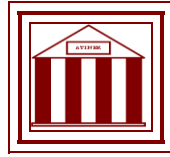


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**Evaluating Learning Management System
(LMS)-facilitated Delivery of Universal
Design for Learning (UDL) in Postsecondary
Education**

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Dr. Gregory T. Papanikos
President
Athens Institute for Education and Research

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

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Abstract

Universal Design for Learning (UDL) is an inclusive instructional approach that has been endorsed by many organizations, and is characterized as ‘scientifically valid’ (GovTrack.us, 2008). However, UDL’s complexity has challenged its adoption and implementation. Despite its promise, leading practitioners also acknowledge the need for more data on its outcomes (Edyburn, 2010; Center for Applied Special Technologies [CAST], 2012).

This quantitative study involved 157 students in two sections of an undergraduate class in general biology, as well as the instructor who taught both sections. It applied guidelines from CAST to evaluate whether a Learning Management System (LMS) could be designed to provide UDL. It also measured and tracked the instructor’s efficacy in sustaining UDL approaches. In an effort to identify UDL’s specific benefits to students, this study used a pre- and post- test to identify the treatment’s impact on student engagement. Findings indicated the LMS could be designed to comply with UDL guidelines, and the instructor demonstrated a high level of efficacy maintaining that UDL design. However, the treatment had no significant effect on student engagement. Overall, the study added to the literature by suggesting (a) the viability of the LMS as a means of providing UDL, (b) the instructor’s ability to effectively use the LMS to deliver UDL, 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, a single instructor, and a single group of students underscores the need for further research.

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Universal Design for Learning (UDL) is considered a *scientifically valid* approach for instructors at the higher education level (H.R. 1350, 2004; GovTrack.us, 2008). UDL is endorsed as an inclusive approach to instructional design and delivery, yet there is a lack of research clarifying UDL's benefits (Edyburn, 2010). UDL has been emphasized in both the U.S. National Educational Technology Plan (Office of Educational Technology, 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 (Getzel, 2008; Izzo, Murray, & Novak, 2008; Edyburn, 2010).

UDL seeks to provide cognitive access or access to the curriculum as it seeks to meet the needs of all students, including those with disabilities (Center for Applied Special Technologies [CAST], 2010a, 2010b). 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 1 for an overview of each of three brain networks and the UDL principle associated with it.

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 she 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).

Exploring UDL Delivery by Instructors and Outcomes Among Students

Could the use of a Learning Management System (LMS) such as Blackboard or Moodle represent a practical and consistent strategy to extend the face-to-face classroom and promote the provision of UDL approaches? It seems clear that, given the new prescriptions from the HEOA reauthorized in 2008 and the numerous groups advocating for its use, postsecondary instructors in the U.S. and elsewhere 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, 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 such areas as grades, student retention or student engagement.

Could UDL approaches — delivered through the use of an LMS — assist in this effort? If it is possible to use the LMS in this supplementary way, what are the outcomes in terms of benefits to students?

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 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.

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, objectives) and teaching and learning options (online discussions, journals, 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 (Section508.gov, 2010). Specifically, Blackboard has designed and tested its LMS in an 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 promoted the ability to establish and maintain a UDL approach using the LMS.

Some instructors may express an initial hesitance to use 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).

Accessible via the Internet, the LMS provides a digital framework consistent and compatible with many flexible and technologically-based UDL tools and venues (Rose & Meyer, 2002; Gerrard, 2007; 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 have become a readily available technology tool at the postsecondary level. LMSs (sometimes called Virtual Learning Environments [VLEs] or Course Management Systems [CMSs]) are a practical solution that postsecondary instructors can use to supplement their courses because they are built to have flexible features, secure access, and ease of use.

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 LMS (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?

Characteristics of Participants, Study Design, and Data Collected

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

- to verify the ability to establish and facilitate an initial UDL design via a site in the LMS,
- to identify levels of instructor efficacy in implementing UDL using the LMS, and
- to identify any variations in student engagement that may have resulted from the UDL treatment.

Study participants included two sections of predominantly undergraduate college freshmen enrolled in general biology, and the instructor who taught them. 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 (77 in Section 001 and 80 in 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.

Findings

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 independent *evaluator* (a project consultant who holds a Ph.D. in instructional design), the instructor, and the investigator met to review both control and treatment sites. Each used an instructor response and validation form based on UDL guidelines from CAST (2012) 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 evaluator, 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 (12/12 for Recognition, 9/9 for Strategic and 10/10 for Affective), whereas the control site was lacking in elements needed to fully meet UDL guidelines.

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 5-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 an independent evaluator and investigator, with the plan being to intervene if needed with suggestions and support.

Summary Conclusions of Research Question 2

Table 2 shows the instructor's rating of her level of efficacy with the three domains of UDL. 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.

On 9/15/11, the instructor reported she was less efficacious (4/5) in applying the 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 independent evaluator 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 evaluator 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.

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 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. The Student Course Engagement Questionnaire (SCEQ) survey was validated and designed to measure student engagement at the course level (Handelsman, Briggs, Sullivan, & Towler, 2005).

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.

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 (5=high or frequent use) 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. This additional analysis allowed for another look at whether and how actual usage of the LMS site and exposure to the treatment impacted student engagement.

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 general biology 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.

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.

Conclusions and Future Recommendations

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.

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, 2007; 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 simultaneously explore implementation approaches involving instructor application and UDL validation procedures.

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 results may differ.

It will also be interesting for future studies to identify the responses of diverse students such as English language learners (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, 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 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.

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 SCEQs, 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 (Vygotsky, 1978; Howard, 2004; Jimenez, Graf, & Rose, 2007) 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; Jimenez et al., 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. However, 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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Table 1. Three Cognitive Domains and Three Principles of Universal Design for Learning (UDL)

Brain Network	Associated UDL Principle
<p>Recognition networks 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 <i>what</i> of learning.</p>	<p>Multiple means of representation Give learners various ways of acquiring information and knowledge.</p>
<p>Strategic networks Planning and performing tasks. How we organize and express our ideas. Writing an essay or solving a math problem are strategic tasks — the <i>how</i> of learning.</p>	<p>Multiple means of action and expression Provide learners alternatives for demonstrating what they know.</p>
<p>Affective networks How students are engaged and motivated. How they are challenged, excited, or interested. These are affective dimensions — the <i>why</i> of learning.</p>	<p>Multiple means of engagement 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

Table 2. 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