

Measuring the Effectiveness of Universal Design for Learning Intervention in Postsecondary Education

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Abstract

To date, a mere handful of studies have been conducted to determine the effectiveness of providing training to university instructors on the principles of Universal Design for Learning (UDL) and the impact this training has on student outcomes, especially for students with disabilities. While these studies offer some useful data, their results may be considered inconclusive because they did not use control groups and therefore had no comparative data regarding outcomes in courses where UDL was not implemented. This paper, which builds on a study published by these authors in a previous issue of JPED (Schelly, Davies, & Spooner, 2011), responds to the gap in the literature by measuring the effectiveness of instructor training regarding the principles of UDL and techniques for its implementation. It does so by comparing student perceptions of instructor teaching methods, as measured by a UDL questionnaire, completed before and after the instructors received UDL training and by comparing those results to a control group of students taking the same course in a different section where instructors did not receive UDL training.

Keywords: College students with disabilities, universal design for learning, pre and post data

With its emphasis on diversity, inclusion, multi-modal learning, and technology, Universal Design for Learning (UDL) holds the potential to ameliorate some of higher education's most pressing issues, including the intractably low rates of persistence, retention, and degree completion evident at most colleges and universities today. UDL is the offspring of Universal Design (UD), a philosophy and set of principles pertaining to architecture and product design, whose own origin can be traced back to the disability rights movement of the 1970s, '80s, and especially the '90s following passage of the Americans with Disabilities Act (ADA, 1990; Center for Universal Design, 2012; Fair Housing Act, 1988; Institute for Human Centered Design, 2012; Rehabilitation Act, 1973). While both UD and UDL share the goal of universal access, UD seeks to eliminate barriers from the *built* environment, while UDL strives to remove barriers from the *learning* environment (Burgstahler, 2008).

Embraced first by K-12 educators, UDL has become increasingly popular among college and university instructors who see it as "a conceptual and philosophical foundation on which to build a model of teaching and learning that is inclusive, equitable, and guides the creation of accessible course materials" (Schelly, et al., 2011, p. 18). Just as architects and designers have discovered that UD "proactively builds in features to accommodate the range of human diversity" (McGuire, Scott, & Shaw, 2006, p. 173), college educators are finding that UDL helps guide the selection of teaching strategies and the design of course materials that support the diverse learning needs of today's students (Burgstahler, 2008). According to David Rose, one of UDL's founders, "UDL puts the tag 'disabled' where it belongs—on the curriculum, not the learner. The curriculum is disabled when it does not meet the needs of diverse learners" (Council for Exceptional Children, 2011).

As defined by the Center for Applied Special Technology (2009), UDL is composed of three principles: (1) multiple means of representation, giving learners various ways of acquiring information and knowledge; (2) multiple means of student action and expression, providing learners alternative ways of demonstrating what they know; and (3) multiple means of student engagement, tapping into learners' interests, challenging them appropriately, and motivating them to learn. The three UDL principles map onto three groups of neural networks – recognition, strategic, and affective – that, through their interaction, create a model of cognition that helps explain how the brain works during learning episodes (Hall, Meyer, & Rose, 2012).

UDL is one of several educational adaptations of the philosophy and principles of UD. Other adaptations include Universal Design of Instruction (Burgstahler, 2009), which applies the original seven UD principles to the learning environment; Universal Design for Instruction (UDI) (McGuire, et al., 2006), which takes the original seven principles and adds two new ones related specifically to education; and Universal Instructional Design (Higbee & Goff, 2008), which modifies Chickering & Gamson's widely acclaimed "Seven Principles for Good Practice in Undergraduate Education" (Chickering & Gamson, 1987, 1999) to make them more applicable to the issues of access and disability. Although these adaptations of UD differ in their particulars, each shares a common thread: proactive planning and inclusive design of instruction, course materials, and learning environments to meet the needs of a wide range of students. UDL, however, distinguishes itself from the others due to its foundation in cognitive neuroscience (Center for Applied Special Technology, 2009; Hall, et al., 2012) and its codification in federal law (Higher Education Opportunity Act, 2008).

While all students may benefit from learning environments that are "universally designed," the benefits of UDL may be experienced most keenly by college students with disabilities, a population that tripled between 1978 (3%) and 1998 (9%) (National Council on Disability, 2003). Today approximately 11% of undergraduates report having a disability (National Center for Education Statistics, 2008; U.S. Government Accountability Office, 2009). The percentage of college students with disabilities may actually be higher because a significant number (as many as 90% in one study) choose not to identify themselves or

seek disability-related services (Fichten, Jorgensen, Havel, & Barile, 2006). Despite the influx of students with disabilities at colleges and universities across the nation, rates of persistence, retention, and graduation for this population remain unacceptably low (Belch, 2004; Kochhar-Bryant, 2006). According to a 2011 study, only 12.5% of working-age Americans with disabilities ages 21-64 have attained a Bachelor's degree or higher, compared to 31.2% of their peers without disabilities (Erickson, Lee, & von Schrader, 2012). The implications of this statistic are sobering: failure to complete a college education is correlated with reduced quality of life, underemployment, and unemployment (Mamiseishvili, 2010).

Despite numerous appeals in the literature for more empirical data to help evaluate UDL's proposed benefits (Izzo, Murray, & Novak, 2008), little research has been conducted to determine its impact on student outcomes, nor have there been more than a handful of studies to examine the efficacy of instructor UDL training. A systematic review of the literature was conducted in 2011 to identify empirical studies of UDI in postsecondary education (Roberts, Park, Brown, & Cook, 2011). The authors' selection criteria included articles published "(a) as empirical studies in peer-reviewed journals, (b) in 2000 or after, and (c) on the use of UDL, UDI, UID, and UD in postsecondary, college, university, and higher education settings" (p.7). Eight articles were found to meet those criteria; of the eight, only three investigated the impact of training college faculty on the principles and techniques of implementing UDL with the goal of improving student outcomes.

The first study (Izzo, et al., 2008) examined the perceptions of 63 faculty following their review of an online UDL training module. After completing a formative evaluation of the module, called Level I piloting, 92% of the faculty participants reported feeling more comfortable meeting the needs of students with disabilities. In addition, those who reported a moderate to very high degree of knowledge increased from 31% before completing the module to 83% after completing it. Results obtained from Level II piloting, which was summative in nature, were similar: of the 35 faculty and administrators who evaluated the module, 29% reported a moderate to very high degree of UDL knowledge before completing the module compared to 94% after completing it.

In the second study (Parker, Robinson, & Hanafin, 2008), a team at a public university redesigned a

large undergraduate special education course to employ principles from UDI and adult learning theories. The authors analyzed online interactions, discussions, and student evaluations from the 114 students enrolled in the course to evaluate student learning outcomes. At the end of the semester, students in the redesigned course rated it higher than other courses in the department or at the university. Comments from the students emphasized their appreciation of the online delivery of course material through a course management system and the delivery of course materials in multiple mediums.

The third study (Zhang, 2005) involved UDL training and collaboration between an institution of higher education and a public middle school. Instruction on UDL principles and the use of learning technologies was provided to the university faculty and school teachers through summer institutes, workshops, and technology labs. The online delivery of the institutes and workshops throughout the project allowed participants to collaborate on projects while increasing the use of technology in their teaching. The author of the study concluded that collaboration between school teachers and university faculty was beneficial because it increased participants' knowledge of UDL principles and their experience incorporating it into their own teaching.

