explore this approach as a possible means of improving the level of engagement among her students. Resources available included the CAST guidelines and learning modules, consultation and support in the initial design of the LMS template and a collaborative review of the control versus treatment sites. As the course proceeded, the instructor benefitted from frequent check-ins involving her use of CAST's detailed checklist materials available to assist with her completion of periodic efficacy reports (see Appendix A). This infrastructure and support were quite possibly relevant to the instructor's ability to establish and maintain a high level of efficacy.

Depending on the individual implementing the UDL approach, it is acknowledged UDL does *not* come naturally but instead is a very specific approach that is likely to require varying levels of training and support. The LMS with its rich array of resources supported the instructor in her implementation efforts. By taking advantage of features inherent to the LMS as well as publisher-created materials (glossary, videos, interactive quizzes, animations, etc.) the instructor did not need to possess an advanced level of technical or instructional design skills. However, it should be noted the instructor in this study had previous experience using a site in the LMS to supplement her courses. Thus, the fact that she was quickly able to establish and maintain a high level of efficacy cannot be assumed or expected from all instructors.

Overall, the use of the LMS seems promising as an approach that one (and possibly many other) instructors find helpful in the effort to provide students with UDL-compliant approaches.

UDL and its impact on student engagement. Although results of this study clearly indicated the UDL treatment conducted in BIO 1110: General Biology had no significant impact in terms of student engagement, this was one study conducted among one group of students in the context of a single instructor and subject area. In devising the methodology, this research sought the largest class possible in an effort to craft a strong experimental design. But perhaps a smaller class size and a situation in which the instructor could make more frequent references or use of the LMS-facilitated treatment would yield a different result.

The methodology involving undergraduate (as opposed to graduate or non-traditional) students was guided by suggestions in the literature that college students aged

18-21 are accustomed and even expectant of technology-driven approaches and thus they may be more likely to appreciate and respond to LMS-facilitated UDL. However, in considering these results and the overall decline in student engagement, a look at the student demographic may be relevant. The study was conducted and findings were generated by participants who were predominantly first-semester freshmen, a group that may be out of the ordinary or uncharacteristic based on the extreme pressures and adjustments they are called upon to make.

The literature suggests student engagement thrives in situations that involve the right level of challenge. According to Jimenez et al. (2007) engagement is related to ‘appropriate challenges’ that increase motivation. Thus, if an incoming group of freshmen lack the scaffolding or foundational knowledge needed, the level of engagement or motivation may be lacking.

According to Registrar reports, both the control and treatment sections included a large proportion of freshmen. The comparison shown in Figure 3 demonstrates a similar composition between the two sections.

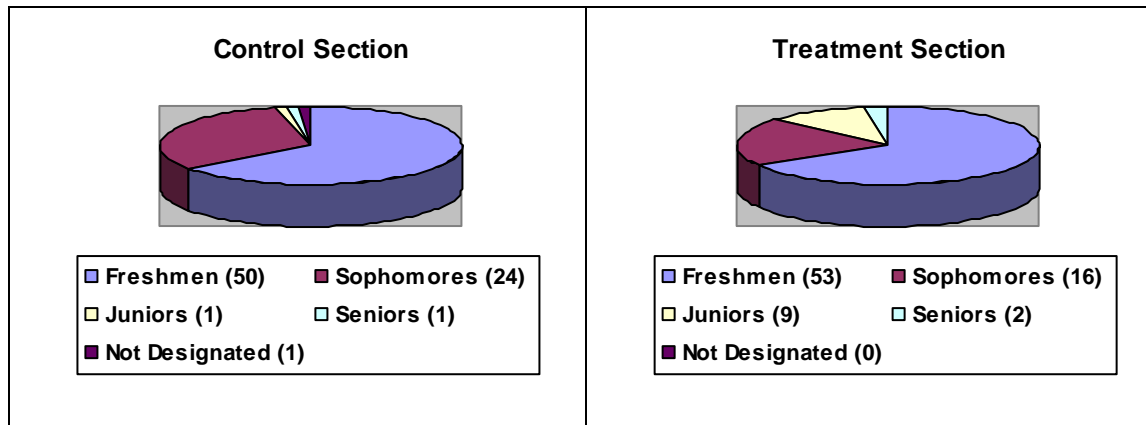


Figure 3. Information from the Registrar's Office confirmed both sections of the fall semester course in general biology had a high proportion of freshmen.

Perhaps the fact that most participants needed to adjust to demands of college life contributed to the overall decline in student engagement and – more specifically – the treatment's inability to yield an improved result in the area of student engagement. In the current study, freshmen may have been struggling to keep up with a multitude of new expectations, experiences, and challenges, and were thus resistant to absorbing UDL's benefits in the area of student engagement.

The singularity of this example involving a predominantly freshmen group indicates the book is not closed on UDL's potential to improve student engagement; instead, more research is needed to explore this question in different settings and contexts.

Future Recommendations

The use of LMS-facilitated approaches to support instructor efficacy and reliable delivery of UDL approaches may not be appealing to all college instructors seeking to implement UDL. However, this and other studies (Gerrard, 2008; Sapp, 2008) indicate

the LMS represents a viable approach for some higher education instructors. Future LMS use is worth pursuing with efforts to generate both qualitative and quantitative data on the outcomes and benefits of UDL approaches.

The quality of the objective data generated in the area of student engagement for this study was dependent upon a design that involved ongoing checks to ensure the fidelity of the treatment site with UDL approaches. Other researchers are advised to consider adopting similar instructor efficacy and monitoring procedures. Not only has this approach resulted in a more valid study, it may also promote instructor expertise through repeated opportunities to apply the CAST checklists and reflect upon and document their UDL implementation. It is suggested that efforts to collect data on UDL's outcomes may be effectively and simultaneously supplemented with an inquiry in implementation approaches involving instructor training, validation, and coaching or resource-availability.

The findings that demonstrate no significant difference in terms of the treatment's impact on student engagement should be viewed with caution as this study took place in a specific context that may or may not be applicable to other courses or groups of students. Additional studies are needed to explore UDL's impact on student engagement as well as other variables or benefits in different settings, contexts, or populations.

UDL supports diverse learners, and it has been designated a scientifically valid approach (GovTrack.us, 2008). However, benefits in terms of student achievement, higher levels of student engagement, improved retention, or other specific outcomes have yet to be confirmed in the research, and as long as UDL is endorsed by law, the pursuit of such data continues to be important.

Our collective understanding of UDL and its benefits needs to be expanded upon through continued and carefully constructed studies. In the area of instructor implementation, the results of this study are promising but based on the sole experience of one college instructor. Different instructors may be unable to use the LMS or to develop and apply digital approaches in general. Therefore, this result is positive, but possibly limited to some faculty members.

