Effects of Training in Universal Design for Learning on Lesson Plan Development

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ABSTRACT

The effects of training in Universal Design for Learning (UDL) on lesson plan development of special and general educators in a college classroom environment were investigated. A true experimental group design with a control group was used for this study. A one-hour teacher training session introduced UDL to the experimental group; the control group received the intervention later. A three-factor analysis of variance with repeated measures was completed for each of the dependent variables (i.e., UDL lesson plan). Differences were found between pretest and posttest measures for both treatment groups for special education and general education teachers. The results suggest that a simple introduction to UDL can help teachers to design a lesson plan accessible for all students.

THE INDIVIDUALS WITH DISABILITIES EDUCATION Act (IDEA; 1997) and its most recent revision, the Individuals with Disabilities Education Improvement Act (IDEIA; 2004), have suggested that research has found that all students with disabilities must be held to high expectations and must be ensured access to the same general education curriculum taught to students without disabilities to the maximum extent possible. Yet *how* they have to access the general curriculum has been unclear, especially for students with significant disabilities (Browder et al., 2005). Throughout the past 2 decades, the field of special education has debated the pros and cons of including students with disabilities in general education classrooms (Huber, Rosenfeld, & Fiorello, 2001; McLeskey, Waldron, So, Swanson, & Loveland, 2001; Polloway & Bursuck, 1996). On the one hand, studies have shown that students with mild to moderate disabilities (Blum, Lipsett, & Yocom, 2002; Waldron & McLeskey, 1998; Witzel, Mercer, & Miller, 2003) and students with severe disabilities (Burns, Storey, & Certo, 1999; Kennedy, Shukla, & Fryxell, 1997; McDonnell, Mathot-Buckner, Thorson, & Fister, 2001; Mu, Siegel, & Allinder, 2000) have been successfully included in general education classrooms. On the other hand, parents, teachers, and support associations have continued to voice concerns that exceptional students' needs are not always met in inclusive settings (Mancini & Layton, 2004; McLeskey, Henry, & Axelrod, 1999; Praisner, 2003). In particular, concerns have largely focused on meeting students' needs through adaptations or modifications of the general education curriculum and instruction.

Researchers and advocates of inclusion have claimed that individualized instruction is the quintessential guide to modifying the curriculum for all students. In this model, it is typically special education teachers who are responsible for reducing curriculum capacity and teaching remedial skills, often outside the general education classroom. When Ryndak, Jackson, and Billingsley (2000) asked experts in the field of severe disabilities to define inclusion, one definition they provided was to collaboratively plan, implement, and evaluate instruction that is integrated through the general education instruction that meets the need of each student. Through a triangulation process across 19 studies, Hunt and Goetz (1997) found that curricular adaptation as a vital com-

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ponent for effective inclusion was one of the six themes that ran across the studies.

Other researchers have suggested that one reason for the potential failure of students with disabilities in general education settings is related to lesson plan development. For example, Schumm and Vaughn (1995) found that although teachers viewed accommodations as advantageous for all students, they were unable to modify their instruction due to time constraints, classroom management, and differing achievement levels of students. They also suggested that many general education teachers are uncertain of what inclusion entails and doubt their ability to teach students with disabilities. In the area of severe disabilities, Smith (2000) found that teachers did not feel they have the proper training or preparation to include students. Cawley, Foley, and Miller (2003) acknowledged that lack of teacher education and limited training within university teacher preparation programs could be a possible explanation for deficiencies in curriculum modifications.

Universal Design for Learning

One possible solution to assist special and general education teachers in developing lesson plans that accommodate a diverse student population is called Universal Design for Learning (UDL). UDL, designed by the Center for Applied Special Technology (CAST; 1998), uses flexible instructional materials and methods to accommodate a variety of learning differences (Orkwis, 2003). UDL was first derived when CAST established the National Center on Accessing the General Curriculum (NCAC; 1999). NCAC was a 5-year, federally funded program that was committed to improve general curriculum access for students with disabilities. NCAC's funding was terminated in 2004; however, its achievements are carried on today at CAST. CAST's Web site describes UDL as a "blueprint for creating flexible goals, methods, materials, and assessments that accommodate learner differences" (CAST, 1998, ¶ 2). This instructional application extends the early principles of *universal design* from architecture, where easily accessible structures (e.g., cut-away curbs, captions on televisions, automotive doors) were created to accommodate a variety of users (Burgstahler, 2001) to actively participate in everyday activities.