Two studies published since the literature review by Roberts et al. also deserve mention. A study by Street et al. (2012) describes the results of incorporating UDI into the training of peer mentors for the national peer mentoring model called Peer-led Team Learning (PLTL), which is designed to promote student success in STEM courses (Peer-led Team Learning, 2013). Previous research has shown that the students who participate in PLTL earn higher grades than students who do not participate in PLTL (Hockings, DeAngelis, & Frey, 2008). However, preliminary data suggested that students with disabilities who participated in PLTL actually did not perform as well as students with disabilities who did not participate in PLTL. Thus, Street and colleagues conducted a study to examine if providing UDI training for mentors leading the PLTL groups would provide better outcomes for students with disabilities. Due to the small sample size and mixed results, generalized conclusions from this study are limited. However, in some cases students with disabilities who were in the enhanced PLTL groups where the mentors received UDI training demonstrated better outcomes compared to students with disabilities who chose not to participate in the PLTL groups.

Another contribution to the literature that appeared after publication of the review by Roberts et al. was a study by this paper's authors (Schelly, et al., 2011), which described an earlier stage of the research presented in this paper. That study, like the current one, was conducted at a large land-grant university with the goal of examining the effectiveness of instructor training as a means of increasing the use of inclusive, "universally designed" teaching practices. The study included the development of a questionnaire to be filled out by students enrolled in Psychology "gateway" courses. The questionnaire was designed to measure key indicators of UDL implementation by instructors who had received training on the three UDL principles as well as teaching practices related to those principles. Instructors were provided with a short series of trainings on the principles of UDL and methods for effectively implementing them. Results from the study indicated that instructor training in the use of UDL strategies increased the use of those strategies. In fact, in 14 of the 24 UDL-specific survey questions, students reported observing an increase in their instructors' use of universally-designed teaching practices. However, because the study lacked a control group, it was not possible to determine whether the perceived changes were due to the training the instructors had received.

The present study builds on the previous one by comparing student survey data about an intervention group of instructors who received UDL training to student survey data from a control group of instructors who did not receive UDL training. The student survey instrument was revised and expanded for this study to more accurately capture student perceptions of their instructors' teaching practices – especially those practices that correspond to the three UDL principles. This paper thus presents a more refined and potent analysis of the effectiveness of UDL instructor training.

Method

Participants

The participants in the Intervention Group included six instructors teaching nine psychology classes (six sections of Introduction to Psychology; one section of Mind, Brain and Behavior; one section of Child Psychology; and one section of Psychological Measurement and Testing). A total of 1,164 students were enrolled in the nine sections; of these, 622 students (approximately 53%) filled out the pre-questionnaire

of the semester and 421 students (approximately 36%) filled out the post-questionnaire. A total of 386 students (approximately 33%) completed both the pre- and post-questionnaires.

The participants in the Control Group included three instructors teaching six sections of Introduction to Psychology. A total of 646 students were enrolled in these six sections; 276 students (approximately 43%) filled out the pre-questionnaire and 223 students (approximately 35%) filled out the post-questionnaire. A total of 204 students (approximately 32%) filled out both the pre- and post-questionnaires.

Instructors in both the intervention and control groups were Ph.D. candidates in the Psychology Department who had been selected for teaching fellowships in a competitive process based on demonstration of teaching excellence. The selection process was the same for both groups of instructors; therefore, the instructor selection process should not have had an impact on the study outcomes. The instructors were mentored by an assistant professor in the Psychology Department. Both groups of instructors were mentored by the same assistant professor. The instructors attended weekly one-hour Teaching Fellow meetings, facilitated by the assistant professor. During this seminar, the instructors were exposed to concepts such as creating writing assignments, providing feedback to students on assignments, holistic rubrics, and a hierarchy of rhetorical concerns (Doe, Gingerich, & Richards, in press). Other issues arising during the semester and potential solutions were discussed in this seminar. It was during this seminar that the UDL training was provided to the instructors in the intervention group as described below. Thus, both groups of instructors received an equal amount of formal meeting time regarding teaching; however, only the instructors in the intervention group received UDL training.

Materials

In a previous study (Schelly, et al., 2011), we used a paper questionnaire that was filled out in class by the students to measure their perception of instructors' implementation of the UDL principles. To address some of the limitations of that instrument, our research team redesigned the questionnaire for this study. The new questionnaire expanded the Likert scale from a five-point scale to an eleven-point scale to correct for ceiling effects and improve the sensitivity to detect change (Darbyshire & McDonald, 2004; Wittink &

Bayer, 2003). Additional questions, especially in the area of student engagement, were added to the questionnaire to better denote the three UDL principles. We also added 10 open-ended questions to learn what instructional methods students find engaging and helpful for learning.

The net effect of these additions caused the number of questions to increase from 27 to 50. Because the number of questions nearly doubled, it was no longer feasible to administer the questionnaire in class using paper and pencils. Instead, the new questionnaire was adapted to online delivery using the university's online course management system, WebCT. Offering the questionnaire in an online format increased its accessibility, as it could now be filled out anytime and anywhere students had Internet access. Unfortunately, online delivery also resulted in a lower response rate compared to our previous study because students were no longer a "captive audience" in the classroom. The questionnaire used for the current study can be found in the Appendix.

Procedures

At the beginning of the semester, the participating instructors were given directions and guidance for delivering the UDL questionnaires to students in their courses through the online course management system. Students were also provided with guidance about how to access the questionnaire and were encouraged to complete the questionnaire in their free time outside of class. Students were made aware of how their feedback would be used to improve the development and delivery of the course. It was explained that their input would help instructors, and ultimately the university, address student learning needs and interests.

When the students first accessed the questionnaire, a cover letter appeared containing information about the research. Included was a statement explaining that if the student filled out the survey and submitted it, this action would acknowledge their interest and willingness to participate in the study, and thus constitute an "informed consent."

The pre- and post-questionnaires contained the same questions, were administered online in the same way, and were completed by students during free time outside of class. The questionnaires required 15-20 minutes to complete. Students were allowed a window of ten days, between the third and fifth week of the semester, to complete the pre-questionnaire. During

the last two weeks of the semester the students were asked to complete the post-questionnaire.

Training Procedures

For the instructors in the intervention group only, the research team provided UDL training during five of the weekly one-hour Teaching Fellow meetings in the 10 weeks between the first and second administration of the questionnaire. Several supplemental readings were also assigned, including “Universal Design for Learning in Postsecondary Education: Reflections on Principles and their Applications” (Rose, Harbour, Johnston, Daley, & Abarbanell, 2006) and several chapters from *Universal Design in Higher Education: From Principles to Practice* (Burgstahler & Cory, 2008). The research team frequently referred back to these readings during the training sessions. The training included techniques and strategies to address each of the three UDL principles as they apply to classroom teaching and the development of accessible course materials. The UDL training was slightly modified after reviewing the results of the first questionnaire to address areas of particular interest or concern from the students’ perspectives. For example, the students reported that the use of i>clickers®, a classroom response system, increased their feeling of engagement during lecture. In response to this finding, the research team explored the effective uses of i>clicker® technology. The instructors were also directed to the online tutorials¹ developed by the research team for additional information about how to create universally-accessible course materials. The instructors in the control group received no training during the study or prior to it on the UDL principles or implementation strategies.

Data Analysis

Descriptive statistics were used to compile information about the percentage of students completing the questionnaires, as well as details about student demographics, in both the intervention and control groups. ANOVAs were conducted to compare students’ perceptions of their instructors’ use of UDL strategies

at the beginning of the semester to their perceptions at the end of the semester across the groups. A two-way ANOVA was conducted with “PrePost” (2 levels: pre-questionnaire and post-questionnaire) as a within subject factor and “Group” (2 levels: intervention/UDL training and control/no UDL training) as a between factor. All data analyses were conducted using Statistical Package for Social Sciences (SPSS) for Windows software, version 19.0. Hand-calculated *a priori* tests were used to compare cell means (Kirk, 1995), to examine the PrePost results. An alpha level of 0.05 was used to determine levels of significance for all statistical tests in this study. Adjustments to the family-wise alpha were not made for any of the analyses because this study is descriptive in nature.