When studying the intervention in terms of benefits to learners, the results are needed as the literature is lacking in data that specifically document the outcomes of UDL. This single carefully constructed study indicated the UDL treatment did not lead to higher levels of student engagement. However, if conducted in other classes or subject areas and with other instructors and students, the result may differ.

It will also be interesting for future studies to identify the responses of diverse students such as ELLs, non-traditional or adult students, and students with special needs.

As we reviewed and considered the checklists and validation of control versus treatment sites in the LMS (Appendix H and I), it was evident – even with little deliberate effort on the part of the LMS site designer – the LMS itself offered features that were hugely beneficial to the construction of a UDL design.

Incorporated in the LMS are elements that might not readily be available in the typical classroom or non-digital learning environment. For example, intrinsic to the Blackboard LMS were such UDL-endorsed features as the ability to pre-set the course environment with alternative font sizes, customizable menu displays, language alternatives, and other accessibility options. The instructional design consultant who evaluated the sites determined the treatment site in the Blackboard LMS was a strong

representation of UDL elements but that the control site could not be deemed consistent with UDL as a whole.

The intrinsic design of the LMS, with its array of tools and features designed to provide an optimal level of academic support and accessibility features, made possible for both the control and the treatment site to meet certain hard-to-reach UDL standards, including those relating to accessibility. Thus, by facilitating such features of UDL, the very use of this tool may have actually made it more difficult to provide the control group with a site that was devoid of certain UDL elements.

Ethical considerations also came into play as certain additions to the UDL treatment seemed essential for the control group as well. Decisions were guided by the standard that basic information provided in the treatment should also be available to the control group. This meant that while the instructor did not feel compelled to share collaborative features or content in *all* its diverse formats, a key content-addition (such as the provision of unit objectives) should be included in the control group's LMS site.

The very attributes that make the electronic LMS such a promising system for organizing and designing UDL approaches may have concurrently diminished the strength of the research design itself and perhaps even its ability to yield a demonstrably positive result.

In the area of student engagement, this study may have serendipitously added to the literature that describes situations in which student engagement thrives or falters. Looking at the data collected from the validated Student Course Engagement Surveys, it is clear student engagement showed a significant decline among both groups of students. With this determination and in light of the fact that the students surveyed were

predominantly first-semester freshmen, this study may have accumulated evidence that supports previous suggestions (Howard, 2004; Jimenez, et al., 2007; Vygotsky, 1978) that student engagement is context-dependent, and relies on a situation in which the learner's overall and course-specific experience is within a manageable range of challenge.

When examining potential benefits of UDL, student engagement is one of many outcomes UDL might alter or improve. However, in designing future studies of how UDL impacts engagement among postsecondary students, the exploration of this outcome might additionally be conducted using a sophomore-level class or perhaps another more established group of student-participants.

Benefits to be derived from LMS-facilitated approaches to UDL include essential accessibility to curriculum content, as well as the possibility of improved learning or higher retention rates. If UDL is to continue to be endorsed by U.S. law, it is important that evidence be assembled that points to advantages that will make the time, effort, and resource allocations worthwhile.

This study has provided foundational data in the area of implementation by showing the Blackboard LMS is flexible and supportive to the point it can be designed to deliver UDL and also that an instructor who was initially unfamiliar with UDL demonstrated the ability to use CAST checklists and resources to implement UDL with a high level of efficacy. The current study demonstrated UDL had no significant impact on student engagement. However, this finding must be viewed as the result of one early study that involved a single subject-area and instructor as well as a high percentage of first-semester freshmen.

As an inclusive approach, UDL holds great promise as a means of improving the learning experience for all people. This study was an early effort to understand and address the benefits and challenges associated with UDL. It also sought to find practical ways to implement UDL using the LMS.

Advocates of instructional innovations have often been called upon to document the worth of the approaches they endorse. Although the current study did not quantify any specific benefits to students, it did confirm the value of the LMS as a possible approach to meeting the complex design demands of UDL. Previous studies on student engagement (Howard, 2004; Jiminez, 2007) indicate student engagement may be contextually sensitive. Thus, many more studies are needed before we can fully comprehend or articulate UDL's impact on learner engagement.

UDL has been endorsed by the U.S. government and other entities, but such support has already drawn criticism from various sectors. And while it represents a promising and inclusive construct, UDL's benefits and the means for its implementation are still not fully understood. In supporting the diverse learner, it is important that administrators, practitioners, and scholars continue to explore strategies for UDL's implementation and to document the advantages that UDL has to offer.

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Appendices

Appendix A

UDL Guidelines – Educator Checklist

UDL Guidelines – Educator Checklist

I. Provide Multiple Means of Representation:	Your notes
1. Provide options for perception	
1.1 Customize the display of information	
1.2 Provide alternatives for auditory information	
1.3 Provide alternatives for visual information	
2. Provide options for language and symbols	
2.1 Define vocabulary and symbols	
2.2 Clarify syntax and structure	
2.3 Decode text and mathematical notation	
2.4 Promote cross-linguistic understanding	
2.5 Illustrate key concepts non-linguistically	
3. Provide options for comprehension	
3.1 Provide or activate background knowledge	
3.2 Highlight critical features, big ideas, and relationships	
3.3 Guide information processing	
3.4 Support memory and transfer	
II. Provide Multiple Means for Action and Expression:	Your notes
4. Provide options for physical actions	
4.1 Provide varied ways to respond	
4.2 Provide varied ways to interact with materials	
4.3 Integrate assistive technologies	
5. Provide options for expressive skills and fluency	
5.1 Allow choices of media for communication	
5.2 Provide appropriate tools for composition and problem solving	
5.3 Provide ways to scaffold practice and performance	
6. Provide options for executive functions	
6.1 Guide effective goal setting	
6.2 Support planning and strategy development	
6.3 Facilitate managing information and resources	
6.4 Enhance capacity for monitoring progress	

III. Provide Multiple Means for Engagement:	Your notes
7. Provide options for recruiting interest	
7.1 Increase individual choice and autonomy	
7.2 Enhance relevance, value, and authenticity	
7.3 Reduce threats and distractions	
8. Provide options for sustaining effort and persistence	
8.1 Heighten salience of goals and objectives	
8.2 Vary levels of challenge and support	
8.3 Foster collaboration and communication	
8.4 Increase mastery-oriented feedback	
9. Provide options for self-regulation	
9.1 Guide personal goal-setting and expectations	
9.2 Scaffold coping skills and strategies	
9.3 Develop self-assessment and reflection	