IDEIA (2004) recognizes the term *universal design* according to Section 3 of the Assistive Technology Act (1998). The act states that universal design "is a concept or philosophy for designing and delivering products and services that are usable by people with the widest possible range of functional capabilities, which include products and services that are directly usable (without requiring assistive technologies) and products and services that are made usable with assistive technologies" (pp. 8–9).

Similar to the guidelines of architects, UDL introduces the notion that teachers should plan instructional supports at the beginning of lesson planning, instead of modifying materials as an afterthought (Hitchcock, 2001). The UDL model introduces educators to three components for overcoming barriers that are particularly presented within the general education classroom: representation, expression, and engagement (CAST, 1998).

Representation refers to modifications that can be made to classroom materials that would make them more accessible to students with disabilities (e.g., modified books, larger print, digital text). The second component, *expression*, designates alternate methods of communication for students with limited speech (e.g., use of augmentative devices, computers, graphic programs). This second component explains how students can express themselves by answering questions and communicating within the classroom setting. The third component, *engagement*, designates the use of strategies that involve students with disabilities in the learning process (e.g., providing repetition, familiarity, opportunities to respond). To encourage engagement for all students, the curriculum needs to provide flexible alternatives.

Much of the UDL literature provides basic descriptions of UDL principles and components and suggestions on how to implement them (Hitchcock, 2001; Hitchcock, Meyer, Rose, & Jackson, 2002; Rose, 2001). Some researchers (e.g., O'Connell, 2001; Rose & Dolan, 2000) have focused on examining current limitations of traditional teaching practices and providing alternative methods for emphasizing a broader curriculum access for students with disabilities. Other researchers (e.g., Orkwis, 2003; Rose & Meyer, 2002) examined the role of pragmatic classroom settings and teachers' perceptions of instructional accommodations.

With the present emphasis on scientific research in education and special education (Odom et al., 2005; Shavelson & Towne, 2002; Spooner & Browder, 2003), it is essential to develop experimental studies that provide the educational community with evidence-based practices. Although there has been some documented success with students with disabilities in the general curriculum (e.g., Kennedy et al., 1997; McDonnell et al., 2001), there is a lack of scientific investigation on the feasibility, application, or use of UDL.

The purpose of this study is to determine the effects of teacher training about UDL on the lesson plan designs of special education and general education teachers in a college classroom setting. It was reasoned that before UDL can have a profound impact on teaching and learning, there must be evidence that teachers can learn to use it in planning instruction for students with disabilities.

Method

Participants

Participants were 72 graduate and undergraduate students enrolled in four education classes (i.e., two special education classes and two general education classes) in a southeastern university. Participants ranged in age from 19 to 58 years,

with a mean age of 33 years. There were 55 (76%) women and 17 (24%) men. Sixty (83%) of the participants were European American, 9 (13%) were African American, and 3 (4%) indicated other ethnicities. Twenty-one (29%) of the participants were working toward a bachelor's degree, and 51 (71%) of the participants were working toward a master's degree. Forty-one (57%) of the participants were special education students, and 31 (43%) were general education students. Further demographics showed that 13 (18%) of the participants had never written a lesson plan, 63 (87%) were unfamiliar with UDL, and none of the participants had written a lesson plan considering the concepts of UDL. The participants who had not written a lesson plan were in the special education class, representing approximately a quarter of the class (24%). Furthermore, the special education class had more participants with UDL knowledge (17%) than the general education class (3%).