Results

Descriptive Data Pertaining to the Student Participants

The questionnaires of students who filled out both the pre- and post-questionnaires were included in the analyses and results. For the intervention group, a total of 386 students (approximately 33%) completed both the pre- and post-questionnaire. For the control group, a total of 204 students (approximately 32%) filled out both the pre- and post-questionnaires.

One demographic item on the questionnaire asked students whether they had a disability. At the time of the pre-questionnaire, 9.3% of the students ($n = 57$) in the intervention group reported having a disability, while 9.5% of the students ($n = 27$) in the control group said the same. In the post-questionnaire results, 41 students (9.7%) in the intervention group reported having a disability, while only 13 students (6%) in the control group agreed with that self-assessment. Although disability information was provided by the students, for this study both students with and without reported disabilities were included. The small number of students with disabilities in both groups prevented us from conducting separate analyses for the students with disabilities. Because both groups had a similar number of students with disabilities, this is not a confounding factor.

Effects of the Instructor UDL Training

The analyses in this study include only 21 items from the 50-item questionnaire. The questionnaire items excluded from analyses included demographic

1 The ACCESS modules and tutorials are freely available online at <http://accessproject.colostate.edu/udl>. These cover a range of topics, including how to make electronic documents (Microsoft Word and PowerPoint, Adobe PDF, HTML, E-Text and video) usable and accessible, or “universally designed.” Other modules on the website include Faculty Rights and Responsibilities, a glossary of assistive technology terminology, and information about a variety of disabilities and accommodations frequently seen in higher education.

Table 1

ANOVA Results for Students' Responses on the Pre- And Post-Questionnaires for Both the Intervention and Control Groups

Questionnaire Item	<i>F</i>	<i>df</i>	<i>p</i>	Effect Size Partial η^2	Power
Q1. Instructor present course material in multiple formats					
PrePost main effect	9.87	1,588	.002	.017	.88
Group main effect	6.09		0.14	.010	.68
PrePost x Group interactions	1.33		.250	.002	.21
Q2. Instructor actively engages students in learning					
PrePost main effect	63.48	1,591	<.0005	.097	1.00
Group main effect	8.28		.004	.014	.82
PrePost x Group interactions	3.65		0.57	.006	.48
Q5. Instructor relates key concepts to larger objectives of the course					
PrePost main effect	11.91	1,580	.001	.020	.93
Group main effect	14.80		<.0005	.025	.97
PrePost x Group interactions	5.50		.019	.009	.649
Q6. Expectations for student performance are consistent with the learning objectives					
PrePost main effect	0.20	1,588	.658	<.0005	.07
Group main effect	.009		.923	<.0005	.05
PrePost x Group interactions	1.64		.196	.003	.25
Q7. Instructor begins lecture with outline of what will be covered					
PrePost main effect	55.06	1,579	<.0005	.087	1.00
Group main effect	1.14		.387	.002	.19
PrePost x Group interactions	5.45		.020	.009	.645

Questionnaire Item	<i>F</i>	<i>df</i>	<i>p</i>	Effect Size Partial η^2	Power
Q8. Instructor summarizes key points during or at end of lecture					
PrePost main effect	2.18	1,584	.141	.004	.313
Group main effect	.009		.922	<.0005	.05
PrePost x Group interactions	10.20		.001	.017	.89
Q9. Instructor faces the board or screen while speaking					
PrePost main effect	3.17	1,590	.075	.005	.43
Group main effect	0.46		.497	.001	.10
PrePost x Group interactions	.059		.808	<.0005	.06
Q16. Online material offered in multiple file formats					
PrePost main effect	0.715	1,288	.398	.002	.14
Group main effect	3.41		.066	.012	.45
PrePost x Group interactions	.01		.929	<.0005	.05
Q17. Instructor highlights key points after showing instructional videos					
PrePost main effect	13.23	1,566	<.0005	.023	.95
Group main effect	5.26		.022	.009	.63
PrePost x Group interactions	.61		.437	.001	.121
Q20. Instructional technologies are used to enhance learning					
PrePost main effect	1.27	1,589	.261	.002	.20
Group main effect	4.25		.040	.007	.54
PrePost x Group interactions	.61		.437	.001	.121
Q22. Course content delivered employing instructional technologies					
PrePost main effect	8.14	1,497	.005	.016	.81
Group main effect	3.78		.053	.008	.49
PrePost x Group interactions	.399		.528	.001	.10

Questionnaire Item	<i>F</i>	<i>df</i>	<i>p</i>	Effect Size Partial η^2	Power
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Q24. Materials are accessible, organized, and easy to use					
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PrePost main effect	5.51	1,405	.019	.013	.65
Group main effect	3.87		.050	.009	.50
PrePost x Group interactions	.302		.583	.001	.09
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Q25. Opportunities for students to express comprehension of material in ways other than tests/exams					
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PrePost main effect	.02	1,586	.893	<.0005	.05
Group main effect	.166		.166	.003	.28
PrePost x Group interactions	3.30		.070	.006	.44
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Q30. Students feel engaged and motivated to learn					
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PrePost main effect	.001	1,586	.970	<.0005	.05
Group main effect	19.79		<.0005	.033	.99
PrePost x Group interactions	0.13		.721	<.0005	.07
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Q31. Instructor explains real-world importance					
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PrePost main effect	0.16	1,582	.689	<.0005	.07
Group main effect	19.79		<.0005	.035	1.00
PrePost x Group interactions	2.95		.086	.005	.40
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Q32. Course has challenging and meaningful assignments					
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PrePost main effect	0.25	1,572	.616	<.0005	.08
Group main effect	11.03		.001	.019	.91
PrePost x Group interactions	1.65		.200	.003	.25
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Q33. Instructor expresses personal enthusiasm					
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PrePost main effect	18.18	1,578	<.0005	.031	.99
Group main effect	65.03		<.0005	.101	1.00
PrePost x Group interactions	6.61		.010	.011	.73

Questionnaire Item	<i>F</i>	<i>df</i>	<i>p</i>	Effect Size Partial η^2	Power
Q34. Instructor expresses personal enthusiasm					
PrePost main effect	12.08	1,362	.001	.032	.93
Group main effect	3.37		.067	.009	.45
PrePost x Group interactions	9.07		.003	.024	.85
Q36. Instructor is highly approachable and available to students					
PrePost main effect	0.08	1,571	.783	<.0005	.07
Group main effect	4.74		.030	.008	.585
PrePost x Group interactions	.018		.872	<.0005	.07
Q37. Instructor creates a class climate in which student diversity is respected					
PrePost main effect	0.173	1,574	.877	<.0005	.07
Group main effect	3.65		.057	.006	.479
PrePost x Group interactions	0.429		.513	.001	.10
Q38. Instructor offers contact with students outside of class time in flexible formats					
PrePost main effect	0.11	1,563	.746	<.0005	.06
Group main effect	0.212		.645	<.0005	.08
PrePost x Group interactions	2.54		.111	.004	.36

information, open-ended questions, and a few items that were not specific to UDL strategies. We have reported the results of the ANOVAs for the 21 relevant items in Table 1, including PrePost and Group main effects, as well as the interaction between PrePost and Group factors. For the 11 questions with significant PrePost main effects and significant PrePost X Group interactions, we conducted *a priori* comparison tests (see Table 2). To summarize these results, we have grouped the questions based on similar outcomes.