Appendix B

UDL Instructor Response Form

UDL (CAST, 2011) Instructor Response Form

Attention Instructor: Please use this form for each Unit or Chapter of content to:

- (1) **identify UDL approaches** being used in the treatment section,
- (2) **identify your level of efficacy** with your application of each of three UDL domains, and
- (3) **When saving file, please append filename with current date and email to sbongey@css.edu.**

Name: _____

Date: _____

I. Provide Multiple Means of Representation

1: Provide options for perception. Under this standard, please select one LMS-based strategy you are using for the current unit. Then, please use the entry box to provide further detail. Note: Please refer to your UDL checklist as needed. Select one:

- 1.1 Offer ways of customizing the display of information
- 1.2 Offer alternatives for auditory information
- 1.3 Offer alternatives for visual information

Please explain your selection:

2: Provide options for language, mathematical expressions, and symbols. Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail. Select one:

- 2.1 Clarify vocabulary and symbols
- 2.2 Clarify syntax and structure
- 2.3 Support decoding of text, mathematical notation, and symbols
- 2.4 Promote understanding across languages
- 2.5 Illustrate through multiple media

Please explain your selection:

3: Provide options for comprehension.

Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail. Select one:

- 3.1 Activate or supply background knowledge
- 3.2 Highlight patterns, critical features, big ideas, and relationships
- 3.3 Guide information processing, visualization, and manipulation
- 3.4 Maximize transfer and generalization

Please explain your selection:

On a scale of 1-5 (5 being most), please rate your efficacy in addressing this UDL domain (Multiple Means of Representation): 1 2 3 4 5

II. Provide Multiple Means for Action and Expression

4: Provide options for physical action.

Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail. Select one:

- 4.1 Vary the methods for response and navigation
- 4.2 Optimize access to tools and assistive technologies

Please explain your selection:

5: Provide options for expression and communication.

Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail. Select one:

- 5.1 Use multiple media for communication
- 5.2 Use multiple tools for construction and composition
- 5.3 Build fluencies with graduated levels of support for practice and performance

Please explain your selection:

6: Provide options for executive functions.

Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail.

- 6.1 Guide appropriate goal-setting
- 6.2 Support planning and strategy development
- 6.3 Facilitate managing information and resources
- 6.4 Enhance capacity for monitoring progress

Please explain your selection:

On a scale of 1-5 (5 being most), please rate your efficacy in addressing this UDL domain (Multiple Means of Action & Expression). 1 2 3 4 5

III. Provide Multiple Means of Engagement

7: Provide options for recruiting interest.

Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail.

- 7.1 Optimize individual choice and autonomy
- 7.2 Optimize relevance, value, and authenticity
- 7.3 Minimize threats and distractions

Please explain your selection:

8: Provide options for sustaining effort and persistence.

Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail.

- 8.1 Heighten salience of goals and objectives
- 8.2 Vary demands and resources to optimize challenge
- 8.3 Foster collaboration and community
- 8.4 Increase mastery-oriented feedback

Please explain your selection:

9: Provide options for self-regulation.

Under this standard, please select one strategy you are using in the LMS to enhance the current unit. Then, please use the entry box to provide further detail.

- 9.1 Promote expectations and beliefs that optimize motivation
- 9.2 Facilitate personal coping skills and strategies
- 9.3 Develop self-assessment and reflection

Please explain your selection:

On a scale of 1-5 (5 being most), please rate your efficacy in addressing this UDL domain (Multiple Means of Engagement). 1 2 3 4 5

Appendix C

UDL Design Validation Form

UDL (CAST, 2011) Design Validation Form

Overview: This form along with CAST resources (guidelines and checkpoints) is used to confirm UDL approaches being used. Using the current Instructor-Response form as a reference point, also verify whether the noted UDL approaches are present.

Name: _____ Date: _____ References Instructor-Response Form dated: _____

I. Provide Multiple Means of Representation

1: Provide options for perception. Under this standard, please identify one strategy the instructor used to enhance the current unit or chapter. Then, please use the entry box to provide further detail. Note: Please refer to your UDL checklist as needed. Select one:

- 1.1 Offer ways of customizing the display of information
- 1.2 Offer alternatives for auditory information
- 1.3 Offer alternatives for visual information

Please explain:

2: Provide options for language, mathematical expressions, and symbols. Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail. Select one:

- 2.1 Clarify vocabulary and symbols
- 2.2 Clarify syntax and structure
- 2.3 Support decoding of text, mathematical notation, and symbols
- 2.4 Promote understanding across languages
- 2.5 Illustrate through multiple media

Please explain:

3: Provide options for comprehension.

Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail. Select one:

- 3.1 Activate or supply background knowledge
- 3.2 Highlight patterns, critical features, big ideas, and relationships
- 3.3 Guide information processing, visualization, and manipulation
- 3.4 Maximize transfer and generalization

Please explain:

II. Provide Multiple Means for Action and Expression

4: Provide options for physical action.

Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail. Select one:

- 4.1 Vary the methods for response and navigation
- 4.2 Optimize access to tools and assistive technologies

Please explain:

5: Provide options for expression and communication.

Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail. Select one:

- 5.1 Use multiple media for communication
- 5.2 Use multiple tools for construction and composition
- 5.3 Build fluencies with graduated levels of support for practice and performance

Please explain:

6: Provide options for executive functions.

Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail.

- 6.1 Guide appropriate goal-setting
- 6.2 Support planning and strategy development
- 6.3 Facilitate managing information and resources
- 6.4 Enhance capacity for monitoring progress

Please explain:

III. Provide Multiple Means of Engagement

7: Provide options for recruiting interest.

Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail.

- 7.1 Optimize individual choice and autonomy
- 7.2 Optimize relevance, value, and authenticity
- 7.3 Minimize threats and distractions

Please explain:

8: Provide options for sustaining effort and persistence.

Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail.

- 8.1 Heighten salience of goals and objectives
- 8.2 Vary demands and resources to optimize challenge
- 8.3 Foster collaboration and community
- 8.4 Increase mastery-oriented feedback

Please explain:

9: Provide options for self-regulation.

Under this standard, please identify one strategy the instructor used in the LMS to enhance the current unit or chapter. Then, please use the entry box to provide further detail.