Setting

The participants gave their informed consent and volunteered to take part while enrolled in two special education classes and two general education classes at a southeastern university. The courses used were General Curriculum Access, Instructional Planning of Lesson Plans, Middle-Grade Science Methods, and Middle-Grade Math Methods. These courses were chosen based on the following criteria: (a) course objectives, (b) number of students in the classroom, and (c) pertinence of the topic to the class. The courses' objectives were considered so that there would not be a discrepancy between the intervention and the material that was required under the course title. The number of students in the classroom was considered adequate to provide power to the study. Finally, the four courses were considered appropriate if a class meeting was scheduled in their syllabus to discuss instructional accommodations. All of these courses had lectures planned that were related to this study, with one course (i.e., General Curriculum Access) having a lecture on UDL.

Procedure

Participants in each of the four classes were randomly assigned to either the treatment group or the control group. In each of the four courses, after the pretest, the participants placed their names into a hat. Names were then chosen from the hat to determine whether the participants were in the control group or in the treatment group. On the following class meeting, those chosen for the control group came to class one hour later than those in the treatment group. The intervention consisted of a 1-hour lecture on UDL conducted by one of the co-investigators of the study. The control group received the UDL lesson after completion of the posttest. One of the classroom instructors' videotaped the 1-hour UDL intervention for the control group students to watch later in the semester, whereas the other three instructors repeated the UDL lesson to the control group. The same set of instructional materials (i.e., PowerPoint slides) was used for each presentation.

The intervention was a 1-hour classroom presentation on how to modify lesson plans for students with severe and mild disabilities using the three components of UDL. The presentation consisted of an introduction to the three principles of UDL and training on how to incorporate these principles into daily lesson planning. The introduction to UDL included a description of the individual components that make up universal design according to CAST. For example, visual cues, such as re**presentation**, **expression**, and **engagement** (i.e., underlining and putting key words into bold lettering), were given to allow participants a strategy to remember using UDL concepts in developing their own lesson plans. As the UDL concept of re**presentation** includes developing innovative approaches in presenting materials to students, it was important for participants to remember the term *present*.

To begin implementing daily lessons involving UDL concepts, participants were provided with explicit examples of how students with disabilities may be included in the general curriculum. This was done through the use of a case study (see Figure 1) with a given set of state competencies, including math, language arts, and science goals that were to be addressed. Participants were given various examples of modifying instruction using several types of augmentative devices (e.g., individual prerecorded response pads, leveled communication boards) and modified books (e.g., novels adapted using Boardmaker™ symbols). Participants were then asked to come up with their own examples. In the culminating step, participants, along with the presenter, worked together in developing a universally designed lesson plan (using the pretest case study) that incorporated all three components of UDL. Once the intervention had taken place, participants completed a posttest. The posttest involved a newly constructed case study, including both (a) a different student with disabilities and (b) a variety of state competencies that should be addressed.

Instrumentation. Participants taking the special education coursework were given a case study of a student with a severe disability, whereas the participants in the general education math courses were given a case study that focused on a student with a mild cognitive disability (e.g., a learning disability or dyslexia). The case study consisted of a general description of the student's strengths and interests and three general education curriculum goals, one each in the subject areas of language arts, math, and science (see Figure 1 for an example). The participants were asked to create a lesson plan focusing on the components of universal design for one general curriculum goal as a means to include a student with a disability into the general education classroom. A comparable novel case study was created for the posttest.

A basic lesson plan format was created to include objective, materials, procedure, guided practice, independent

practice, and assessment for the lesson as well as an extra section to provide examples and a clear description of how they would use the three components of UDL to make the curriculum accessible for the student with a disability. Participants' lesson plans were scored after the pretest and posttest using a scoring rubric specifically designed for the study (see Table 1). The scoring rubric consisted of a 3-point scale and evaluated the participants' lesson plans using the three components of UDL. There was a maximum number of 6 points available on the rubric. Points were distributed based on three given criteria:

- 0 points if there was not a clear description of each component,
- 1 point if one or two modifications were discussed, and
- 2 points if three or more modifications were discussed.