Related to significant PrePost effects, four questions yielded significant *a priori* PrePost change for the intervention group, but there was no significant change for the control group. Those questions are Q1 (presenting material in multiple formats), Q17 (highlighting key information after showing videos), Q22 (course content outside of class is delivered using technology), and Q24 (course materials are accessible, clearly organized and easy to use). Figure 1 clearly illustrates the significant changes for the intervention group and lack of change in the control group. The other three questions illustrate similar results as shown in Figure 1. One question – Q2 (actively engaging students in learning) – displayed significant changes for both the intervention and control group from pre- to post-questionnaire (see Figure 2).

Related to significant PrePost and Group interactions, four questions yielded interactions, with the intervention group showing significantly greater change from pre- to post-questionnaire compared to the control group. For three of these items, the intervention group made significant changes from pre- to post-questionnaire and the control group did not make significant differences. These are Q5 (instructor relates key concepts to larger course objectives), Q8 (instructor summarizes key point during or at end of lecture), and Q20 (instructional technologies are used in class). Figure 3 illustrates the significant change for the intervention group and the reported decrease for the control group in the use of the UDL strategy of summarizing key points during or at the end of the lecture. The other questions in this category had similar results. For Q7 (instructor begins with an outline of what will be covered), both groups of students reported a significant increase from beginning of the semester compared to the end of the semester. However, the significant interaction outcome occurred because the intervention group clearly had more change than the control group (see Figure 4).

The control group experienced more change pre- to post-questionnaire than the intervention group for only two questions. The two questions in this grouping were Q33 (the instructor expresses his or her personal enthusiasm) and Q34 (feedback provided on assignments is helpful and instructive). As illustrated for Q34 in Figure 5, the control group began significantly lower than the intervention group and the control group improved, but this did not significantly surpass the student rating for the intervention group at the post survey.

The results of this study suggest that UDL training has a significant effect on students' perceptions of instruction in university courses as measured by student perceptions on the UDL questionnaire. The strategies that were most significantly impacted by the training, according to student report, included (a) presenting material in multiple formats, (b) relating key concepts to the larger objectives of the course, (c) providing an outline at the beginning of each lecture, (d) summarizing material throughout each class session, (e) highlighting key points of an instructional video, (f) using instructional videos, and (g) using well-organized and accessible materials. The addition of a control group in this study allows the interpretation that the increased use of these UDL strategies is a direct result of the training the instructors received. It is possible that other factors could have influenced the students' perception of their instructors' behaviors differentially for the two cohorts of students that were not controlled for in this study. However, because a control group was included for comparison and the mentor and mentoring strategies provided to the instructors were the same for both groups of instructors, except for the UDL training, data suggest that the UDL training had an effect on the student's perception.

The items that showed increased frequency across the semester, as reported by students in the intervention group, include several aspects of UDL. For example, presenting material in multiple formats, using instructional videos, and using well-organized and accessible materials all exemplify the UDL principle of multiple means of representation. Four additional items that also improved – relating concepts to the overall course objectives, providing an outline at the beginning of class, summarizing throughout the session, and highlighting key points of an instructional video – can also be considered a type of representation, but more specifically a type of communication often characterized as “clarity.” Clarity is defined as the process by

Table 2

Questionnaire Items with Significant PrePost x Group Interaction or Significant PrePost Main Effect

Questionnaire Item	Mean Student Rating (<i>SD</i>)		Pre-Post <i>a priori</i> Comparisons	
	Pre	Post	<i>t</i>	<i>p</i>
Q1. Instructor presents course material in multiple formats				
Intervention Group	70.82 (24.62)	75.80 (23.11)	3.66	<.002
Control Group	68.03(22.57)	70.34 (22.92)	1.23	NS
Q2. Instructor actively engages students in learning				
Intervention Group	61.21 (28.42)	68.47 (26.77)	5.15	<.002
Control Group	53.07 (25.93)	64.93 (27.61)	6.11	<.002
Q5. Instructor relates key concepts to larger objectives of the course				
Intervention Group	69.95 (20.75)	75.66 (20.26)	4.91	<.002
Control Group	66.19 (22.70)	67.28 (23.07)	0.69	NS
Q7. Begins lecture with outline of what will be covered				
Intervention Group	68.97 (37.00)	83.29 (25.15)	8.01	<.002
Control Group	69.85 (35.11)	77.31 (31.19)	3.14	<.002
Q8. Summarizes key points during or at end of lecture				
Intervention Group	67.44 (30.58)	73.73 (27.28)	3.94	<.002
Control Group	71.53 (32.57)	69.21 (31.63)	1.06	NS
Q17. Instructor highlights key points after showing instructional videos				
Intervention Group	76.54 (27.17)	82.00 (23.26)	2.56	<.01
Control Group	73.18 (26.65)	76.72 (25.65)	0.89	NS
Q20. Instructional technologies are used to enhance learning				
Intervention Group	84.69 (25.49)	88.51 (21.36)	2.39	<.01
Control Group	83.60 (26.13)	82.56 (25.49)	0.52	NS

Questionnaire Item	Mean Student Rating (<i>SD</i>)		Pre-Post <i>a priori</i> comparisons	
	Pre	Post	<i>t</i>	<i>p</i>
Q22. Course content delivered employing instructional technologies				
Intervention Group	55.11 (32.09)	61.33 (32.57)	2.62	<.005
Control Group	51.68 (31.38)	55.65 (30.11)	1.40	NS
Q24. Materials are accessible, organized, and easy to use				
Intervention Group	71.92 (28.82)	76.64 (26.77)	2.33	<.01
Control Group	68.09 (29.53)	71.02 (29.57)	1.15	NS
Q33. Instructor expresses personal enthusiasm				
Intervention Group	76.43 (24.09)	78.14 (23.02)	1.46	NS
Control Group	57.78 (29.60)	64.65 (28.12)	4.21	<.002
Q34. Feedback provided on assignments is helpful and instructive				
Intervention Group	64.24 (30.32)	65.08 (29.83)	0.39	NS
Control Group	53.73 (31.00)	65.48 (28.33)	4.01	<.002