- 9.1 Promote expectations and beliefs that optimize motivation
- 9.2 Facilitate personal coping skills and strategies
- 9.3 Develop self-assessment and reflection

Please explain:

Based on the current review of the treatment site, is adjustment needed to maintain UDL approach? Yes No

If yes, please provide recommendation for adjustment/action:

Corrective action taken? Yes No

Comments:

Date: _____

Appendix D

Pre-test Student Course Engagement Questionnaire (SCEQ)

BIO 1110: General Biology

Please indicate what section you are in:

Please list the last four
Digits of your cell phone: _____Section 001 (9:15-10:05) _____
Section 002 (10:30-11:20) _____**STUDENT ENGAGEMENT QUESTIONNAIRE**

To what extent do the following behaviors, thoughts, and feelings describe *you*, in *this course*. Please rate each of them on the following scale:

5 = very characteristic of me
4 = characteristic of me
3 = moderately characteristic of me
2 = not really characteristic of me
1 = not at all characteristic of me

1. _____ Raising my hand in class
2. _____ Participating actively in small group discussions
3. _____ Asking questions when I don't understand the instructor
4. _____ Doing all the homework problems
5. _____ Coming to class every day
6. _____ Going to the professor's office hours to review assignments or tests, or to ask questions
7. _____ Thinking about the course between class meetings
8. _____ Finding ways to make the course interesting to me
9. _____ Taking good notes in class
10. _____ Looking over class notes between classes to make sure I understand the material
11. _____ Really desiring to learn the material
12. _____ Being confident that I can learn and do well in the class
13. _____ Putting forth effort

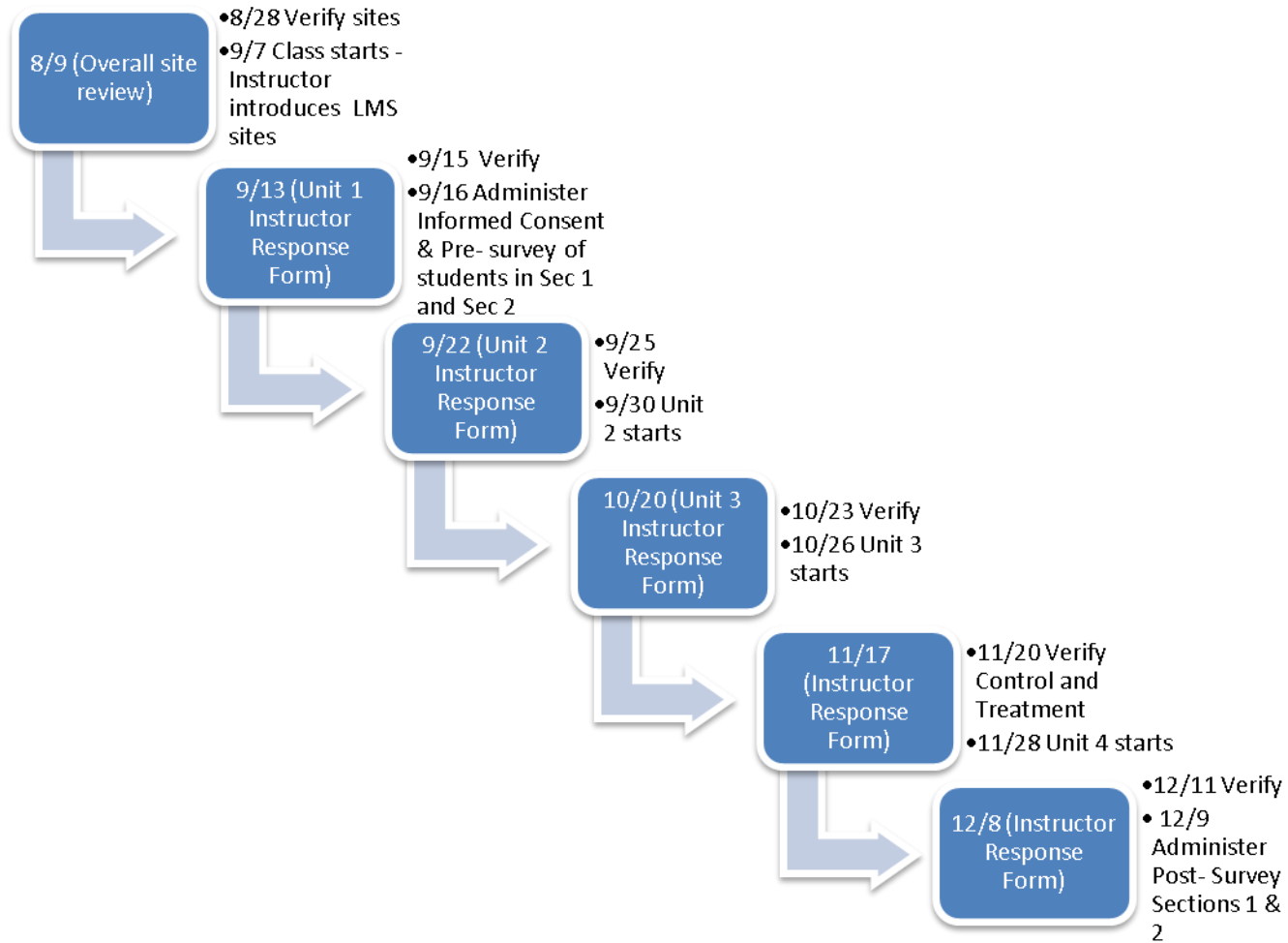
14. _____ Being organized
15. _____ Getting a good grade
16. _____ Doing well on the tests
17. _____ Staying up on the readings
18. _____ Having fun in class
19. _____ Helping fellow students
20. _____ Making sure to study on a regular basis
21. _____ Finding ways to make the course material relevant to my life
22. _____ Applying course material to my life
23. _____ Listening carefully in class

[Source: Handelsman, M. M., Briggs, W. L., Sullivan, N., & Towler, A. (2005). A measure of college student course engagement. *Journal of Educational Research*, 98, 184-191.]

Appendix E

Implementation and Data Collection Timeline

Implementation and Data Collection Timeline



Appendix F

Post-test Student Course Engagement Questionnaire (SCEQ)

STUDENT ENGAGEMENT QUESTIONNAIRE

To what extent do the following behaviors, thoughts, and feelings describe you, in this course. Please rate each of them on the following scale:

5 = very characteristic of me 4 = characteristic of me 3 = moderately characteristic of me 2 = not really characteristic of me 1 = not at all characteristic of me
--

1. _____ Raising my hand in class
2. _____ Participating actively in small group discussions
3. _____ Asking questions when I don't understand the instructor
4. _____ Doing all the homework problems
5. _____ Coming to class every day
6. _____ Going to the professor's office hours to review assignments or tests, or to ask questions
7. _____ Thinking about the course between class meetings
8. _____ Finding ways to make the course interesting to me
9. _____ Taking good notes in class
10. _____ Looking over class notes between classes to make sure I understand the material
11. _____ Really desiring to learn the material
12. _____ Being confident that I can learn and do well in the class
13. _____ Putting forth effort
14. _____ Being organized
15. _____ Getting a good grade

16. _____ Doing well on the tests
17. _____ Staying up on the readings
18. _____ Having fun in class
19. _____ Helping fellow students
20. _____ Making sure to study on a regular basis
21. _____ Finding ways to make the course material relevant to my life
22. _____ Applying course material to my life
23. _____ Listening carefully in class

[Source: Handelsman, M. M., Briggs, W. L., Sullivan, N., & Towler, A. (2005). A measure of college student course engagement. *Journal of Educational Research*, 98, 184-191.]