Content validity was measured by an expert panel composed of a special education professor with expertise in curriculum adaptation, a math education professor who was experienced in the inclusion of students with disabilities into general education classrooms, and a research associate with expertise in research on the literacy of students with significant disabilities. This panel met on three separate occasions throughout the research experiment. Materials such as the UDL instructional package, lesson plans, and case studies made by the investigators were reviewed by the panel to determine the degree to which the materials were representative of the content area. The panel also reviewed pre- and posttest case studies and found them to be comparable.

Procedural fidelity was measured during the 1-hour instruction sessions, using an observer checklist (see Figure 2) to ensure that each topic of the presentation was addressed and discussed. The presentation format used the checklist, in which the professor or teaching assistant marked the procedural fidelity checklist against what was actually being taught. The checklist included the three essential components of UDL and the steps involved in modifying a lesson plan. Using this checklist, uniform lessons across the four classes could be determined. Procedural fidelity checklists showed a 100% accuracy of delivery. As a check of interrater reliability on the scoring of the pretest and posttest lesson plans, 33% of the plans were randomly selected from Microsoft Excel and scored by the second and third authors. The authors used the scoring rubric, then compared the number of agreements and divided them by the number of total possible points. The percentage of interrater reliability agreement was 90%.

Design and Data Analysis Procedures

This study was a true pretest–posttest experimental group design with a randomly assigned control group. This design was

Mr. Allmon is a teacher in a third-grade classroom at a public school. His class consists of 24 students, including 1 student with severe mental disabilities (Rhonda, see below). This class is currently working on a language arts unit about animal and plant life. Students have previously read several books about different animals and have investigated life cycles using the National Geographic Web site.

Rhonda is 9 years old and currently in Mr. Allmon's third-grade general education classroom. As a very young child, Rhonda suffered from recurring ear infections and now has hearing loss in her right ear. Rhonda is also currently attending occupational therapy for weaknesses on the left side of her body. Rhonda has been labeled with a severe mental disability. Although she is nonverbal, Rhonda uses BigMacs and other forms of augmentative and alternative communication. It appears that she loves her teacher and friends, but she often complains about having to sit still all day at school. Rhonda's teachers say that she is very cooperative and motivated. Rhonda enjoys singing and painting.

Math Competency Goal 4. The learner will understand and use data and simple probability concepts.
4.01. Collect, organize, analyze, and display data (including circle graphs and tables) to solve problems.

Language Arts Competency Goal 2. The learner will apply strategies and skills to comprehend text that is read, heard, and viewed.
2.04. Identify and interpret elements of fiction and nonfiction and support by referencing the text to determine the author's purpose, plot, conflict, sequence, resolution, main idea and supporting details, cause and effect, and point of view.

Science Competency Goal 1. The learner will build an understanding of plant growth and adaptations.
1.02. Observe and describe how environmental conditions determine how well plants survive and grow in a particular environment.

State competencies found at http://www.dpi.state.nc.us/curriculum

FIGURE 1. Sample case study used as a posttest measure.

TABLE 1. Scoring Rubric on the Three Components of Universal Design for Learning

Objective	Score		
	0 points	1 point	2 points
Representation	No clear description of modifying materials to provide equal access to all students	Discusses one or two modifications of materials to provide equal access, but needs to be explained more in depth	Discusses three or more modifications of materials to provide equal access to all students; gives clear and precise explanations
Expression	No clear description of providing alternative communication methods	Discusses at least one alternative communication method, but needs to be explained more in depth	Discusses two or more alternative communication methods; gives clear and precise explanations
Engagement	No clear description of strategies to involve or engage students with disabilities	Discusses one or two strategies to involve students with disabilities, but needs to be explained more in depth	Discusses three or more strategies to involve students with disabilities; gives clear and precise explanations

chosen for its ability to control for internal validity issues (e.g., maturation, testing, selection, and regression; Campbell & Stanley, 1963). The scoring rubric mirrored the three essential qualities of UDL. Descriptive statistics were used to describe mean differences between the experimental and control groups. A three-factor analysis of variance (ANOVA) with repeated measures, comparing class, treatment group, and pretest–posttest scores, was completed for each of the dependent variables (i.e., total test score, representation, expression, and engagement scores) on the lesson plan pretest and posttest scores for the control and experimental groups.