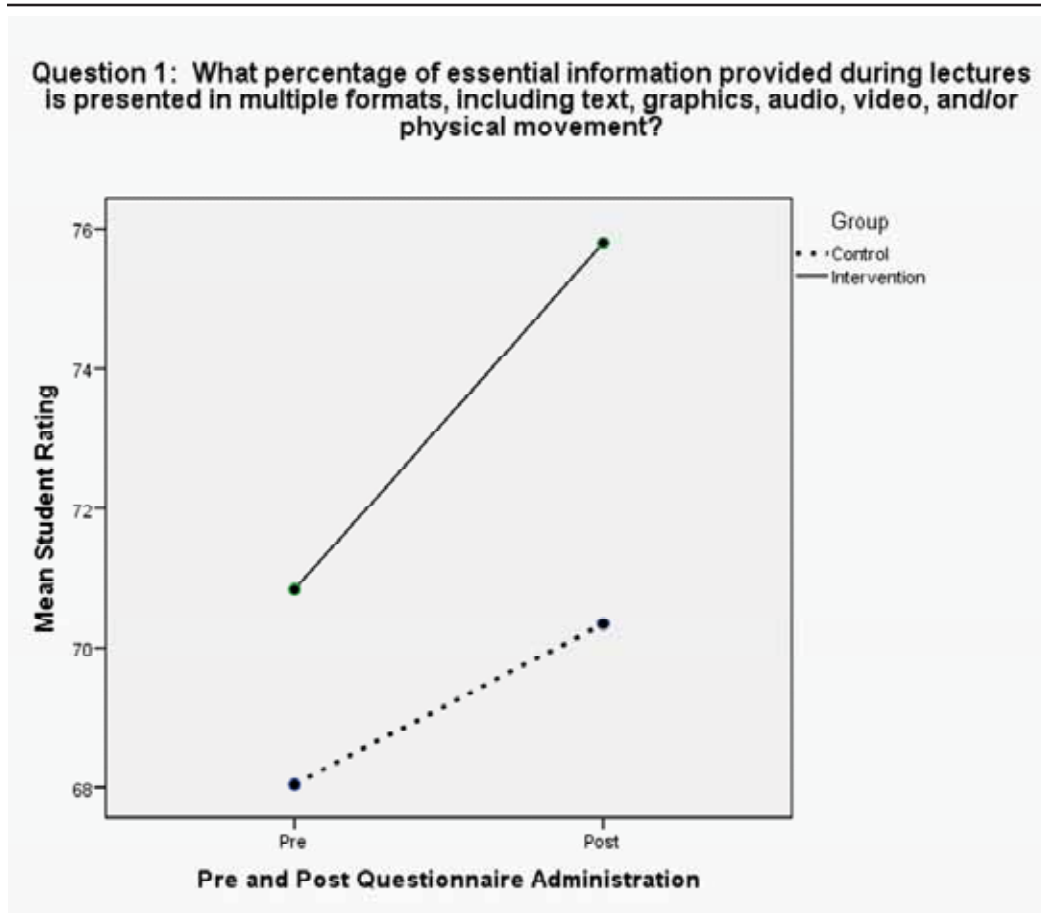
which an instructor effectively stimulates the pertinent meaning of course content and thought processes of the students through structured verbal and non-verbal communication (Chesebro & McCroskey, 2001).

An interesting finding of this study is that the analyses revealed positive changes for several UDL strategies even in the control group of instructors (i.e., instructors who did not receive UDL training). For example, students in all course sections, both intervention and control groups, reported that they were more actively engaged in learning at the end of the semester compared to the beginning. Students in all sections also reported that their instructors expressed their personal enthusiasm more at the end of the semester compared to the beginning. Likewise, students in all sections reported that the feedback provided on assignments was more helpful and instructive at the end of the semester. Hence, the familiarity and rapport that develops between students and instructors across the duration of a course appear to be important factors in the improvement of certain UDL teaching strategies,

such as showing enthusiasm, providing prompt and useful feedback, and actively engaging students in the learning process. In previous research, the lack of a control group prevented researchers from distinguishing as to whether UDL training, or improved communication between instructors and students that developed across the duration of a semester, facilitated positive changes in teaching strategies. With the use of a control group in this UDL study, our results suggest that effective communication, which is likely to evolve naturally between instructors and students over the course of a semester, may contribute to the use of teaching strategies that promote student engagement. These findings are in addition to the significant effects found in the intervention group that can be attributed to UDL training.

A further interpretation of these findings is the importance of faculty or instructor characteristics that influence good teaching and learning environments. Umbach and Wawrzynski (2005) conducted a study using two large data sets, including students and

Figure 1. Pre- and post-questionnaire mean student rating for Question 1 for the intervention group (solid line) and control group (dashed line).



Note: The *a priori* *t* values indicate a significant change in student ratings from pre- to post-questionnaire administration for the intervention group, but not for the control group.

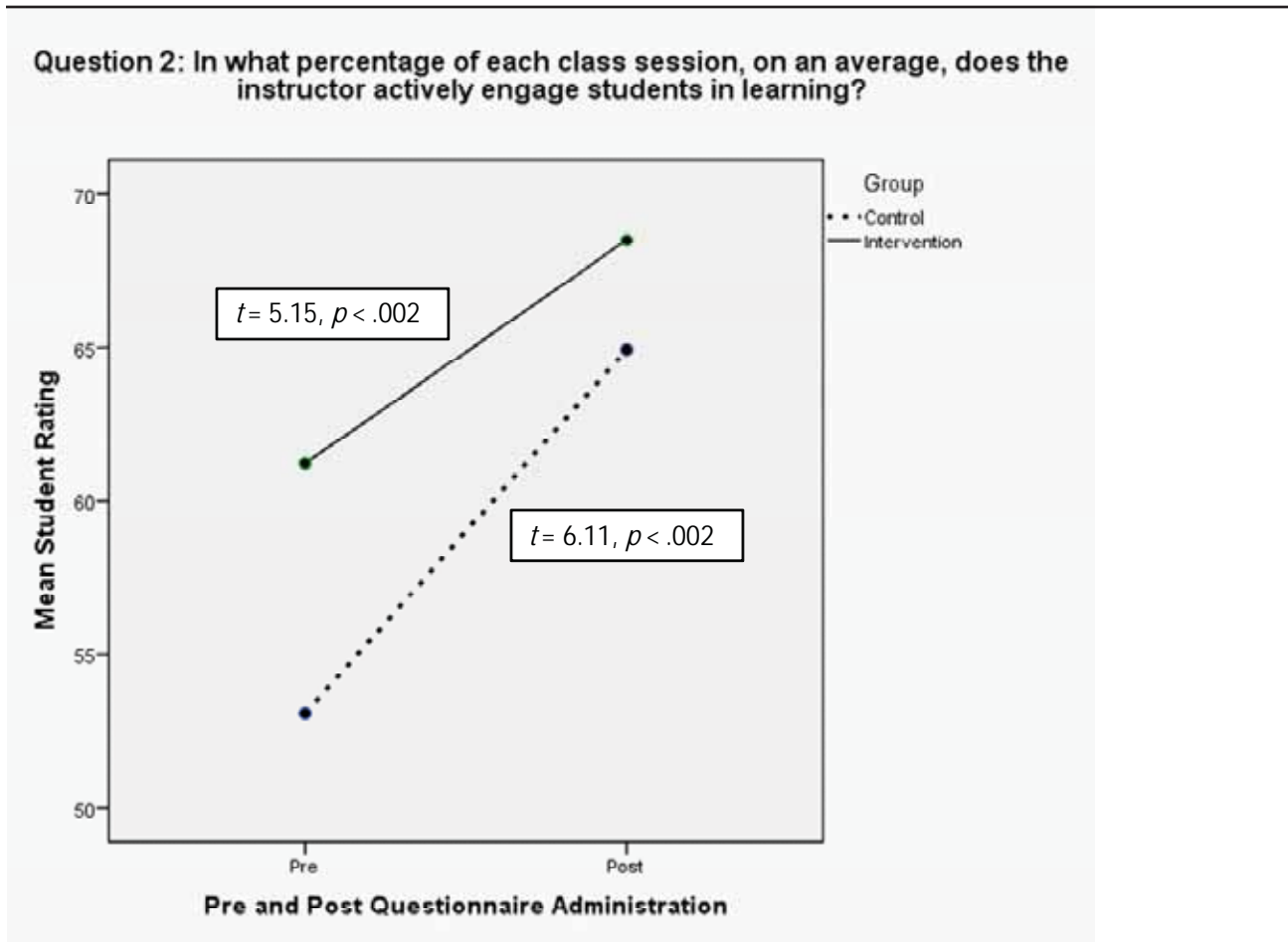
faculty at 137 colleges and universities, to examine faculty behaviors and attitudes that lead to positive student outcomes and student engagement in learning. Overall, they concluded that faculty behaviors and attitudes may be the most important factors to influence student learning. One construct they studied was instructor-student interactions, which correlated with students feeling more engaged and more academically challenged (Umbach & Wawrzynski, 2005).

To varying degrees, the three principles of UDL – multiple means of representation, multiple means of student action and expression, and multiple means of student engagement – are dependent on effective communication. Thus, UDL training should include specific strategies that address the three UDL principles but also emphasize the importance of effective communication, such as clarity. Instructors who are able to

incorporate effective UDL strategies and use effective communication will be more effective at facilitating student learning.