Please specify your level of use of the Blackboard course site associated with this class
(Circle the number):

Infrequent 1 2 3 4 5 Frequent

Appendix G

Student Course Engagement Questionnaire (SCEQ) Scoring

SCEQ: STUDENT ENGAGEMENT SCORING

[Source: Handelsman, M. M., Briggs, W. L., Sullivan, N., & Towler, A. (2005). A measure of college student course engagement. *Journal of Educational Research*, 98, 184-191.]

For the total score, simply add up the answers. For each subscale, simply add up the answers for the questions in each subscale.

SKILLS ENGAGEMENT SUBSCALE

4. ____ Doing all the homework problems
5. ____ Coming to class every day
9. ____ Taking good notes in class
10. ____ Looking over class notes between classes to make sure I understand the material
13. ____ Putting forth effort
14. ____ Being organized
17. ____ Staying up on the readings
20. ____ Making sure to study on a regular basis
23. ____ Listening carefully in class

EMOTIONAL ENGAGEMENT SUBSCALE

7. ____ Thinking about the course between class meetings
8. ____ Finding ways to make the course interesting to me
11. ____ Really desiring to learn the material
21. ____ Finding ways to make the course material relevant to my life
22. ____ Applying course material to my life

PARTICIPATION/INTERACTION ENGAGEMENT SUBSCALE

1. ____ Raising my hand in class
2. ____ Participating actively in small group discussions
3. ____ Asking questions when I don't understand the instructor
6. ____ Going to the professor's office hours to review assignments or tests, or to
ask questions
18. ____ Having fun in class
19. ____ Helping fellow students

PERFORMANCE ENGAGEMENT SUBSCALE

12. ____ Being confident that I can learn and do well in the class
15. ____ Getting a good grade
16. ____ Doing well on the tests

Appendix H

UDL Treatment – LMS Site Evaluation using CAST’s Educator Checklist & Notes Page

UDL Treatment – LMS Site Evaluation using CAST’s Educator Checklist & Notes Page

I. <u>Provide Multiple Means of Representation:</u>	Notes based on 8/28/2011 Review of LMS
1. <u>Provide options for perception</u>	
1.1 <u>Offer ways of customizing the display of information</u>	Blackboard (Bb) & browser allow sizing of fonts
1.2 <u>Offer alternatives for auditory information</u>	YouTube videos, textbook resources-interactive
1.3 <u>Offer alternatives for visual information</u>	PowerPoints, YouTube videos, textbook interactions
2. <u>Provide options for language, mathematical expressions, and symbols</u>	
2.1 <u>Clarify vocabulary and symbols</u>	Glossary, study games
2.2 <u>Clarify syntax and structure</u>	Glossary, concept maps
2.3 <u>Support decoding of text, and mathematical notation, and symbols</u>	Bb flex display
2.4 <u>Promote understanding across language</u>	Bb language option/features
2.5 <u>Illustrate through multiple media</u>	PowerPoint w/visuals & text-based files, video & interactions
3. <u>Provide options for comprehension</u>	
3.1 <u>Activate or supply background knowledge</u>	PowerPoints, textbook resources, learning games, videos, weblinks
3.2 <u>Highlight patterns, critical features, big ideas, and relationships</u>	PowerPoints, learning objectives
3.3 <u>Guide information processing, visualization, and manipulation</u>	Textbook interactivities, learning games
3.4 <u>Maximize transfer and generalization</u>	Textbook interactivities, virtual lab activities, virtual office hour and options for online collaboration/chatroom discussions

II. <u>Provide Multiple Means for Action and Expression:</u>	Notes based on 8/28/2011 Review of LMS
4. <u>Provide options for physical action</u>	
4.1 <u>Vary the methods for response and navigation</u>	Online meetings, virtual office hour, email, online discussions
4.2 <u>Optimize access to tools and assistive technologies</u>	Bb LMS has some assistive tech, detailed menu
5. <u>Provide options for expression and communication</u>	
5.1 <u>Use multiple media for communication</u>	Online meetings & office hour, discussions, email
5.2 <u>Use multiple tools for construction and composition</u>	Web conferencing/online meeting tools, textbook animations and interactivities
5.3 <u>Build fluencies with graduated labels of support for practice and performance</u>	Supplemental Instruction (SI) posting, interactions, learning games
6. <u>Provide options for executive functions</u>	
6.1 <u>Guide appropriate goal setting</u>	Syllabus & study guide, learning objectives
6.2 <u>Support planning and strategy development</u>	Calendar with text and image-based reminders
6.3 <u>Facilitate managing information and resources</u>	Learning objectives serve as guide for notetaking, PowerPoints with printable/notes-version PDF option
6.4 <u>Enhance capacity for monitoring progress</u>	Use of online grade book in Bb site, interactive practice tests with auto-grading/feedback
III. <u>Provide Multiple Means for Engagement:</u>	Notes based on 8/28/2011 Review of LMS
7. <u>Provide options for recruiting interest</u>	
7.1 <u>Optimize individual choice and autonomy</u>	Interactive activities, games, collaboration areas
7.2 <u>Optimize relevance, value, and authenticity</u>	Options for interactive, visual, auditory and text-based study materials and opportunities, including virtual office hour, collaboration room, and student-generated learning games
7.3 <u>Minimize threats and distractions</u>	Modularized by unit, students are directed to current unit upon log in, header information provides overview of emphasized information, Calendar announcements add focus

8. Provide options for sustaining effort and persistence	
8.1 Heighten salience of goals and objectives	Learning objectives for each unit, links to websites of leading journals, articles and resources
8.2 Vary demands and resources to optimize challenge	Textbook interactions, self-tests
8.3 Foster collaboration and community	Students are encouraged to participate in study groups (S.I.), online meetings & office hours, discussion, built-in email option
8.4 Increase mastery-oriented feedback	grade book, learning games, interactive practice tests with feedback and options to repeat test unlimited times.
9. Provide options for self-regulation	
9.1 Promote expectations and beliefs that optimize motivation	Textbook interactions, Web links to journal articles and relevant sites, option to construct, edit, and play learning games
9.2 Facilitate personal coping skills and strategies	Virtual office hour, online student collaboration room
9.3 Develop self-assessment and reflection	Learning games, option to construct, edit, and play learning games