Results

A quantitative analysis of performance was used to examine participants' abilities to develop universally designed lessons prior to and following the intervention. These results helped researchers to determine individual growth patterns for participants in both experimental and control groups.

Modified Lesson Plan

A three-factor ANOVA with repeated measures, comparing class, treatment group, and pretest–posttest scores, was completed for each of the four dependent variables. Within-group factors included the total pretest and posttest score and the pretest and posttest score for each component of UDL. The between-groups factors analyzed were class (i.e., general education vs. special education teachers) and participant group (i.e., experimental vs. control). Means and standard deviations for pretest and posttest scores for the experimental and control groups are reported in Table 2. ANOVA source tables are also provided for all dependent variables (see Tables 3 and 4).

We found statistically significant within-subject main effects for the total pretest and posttest, $F(1, 68) = 52.027$, $p < .001$, $\eta^2 = .433$; representation component, $F(1, 68) = 31.416$, $p < .001$, $\eta^2 = .316$; expression component, $F(1, 68) = 46.069$, $p < .001$, $\eta^2 = .404$; and engagement component, $F(1, 68) = 6.830$, $p = .011$, $\eta^2 = .091$. Both the special education and general education teachers in the experimental group showed an increase in mean scores from pretest to posttest (see Table 2). The scores of the special education teachers in the experimental group increased considerably from the pretest to the posttest, similar to the rise from pretest to posttest scores for the general education teachers in the experimental group. The mean scores of the special education and general education teachers in the control groups remained the same for both groups between the pretest and the posttest. Figure 3 presents a diagram indicating these differences.

Further results of this analysis also showed a statistically significant between-subjects effect for class (i.e., general education vs. special education teachers) on the total pretest and posttest, $F(1, 68) = 8.902$, $p = .004$, $\eta^2 = .116$; and expression component, $F(1, 68) = 7.066$, $p = .01$, $\eta^2 = .094$. A statistically significant between-subjects effect was also found for participant group (i.e., experimental vs. control) on the total pretest and posttest, $F(1, 68) = 45.028$, $p < .001$, $\eta^2 = .398$; representation component, $F(1, 68) = 17.791$, $p < .001$, $\eta^2 = .207$; expression component, $F(1, 68) = 14.668$, $p < .001$, $\eta^2 = .177$; and engagement component, $F(1, 68) = 33.885$,

_____ Introduction to UDL "At a Glance" concepts

_____ Instructor input: Teaching of curriculum access for all students

_____ Participant practice in developing lesson plans

_____ Questions and answers

_____ Posttests

FIGURE 2. Procedural fidelity checklist, Universal Design for Learning (UDL) agenda for instructional intervention.

TABLE 2. Class and Group Mean Scores and Standard Deviations on the Pretest and Posttest Universal Design for Learning Rubric

	Pretest		Posttest	
Group	***M***	***SD***	***M***	***SD***
General education				
Treatment	1.17	0.92	3.61	1.42
Control	1.23	1.30	1.23	1.30
Special education				
Treatment	0.83	0.98	3.13	1.22
Control	0.44	0.70	0.44	0.62

$p < .001$; $\eta^2 = .333$. Total means and standard deviations of rubric scores for the two classes (i.e., general education vs. special education) on each UDL component are reported in Table 5.

Discussion

We found that a 1-hour intervention on UDL enabled general education and special education teachers to develop lesson plans that involved a student with a mild or severe cognitive disability. These results suggest that teachers need to be informed about UDL to develop lesson plans for all learners in all environments. A three-factor analysis of variance with repeated measures for each of the dependent variables (i.e., total test score, representation, expression, and engagement scores) on the lesson plan pretest and posttest scores for the control and experimental groups found that the teachers in the experimental group improved in their lesson plan development after the 1-hour intervention. Also, judging by our scoring rubric, teachers in the experimental group showed a considerable amount of growth between the pretest ($M = 0.98$) and posttest ($M = 3.34$), compared to the control group's pretest ($M = 0.77$) and posttest ($M = .077$) scores.