The use of UDL strategies by instructors and faculty in higher education is more important now than ever before. Research suggests that children who grow up in environments with more technology (e.g., computers, internet, and video games) experience improvements in visual and spatial skills, but may suffer decreased ability to think (deeply) about a topic (Greenfield, 2009). In addition, the technologies of today encourage multitasking or parallel processing in teens and young adults (Greenfield, 2009; Gross, 2004), and programs that use multiple message formatting attract teens and young adults (Bergen, Grimes, & Potter, 2005). Such changes in cognitive skills, and the preference for the manner in which material is presented, increase the

Figure 2. Pre- and post-questionnaire mean student rating for Question 2 for the intervention group (solid line) and control group (dashed line).



Note: The *a priori* *t* values indicate a significant change in student ratings from pre- to post-questionnaire administration for both the intervention group and the control group.

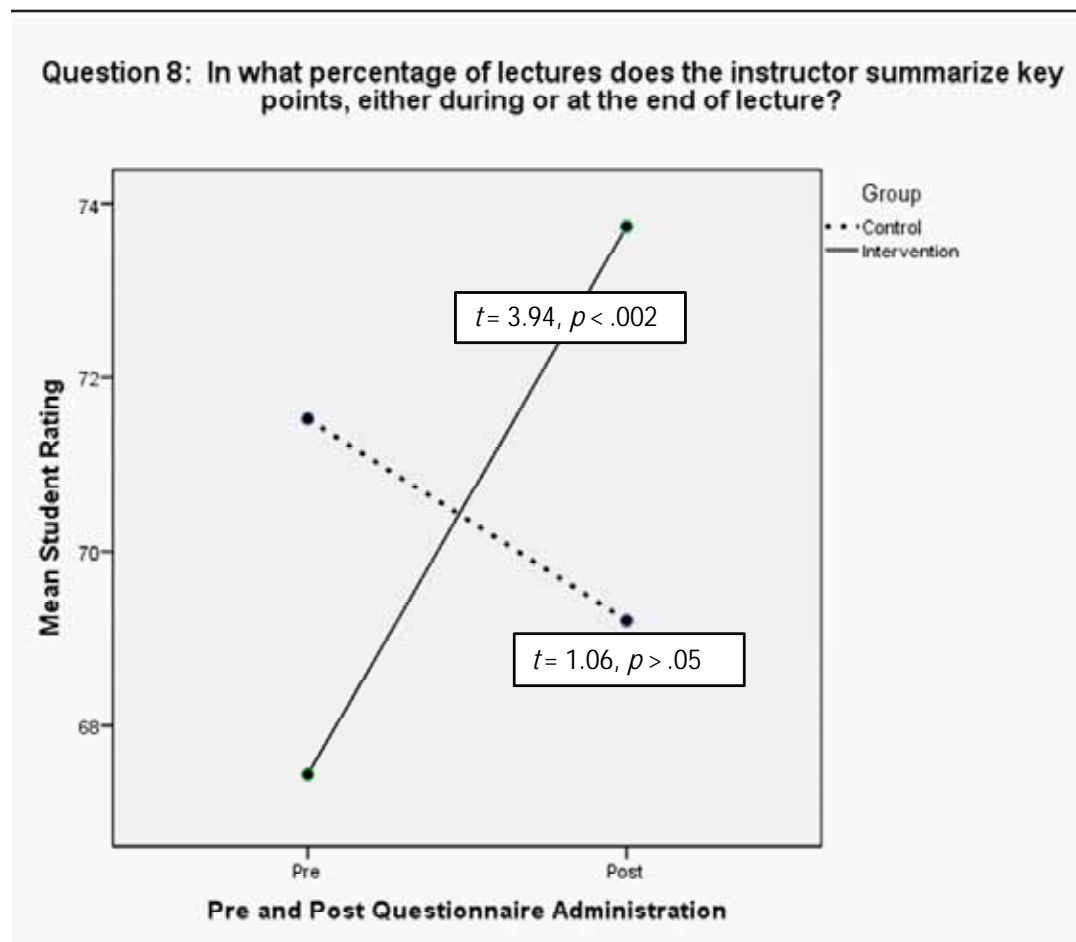
need for instructors in higher education to become more thoughtful about how course material is presented to students. These societal trends support the use of UDL for all students in postsecondary education. However, as student diversity increases in colleges and universities, including an increase in the number of students with disabilities (Fichten, et al., 2006; Raue & Lewis, 2011), the use of UDL strategies in higher education becomes even more important.

Limitations and Future Research Directions

This study expands the scope of previous studies that examine the effectiveness of instructor UDL training by adding a control group and utilizing a more comprehensive instrument. The instrument designed for this study included various questions on the three UDL principles. The tool was effective in distinguish-

ing between student perceptions specifically related to UDL training compared to the impact of increased communication and rapport between instructors and students that naturally occur across the semester, regardless of UDL implementation. However, this study was not without its limitations, and we offer four for consideration. First, the instrument used in this study relied on students' perceptions of their instructors' implementation of UDL. Classroom observations of the instructors' performance would potentially provide additional information about the effectiveness of instructor UDL training and the actual implementation of UDL strategies in the classroom. Thus, future research in this area should include other outcome measures such as classroom observations, student grades, and persistence data. Furthermore, forthcoming studies should equate instructor techniques at baseline and

Figure 3. Pre- and post-questionnaire mean student rating for Question 8 for the intervention group (solid line) and control group (dashed line).



Note: The *a priori* *t* values indicate a significant change in student ratings from pre- to post-questionnaire administration for the intervention group, but not for the control group.

monitor differential changes in teaching/learning methodologies used by instructors in an intervention group compared to a control group.

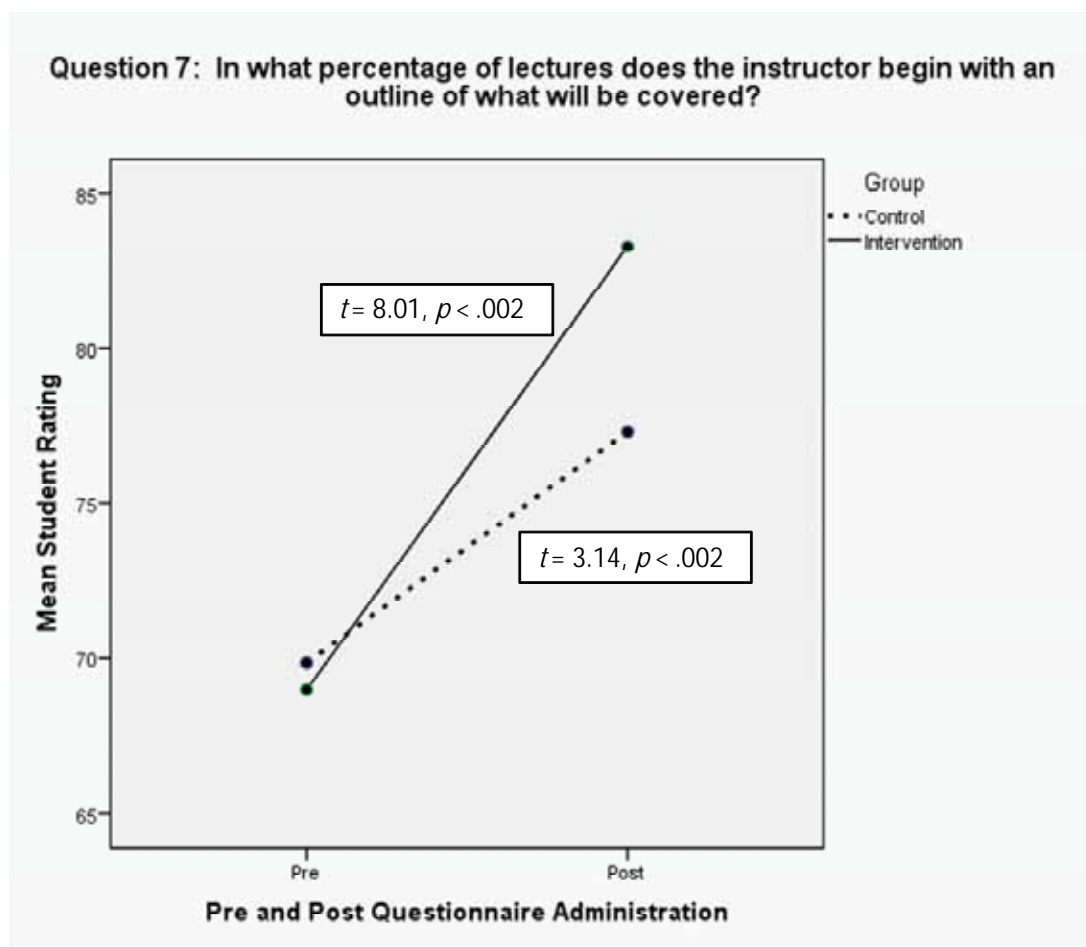
Second, we did not report student outcomes that may have resulted from UDL training, such as persistence and grades in the course. Ultimately, it must be demonstrated that the use of UDL principles in higher education leads to improved student outcomes. Future research should measure outcomes such as grades and persistence.