Appendix I

UDL Control – LMS Site Evaluation using CAST’s Educator Checklist & Notes Page

UDL Control – LMS Site Evaluation using CAST’s Educator Checklist & Notes Page

I. <u>Provide Multiple Means of Representation:</u>	Notes based on 8/28/2011 Review of LMS
1. <u>Provide options for perception</u>	
1.1 <u>Offer ways of customizing the display of information</u>	Blackboard (Bb) & browser allow sizing of fonts
1.2 <u>Offer alternatives for auditory information</u>	-
1.3 <u>Offer alternatives for visual information</u>	-
2. <u>Provide options for language, mathematical expressions, and symbols</u>	
2.1 <u>Clarify vocabulary and symbols</u>	-
2.2 <u>Clarify syntax and structure</u>	-
2.3 <u>Support decoding of text, and mathematical notation, and symbols</u>	Bb flex display
2.4 <u>Promote understanding across language</u>	Bb language option/features
2.5 <u>Illustrate through multiple media</u>	PowerPoint w/visuals & text-based files present
3. <u>Provide options for comprehension</u>	
3.1 <u>Activate or supply background knowledge</u>	PowerPoint slides of lectures, old exams
3.2 <u>Highlight patterns, critical features, big ideas, and relationships</u>	PowerPoints
3.3 <u>Guide information processing, visualization, and manipulation</u>	-
3.4 <u>Maximize transfer and generalization</u>	-
II. <u>Provide Multiple Means for Action and Expression:</u>	Notes based on 8/28/2011 Review of LMS
4. <u>Provide options for physical action</u>	
4.1 <u>Vary the methods for response and navigation</u>	-
4.2 <u>Optimize access to tools and assistive technologies</u>	Bb LMS has some assistive tech

5. Provide options for expression and communication	
5.1 Use multiple media for communication	-
5.2 Use multiple tools for construction and composition	-
5.3 Build fluencies with graduated labels of support for practice and performance	Supplemental Instruction (SI) posting
6. Provide options for executive functions	
6.1 Guide appropriate goal setting	Syllabus & study guide
6.2 Support planning and strategy development	-
6.3 Facilitate managing information and resources	-
6.4 Enhance capacity for monitoring progress	Use of online grade book in Bb site
III. Provide Multiple Means for Engagement:	Notes based on 8/28/2011 Review of LMS
7. Provide options for recruiting interest	
7.1 Optimize individual choice and autonomy	-
7.2 Optimize relevance, value, and authenticity	-
7.3 Minimize threats and distractions	All content items are in one area
8. Provide options for sustaining effort and persistence	
8.1 Heighten salience of goals and objectives	-
8.2 Vary demands and resources to optimize challenge	-
8.3 Foster collaboration and community	Students are encouraged to participate in study groups (S.I.)
8.4 Increase mastery-oriented feedback	grade book
9. Provide options for self-regulation	
9.1 Promote expectations and beliefs that optimize motivation	-
9.2 Facilitate personal coping skills and strategies	-
9.3 Develop self-assessment and reflection	-

Appendix J

UDL Approaches in Control and Treatment Sites – Consultant’s Evaluation Report

Initial Verification of Control and Treatment Sites

8-9-2011 and 8-28-2011

Narrative summary of the Universal Design for Learning (UDL) initial verification of the control and treatment sites.

Based on information from the Center for Applied Special Technology (CAST) on the three primary principles of Universal Design for Learning – Multiple means of representation, multiple means of action and expression, and multiple means of engagement.

Control Site

Provide Multiple Means of Representation - UDL Brain Network – Recognition Networks – Present information and content in different ways –

The control site has very limited elements meeting this principle.

It offers some ways to customize the display of information through Blackboard and Web browsers allowing the sizing of the screen. Blackboard also allows for some decoding of mathematical notations and the understanding across languages. The control site supplies some background knowledge by providing prior exams and PowerPoint notes.

Provide Multiple Means of Action and Expression - UDL Brain Network – Strategic Networks – Differentiate the ways that students can express what they know -

The control site has very limited elements meeting this principle.
Blackboard has some built-in assistive technology.

The supplemental instruction will give some level of support for practice and performance.

The syllabus, study guide, and grade book with guide goal setting and allow the monitoring of progress.

Provide Multiple Means of Engagement - UDL Brain Network – Affective Networks– Stimulate interest and motivation for learning -

The control site contains no elements meeting this principle.

Treatment Site**Provide Multiple Means of Representation - UDL Brain Network – Recognition Networks – Present information and content in different ways –**

The treatment site contains elements of all CAST checkpoints for the principle Provide Multiple Means of Representation.

Provide Multiple Means of Action and Expression - UDL Brain Network – Strategic Networks – Differentiate the ways that students can express what they know -

The treatment site contains elements of all CAST checkpoints for the principle Provide Multiple Means of Action and Expression.

The 8-9-2001 review of the site recommended that a course calendar be added. The 8-28-2011 review verified it was added.

Provide Multiple Means of Engagement - UDL Brain Network – Affective Networks– Stimulate interest and motivation for learning -

The treatment site contains elements of all CAST checkpoints for the principle Provide Multiple Means of Engagement.

The 8-9-2001 review of the site recommended that learning objectives be added to all course units. The 8-28-2011 review verified they were added.