A third limitation is the possible impact the length of the instrument (i.e., 50 items) and the fact that it was electronically delivered may have had on student response. It is possible that students found the instrument somewhat cumbersome to complete, which may have affected the lower response rate post-study. Subsequent research should look closely at shortening

the instrument, which may facilitate a higher response rate even with electronic submission. It is important to note that the authors have found it beneficial to allow for electronic instrument completion, in efforts to “go green” as well as to respond to contemporary students’ preferred method of communication (Greenhow, Robelia, & Hughes, 2009).

Finally, the instructors included in this study were doctoral students. It is possible that the results may have been different if the participants had been full-time faculty. Even though these doctoral students were selected as instructors for their extraordinary teaching experience, graduate students are in a different stage of professional development when compared to full-time faculty and the UDL training may have differential effects for full-time faculty. Thus, the results may not be generalizable to UDL training for full-time faculty

Figure 4. Pre- and post-questionnaire mean student rating for Question 7 for the intervention group (solid line) and control group (dashed line).



Note: The *a priori* *t* values indicate a significant change in student ratings from pre- to post-questionnaire administration for both the intervention group and the control group. A significant interaction confirms that the intervention group clearly demonstrated more change from pre- to post-ratings compared to the control group.

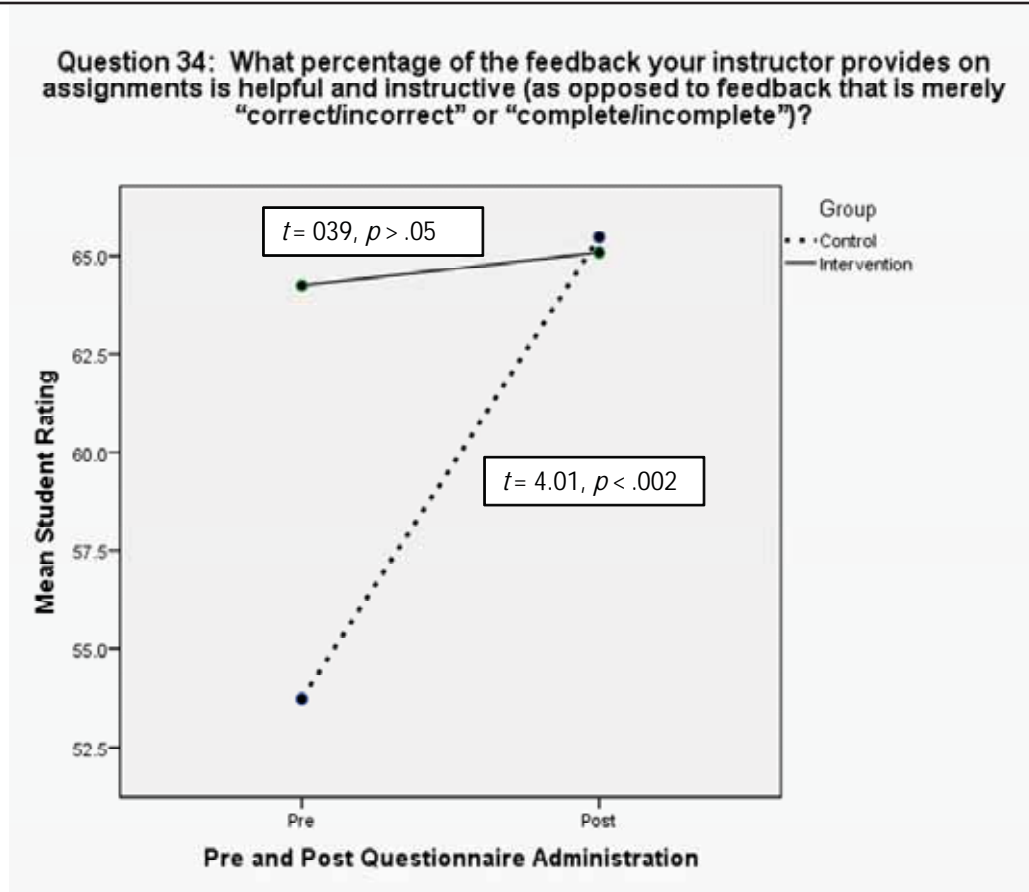
and future studies should include both full-time faculty and graduate teaching assistants.

Conclusions

The results of this study demonstrate that as little as five hours of group instruction for higher education instructors on the use of UDL principles and teaching strategies effectively increases the implementation of those strategies. Changes in instructor implementation of UDL strategies, based on student survey responses, were compared between instructors who received UDL training and a control group of instructors who did not receive UDL training. Students enrolled in the course in which their instructors received training reported a

positive change in instructors' use of UDL strategies, especially those strategies related to the principle of multiple means of representation. To our knowledge, this is the first study to use a control group methodology to examine the effects of training instructors on UDL implementation. Students in both the intervention and control groups reported a positive change in engagement, which indicates that some teaching and learning strategies may emerge across a semester regardless of instructor training. These results emphasize the importance of using control groups when examining the effectiveness of UDL training and implementation.

Figure 5. : Pre- and post-questionnaire mean student rating for Question 34 for the intervention group (solid line) and control group (dashed line).



Note: The *a priori* *t* values indicate a significant change in student ratings from pre- to post-questionnaire administration for the control group, but not for the intervention group.

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About the Authors

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Appendix

UDL Questionnaire

(Author note: 51 Questions from WebCT used for this research study)

1. What percentage of essential information provided during lectures is presented in multiple formats, including text, graphics, audio, video, and/or physical movement?
 - a. 0%
 - b. 10%
 - c. 20%
 - d. 30%
 - e. 40%
 - f. 50%
 - g. 60%
 - h. 70%
 - i. 80%
 - j. 90%
 - k. 100%
 - l. N/A
2. In what percentage of each class session, on an average, does the instructor actively engage students in learning?
 - a. 0%
 - b. 10%
 - c. 20%
 - d. 30%
 - e. 40%
 - f. 50%
 - g. 60%
 - h. 70%
 - i. 80%
 - j. 90%
 - k. 100%
 - l. N/A
3. Describe how the instructor gets students actively engaged in learning:
[Answer Box]
4. What could the instructor do better to actively engage students in learning?
[Answer Box]
5. In what percentage of class sessions does your instructor relate key concepts to the larger objectives of the course?
 - a. 0%
 - b. 10%
 - c. 20%
 - d. 30%
 - e. 40%
 - f. 50%
 - g. 60%
 - h. 70%
 - i. 80%
 - j. 90%
 - k. 100%
 - l. N/A
6. For each activity and assignment, the instructor's expectations for student performance are consistent with the learning objectives as stated on the syllabus and/or study guides.
 1. Strongly Agree
 2. Agree
 3. Neutral
 4. Disagree
 5. Strongly Disagree
 6. N/A
7. In what percentage of lectures does the instructor begin with an outline of what will be covered?
 - a. 0%
 - b. 10%
 - c. 20%
 - d. 30%
 - e. 40%
 - f. 50%
 - g. 60%
 - h. 70%
 - i. 80%
 - j. 90%
 - k. 100%
 - l. N/A

8. In what percentage of lectures does the instructor summarize key points, either during or at the end of lecture?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

9. What percentage of class time, on average, does the instructor spend facing the board or screen, or looking down at his/her notes, laptop, or overhead transparency while speaking?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

10. What are the things your instructor does, or things about the structure of this course, that help you learn?

[Answer Box]

11. What are the things your instructor does, or things about the structure of this course, that hinder your learning?

[Answer Box]

12. What does the instructor of this course do better than instructors of other courses to help you learn?

[Answer Box]

13. What have instructors of other courses done better than this instructor to help you learn?

[Answer Box]

14. The syllabus for this course clearly describes the nature and scope of content, as well as the instructor's expectations for student performance.

- 1. Strongly Agree
- 2. Agree
- 3. Neutral
- 4. Disagree
- 5. Strongly Disagree
- 6. N/A

15. What percentage of essential reading materials (other than the textbook) are available to students online?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A: There were no essential reading materials besides the textbook

16. Of the materials posted online for this course, what percentage are offered in multiple file formats (for example, HTML, PDF, DOC, RTF, etc.)?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

17. For what percentage of instructional videos used in this course does the instructor call attention to key points to help students understand the content?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A: There are no videos used in this course

18. If videos are used in this course, what percentage of them are captioned?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

19. Would video captions help you grasp more content from the videos?

- 1. Yes
- 2. No

20. In what percentage of each class session are instructional technologies (clickers, videos, PowerPoint, etc.) used to enhance learning?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

21. If your instructor uses instructional technologies during class sessions, please describe the technologies used:

[Answer Box]

22. For what percentage of course content delivered outside of class are instructional technologies employed? (For example, RamCT, videos, podcasts, online materials, external websites, etc.)

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%

l. N/A: There are no instructional technologies used outside of class for this course.

23. For instructional technologies used outside of class, please describe the technologies used:

[Answer Box]

24. What percentage of materials for this course (other than the textbook) are accessible, clearly organized, and easy to use?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%

l. N/A: There are no course materials other than the textbook.

25. As a student in this course, you are given opportunities to express your comprehension of material in ways other than traditional tests and exams (for example, through written essays, projects, portfolios, presentations, etc.).

- 1. Strongly Agree
- 2. Agree
- 3. Neutral
- 4. Disagree
- 5. Strongly Disagree
- 6. N/A

26. If you are allowed to express your comprehension in alternative ways besides tests and exams, briefly describe these alternative forms of expression:

[Answer Box]

27. This course employs technology to facilitate communication among students and between students and the instructor.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree
6. N/A

28. If your instructor uses technology to facilitate communication among students and between students and the instructor, briefly describe each communication technology and how it is used:

[Answer Box]

29. What percentage of assignments for this course can be submitted electronically?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A: None of the assignments for this class can be submitted electronically.

30. In what percentage of each class session, on an average, do you feel engaged and motivated to learn?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

31. For what percentage of topics taught in this course does the instructor explain the real-world importance?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

32. This course challenges you with meaningful assignments.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree
6. N/A

33. For what percentage of the topics covered in class does the instructor express his or her personal enthusiasm?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

34. What percentage of the feedback your instructor provides on assignments is helpful and instructive (as opposed to feedback that is merely “correct/incorrect” or “complete/incomplete”)?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%
- l. N/A

35. The average length of time I wait to receive feedback on assignments is:

- a. 1 day
- b. 2 days
- c. 3 days
- d. 4 days
- e. 5 days
- f. 1 week
- g. 1.5 weeks
- h. 2 weeks
- i. 3 weeks
- j. 4 weeks

36. The instructor for this course is highly approachable and available to students.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree
6. N/A

37. The instructor creates a class climate in which student diversity is respected.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree
6. N/A

38. The instructor offers contact with students outside of class time in flexible formats (for example, face-to-face, email, online chat, telephone, etc.)

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree
6. N/A

39. What percentage of class sessions have you attended this semester?

- a. 0%
- b. 10%
- c. 20%
- d. 30%
- e. 40%
- f. 50%
- g. 60%
- h. 70%
- i. 80%
- j. 90%
- k. 100%

40. The syllabus for this course includes a statement about the instructor’s appreciation for diversity and his or her willingness to make “appropriate accommodations” for students with disabilities.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree
6. N/A

41. I am familiar with the services provided by the following offices on campus (check all that apply):

1. Academic Advancement Center (AAC)
2. Ask Pat website
3. Assistive Technology Resource Center (ATRC)
4. Career Center
5. Center for Advising and Student Achievement (CASA)
6. Center for Community Partnerships (CCP)
7. College of Natural Science Tutorial Hall
8. Division of Student Affairs advocacy offices
9. The Institute for Learning and Teaching (TILT)
10. Learning Assistance Program (LAP)
11. Morgan Library Assistive Technology
12. Psychological Services Center (PSC)
13. Resources for Adult Learners
14. Resources for Disabled Students (RDS)
15. The Writing Center
16. University Counseling Center
17. The Wellness Zone

42. What grade do you think you will receive in this course?

1. A
2. B
3. C
4. D
5. F
6. W

43. What grade do you think the average person will receive in this course?

1. A
2. B
3. C
4. D
5. F
6. W

44. Are you a student with a disability (for example, a learning disability, ADHD, a physical disability, etc.)?

1. Yes
2. No

45. If you are a student with a disability, have you contacted the Resources for Disabled Students office (RDS) to request accommodation services?

1. Yes
2. No
3. N/A

46. Please identify your student status, mark all that apply:

1. 1st semester of college
2. 2nd semester of college
3. Newly transferred from another college/university
4. First generation college/university student
5. Non-traditional student (a student who does not follow a direct path from high school to college)
6. Part-time student
7. Other

47. If you identified your student status as "Other," please describe:

[Answer Box]

48. How many hours per week are you employed in a University job?

1. 0 hours per week
2. 1-4 hours per week
3. 5-9 hours per week
4. 10-19 hours per week
5. 20-29 hours per week
6. 30-39 hours per week
7. 40 or more hours per week

49. How many hours per week are you employed in a non-University job?

1. 0 hours per week
2. 1-4 hours per week
3. 5-9 hours per week
4. 10-19 hours per week
5. 20-29 hours per week
6. 30-39 hours per week
7. 40 or more hours per week

50. How long did it take you to complete this survey?

- a. 10 minutes or less
- b. 11-20 minutes
- c. 21-30 minutes
- d. 31-40 minutes
- e. 41-50 minutes
- f. 51-60 minutes
- g. More than 1 hour