Appendix K

UDL Instructor Response and Site Validation Activity

Representation: Options for perception.	Please explain your selection	Representation: Options for language, mathematical expressions, and symbols.	Please explain your selection:	Representation: Options for comprehension.	Please explain your selection:	Efficacy (1-5)	Verified (Enter name and date)	Verified (Enter name and date)	Based on current review of LMS/treatment site, is adjustment needed to maintain UDL approaches? (Enter Yes or No)
Offer alternatives for visual information	There are animations, videos, and alternative images from the book's website "mastering biology" that we have posted on blackboard that gives students new ways of processing lecture information.	Illustrate through multiple media	There are many animations and interactive graphics posted on blackboard that rely more on graphics than text that would help individuals with English as their second language or have language related disabilities.	Highlight patterns, critical features, big ideas, and relationships	I post a file with the learning outcomes for each chapter so that students know what to focus on for exams/quizzes. Blackboard for the experimental section is divided into units that correspond to different exams so that students know what material to focus on for the exams.	5	Diana Johnson, 9-15-2011	Sarah Bryans Bongey 9-15-2011- Items noted by instructor as UDL features are present. Although instructor rated her efficacy in the area of Multiple Means of Action and Expression as 4/5, her examples were reflective of UDL.	No - UDL approaches are maintained but following are two suggestions - The Lab 2 folder is empty - content needs to be added. It would be useful to include the Unit numbers that are being covered on the Monday of the week. Students can then view month and see the unit that is being covered for the week.
Offer alternatives for visual information	There are many animations and extra videos posted on the experimental site that give the students new ways to digest lecture material.	Clarify vocabulary and symbols	There is an online glossary posted on blackboard where students can look up any vocabulary words they are unsure about.	Highlight patterns, critical features, big ideas, and relationships	The students can download learning outcomes for each exam. The learning outcomes are a laundry list of all the major concepts covered and conveys most of material covered on exams.	5	Diana Johnson, 9-24-2011	Instructor rated her confidence/efficacy as 5/5 in all domains. PI believes site and Unit 2 is compliant with UDL. In keeping with the SI example provided for the Engagement domain. Suggest that SI events be posted in the online calendar. Dr. Johnson, the Independent ID Consultant is scheduled to evaluate Unit 2 tomorrow.	No - UDL approaches are maintained but following are two suggestions - The Lab 2 folder is empty - content needs to be added. It would be useful to include the Unit numbers that are being covered on the Monday of the week in the Calendar tool. Students can then view month and see the unit that is being covered for the week.

Representation: Options for perception.	Please explain your selection	Representation: Options for language, mathematical expressions, and symbols.	Please explain your selection:	Representation: Options for comprehension.	Please explain your selection:	Efficacy (1-5)	Verified (Enter name and date)	Verified (Enter name and date)	Based on current review of LMS/treatment site, is adjustment needed to maintain UDL approaches? (Enter Yes or No)
Offer alternatives for visual information	Students are given access to animations and videos from the text book that are related to the material covered in class.	Clarify vocabulary and symbols	There is a glossary embedded in the blackboard environment for the experimental section. This glossary is accessible to both Mac and PC users.	Highlight patterns, critical features, big ideas, and relationships	Students are given learning objectives for each exam. These learning objectives are posted in blackboard for both sections.	5	Diana Johnson 10- 22-2011	SBB - 10/21/2011 15:09:57	No adjustments needed.
Offer alternatives for visual information	There are many images, videos, and animations from the text book company that have been made available on blackboard.	Clarify vocabulary and symbols	There is a glossary with biology terms on blackboard that the student in the UDL section can use. The glossary can be accessed on a Mac or a PC.	Guide information processing, visualization, and manipulation	All of the information posted on blackboard is organized into 4 units. Each of the four units contains all of the resources for a particular exam. The units are made available as the semester progresses and the unit that we are working on is the unit that pops up when the students enter blackboard.	5	Diana Johnson 11- 20-2011	SBB - 11/19/2011 17:14:57	No adjustments are needed
Offer alternatives for visual information	There are lots of animations and videos from the text book that are on the experimental groups blackboard but not on the comparison groups blackboard.	Illustrate through multiple media	The animations and videos posted on the experimental site give students alternative ways to learn the information presented in class, which is mostly presented in text form.	Activate or supply background knowledge	Many of the animations and videos and exercises posted on blackboard in the experimental section give the necessary background to understand the current information. The videos and exercises also give the relationships between key concepts.	5	Diana Johnson 12- 10-2011	SBB - 12/11/2011 09:50:51	No adjustment needed.

Action and Expression: Options for physical action:	Please explain your selection:	Action and Expression: Options for expression and communication:	Please explain your selection:	Action and Expression: Options for executive functions:	Please explain your selection:	Efficacy (1-5)	Verified (Enter name and date)	Verified (Enter name and date)	Based on current review of LMS/treatment site, is adjustment needed to maintain UDL approaches? (Enter Yes or No)
Optimize access to tools and assistive technologies	I believe that blackboard works with keyboard alternatives and alt keys.	Use multiple media for communication	I have a wimba office hour that students can use to ask me questions. I will be able to type or draw pictures to answer their questions.	Enhance capacity for monitoring progress	students will be able to monitor their progress in class using the gradebook on blackboard. they also get to see the rubrics used to grade their lab writing assignments.	4	Diana Johnson, 9-15-2011	Sarah Bryans Bongey 9-15-2011- Items noted by instructor as UDL features are present. Although instructor rated her efficacy in the area of Multiple Means of Action and Expression as 4/5, her examples were reflective of UDL.	No - UDL approaches are maintained but following are two suggestions - The Lab 2 folder is empty - content needs to be added. It would be useful to include the Unit numbers that are being covered on the Monday of the week. Students can then view month and see the unit that is being covered for the week.
Optimize access to tools and assistive technologies	The software on blackboard with the different keyboard alternatives.	Use multiple media for communication	I have an online office hour using a Wimba classroom. Students can ask questions by typing their questions, or by using a microphone.	Enhance capacity for monitoring progress	The students can monitor their progress using our online gradebook.	5	Diana Johnson, 9-24-2011	Instructor rated her confidence/efficacy as 5/5 in all domains. PI believes site and Unit 2 is compliant with UDL. In keeping with the SI example provided for the Engagement domain. Suggest that SI events be posted in the online calendar. Dr. Johnson, the Independent ID Consultant is scheduled to evaluate Unit 2 tomorrow.	No - UDL approaches are maintained but following are two suggestions - The Lab 2 folder is empty - content needs to be added. It would be useful to include the Unit numbers that are being covered on the Monday of the week in the Calendar tool. Students can then view month and see the unit that is being covered for the week.

Action and Expression: Options for physical action:	Please explain your selection:	Action and Expression: Options for expression and communication:	Please explain your selection:	Action and Expression: Options for executive functions:	Please explain your selection:	Efficacy (1-5)	Verified (Enter name and date)	Verified (Enter name and date)	Based on current review of LMS/treatment site, is adjustment needed to maintain UDL approaches? (Enter Yes or No)
Optimize access to tools and assistive technologies	Blackboard works seamlessly with all the alternative keyboards.	Use multiple tools for construction and composition	Slides are posted on blackboard in both PowerPoint and pdf formats. This allows students who don't have access to PowerPoint software to still be able to view the notes on my slides.	Enhance capacity for monitoring progress	Students can monitor their progress in the gradebook application on blackboard.	5	Diana Johnson 10-22-2011	SBB - 10/21/2011 15:09:57	No adjustments needed.
Optimize access to tools and assistive technologies	Blackboard works with alternative keyboards.	Use multiple tools for construction and composition	Powerpoint slides are posted in PowerPoint and pdf formats.	Enhance capacity for monitoring progress	Students can monitor their grades on gradebook.	5	Diana Johnson 11-20-2011	SBB - 11/19/2011 17:14:57	No adjustments are needed
Optimize access to tools and assistive technologies	Blackboard works with all keyboard alternatives.	Use multiple media for communication	I had an online office hour that the students could take advantage of. We could communicate via a chat function or through our computer microphones or the students could even call in using their cells phones. There were also interactive games that the students could use on blackboard as well as a forum where they could communicate with other students in the course.	Guide appropriate goal-setting	Learning objectives were posted on both the experimental and comparison groups blackboard. It was basically a checklist for everything the student should have learned in that particular unit.	5	Diana Johnson 12-10-2011	SBB - 12/11/2011 09:50:51	No adjustment needed.

Engagement: Options for recruiting interest:	Please explain your selection:	Engagement: Options for sustaining effort and persistence:	Please explain your selection:	Engagement: Options for self- regulation:	Please explain your selection:	Efficacy (1-5)	Verified (Enter name and date)	Verified (Enter name and date)	Based on current review of LMS/treatment site, is adjustment needed to maintain UDL approaches? (Enter Yes or No)
Optimize individual choice and autonomy	Students can reinforce information in many different ways. there are animations they can look at, also flashcards and many word games.	Foster collaboration and community	SI sessions foster collaborative learning as does the Wimba classroom and learning games posted in the collaborative learning section of Blackboard. Students can input different facts into the learning games and other students can use these questions to study or come up with their own questions. both reinforce lecture information.	Promote expectations and beliefs that optimize motivation	Students that attend the si sessions can ask the SI instructor about the class as he took the class 2 years ago. I believe in this way the SI instructor can act as a mentor that can help them to set appropriate goals for the students.	5	Diana Johnson, 9- 15-2011	Sarah Bryans Bongey 9-15- 2011- Items noted by instructor as UDL features are present. Although instructor rated her efficacy in the area of Multiple Means of Action and Expression as 4/5, her examples were reflective of UDL.	No - UDL approaches are maintained but following are two suggestions - The Lab 2 folder is empty - content needs to be added. It would be useful to include the Unit numbers that are being covered on the Monday of the week. Students can then view month and see the unit that is being covered for the week.
Minimize threats and distractions	There is an established a routine in my class. I post notes on Blackboard in advance so that students know what material we will cover. I also start class with announcements, then learning objectives for the day and then background from the lecture before. In the experimental section, there is also a calendar on blackboard that gives them an alert for any upcoming tests, quizzes, assignments, etc.	Foster collaboration and community	We have SI sessions on Thursdays where students work together on a worksheet with all of the relevant information for an upcoming quiz/exam.	Promote expectations and beliefs that optimize motivation	Students can attend SI sessions which are led by an undergraduate who performed well in the course a few years ago. He can give the students advice on how to study and tips on taking exams.	5	Diana Johnson, 9- 24-2011	SBB 9-24-2011 -- Instructor rated her confidence/efficacy as 5/5 in all domains. PI believes site and Unit 2 is compliant with UDL. In keeping with the SI example provided for the Engagement domain. Suggest that SI events be posted in the online calendar. Dr. Johnson, the Independent ID Consultant is scheduled to evaluate Unit 2 tomorrow.	No - UDL approaches are maintained but following are two suggestions - The Lab 2 folder is empty - content needs to be added. It would be useful to include the Unit numbers that are being covered on the Monday of the week in the Calendar tool. Students can then view month and see the unit that is being covered for the week.

Engagement: Options for recruiting interest:	Please explain your selection:	Engagement: Options for sustaining effort and persistence:	Please explain your selection:	Engagement: Options for self- regulation:	Please explain your selection:	Efficacy (1-5)	Verified (Enter name and date)	Verified (Enter name and date)	Based on current review of LMS/treatment site, is adjustment needed to maintain UDL approaches? (Enter Yes or No)
Minimize threats and distractions	There is a calendar on Blackboard that notifies the students of all office hours and all out-of-classroom activities. Also, I have a very regimented classroom routine. Quizzes are always on Fridays and every lecture starts out with announcements, learning objectives and background from the last lecture.	Foster collaboration and community	There are SI sessions which are voluntary learning groups that help students who need a little extra help. There are also many collaboration opportunities on blackboard. There are learning games where students can write questions and answer other students' questions. There is also a student collaboration wimba room on blackboard.	Promote expectations and beliefs that optimize motivation	The SI sessions are led by a former gen bio student who can help them set appropriate learning goals that can help them to be more successful in the course. In helping develop self-assessment and reflection, there is gradebook information and interactive textbook activities that students use to enter ideas/answers and see responses.	5	Diana Johnson 10-22-2011	SBB - 10/21/2011 15:09:57	No adjustments needed.
Minimize threats and distractions	There is a calendar on blackboard that gives the schedule for office hours, SI sessions and quizzes/exams. Also, the course is pretty regimented. I start out lecture with announcements to remind students of deadlines and quizzes are given every Friday at the beginning of lecture.	Foster collaboration and community	There are collaborative learning games on blackboard that the students can participate in.	Develop self-assessment and reflection	There are many interactive animations and self-quizzes posted on blackboard that the students can do. They give the students feedback about which concepts they have mastered and which ones they may to work on a little more. They also have access to old exams that give them an idea about whether or not they are ready for an upcoming exam.	5	Diana Johnson 11-20-2011	SBB - 11/19/2011 17:14:57	No adjustments are needed

Engagement: Options for recruiting interest:	Please explain your selection:	Engagement: Options for sustaining effort and persistence:	Please explain your selection:	Engagement: Options for self- regulation:	Please explain your selection:	Efficacy (1-5)	Verified (Enter name and date)	Verified (Enter name and date)	Based on current review of LMS/treatment site, is adjustment needed to maintain UDL approaches? (Enter Yes or No)
Optimize individual choice and autonomy	Many of the supplemental materials on the experimental sections blackboard relate course material to problems or issues that many people encounter in their daily lives (e.g. cancer, genomics studies, biotechnology etc.).	Foster collaboration and community	There are many opportunities for student collaboration on blackboard for the experimental section. There are interactive games and there is a forum.	Develop self- assessment and reflection	There are many self-quizzes and interactive animations that the students can use for self- assessment.	5	Diana Johnson 12- 10-2011	SBB - 12/11/2011 09:50:51	No adjustment needed.