One of the underlying premises of the UDL model is that teachers should plan instructional supports during the be-

TABLE 3. ANOVA Source Table for Test Rubric Scores by Universal Design for Learning Component

Source	*M*	*F*(1, 68)
Representation		
Between groups		
Class	0.89	2.95
Group	5.39	17.79*
Class × Group	1.22	1.29
Error	0.30	
Within group		
Test	6.36	25.29*
Class × Test	0.39	0.16
Group × Test	7.90	31.42*
Class × Group × Test	0.18	0.69
Error	0.25	
Expression		
Between groups		
Class	2.80	7.07*
Group	5.81	14.67*
Class × Group	0.01	0.01
Error	0.40	
Within group		
Test	6.12	35.95*
Class × Test	0.40	2.32
Group × Test	7.84	46.07*
Class × Group × Test	0.91	0.54
Error	0.17	
Engagement		
Between groups		
Class	0.87	3.30
Group	8.92	33.89*
Class × Group	0.20	0.77
Error	0.26	
Within group		
Test	4.74	23.54*
Class × Test	0.37	0.19
Group × Test	1.38	6.83
Class × Group × Test	0.30	1.47
Error	0.20	

*$p < .01$.

TABLE 4. ANOVA Source Table for Test Rubric Scores by Universal Design for Learning Component

Source	*M*	*F*(1, 68)
Between groups		
Class	12.38	8.90*
Group	62.60	45.03*
Class × Group	1.22	0.87
Error	1.39	
Within group		
Test	48.70	52.03*
Class × Test	0.42	0.05
Group × Test	48.70	52.03*
Class × Group × Test	0.42	0.05
Error	0.94	

*$p < .01$.

TABLE 5. Means and Standard Deviations of Rubric Scores by Universal Design for Learning Component on Pretest and Posttest

	Pretest		Posttest	
Group	*M*	*SD*	*M*	*SD*
Representation				
Treatment	0.27	0.45	1.17	0.63
Control	0.32	0.54	0.29	0.46
Engagement				
Treatment	0.43	0.50	1.02	0.57
Control	0.13	0.34	0.29	0.46
Expression				
Treatment	0.26	0.50	1.14	0.57
Control	0.32	0.54	0.25	0.58

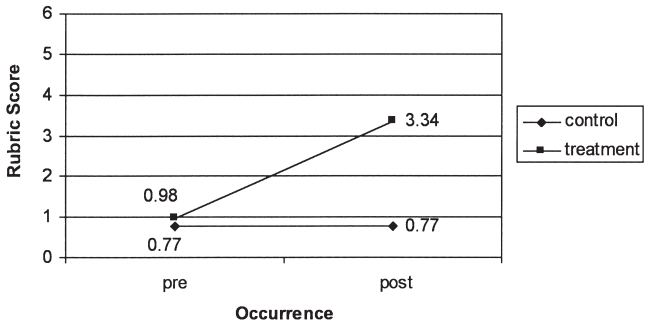

FIGURE 3. Comparison of treatment and control group mean Universal Design for Learning scores on the pretest and posttest. A 6-point scoring rubric was used to grade the lessons.

ginning of lesson planning, instead of modifying materials as an afterthought (Hitchcock, 2001). A possible implication of this study is that universally designed concepts might save teachers an extensive amount of time by creating modified lesson plans rather than changing them after the fact. By designing lessons before the fact, considering all students using the components of UDL, teachers have a better opportunity to teach a curriculum that actively involves all students. Participants in this study were given approximately 20 min to complete lesson plans during the posttest, and they were able to create a lesson plan with modified instruction for all students, including those with disabilities, within that 20-min time period.

We found that training on the concepts and application of UDL can provide general education and special education teachers with the lesson planning skills needed to design a universal curriculum for all students. This study used the three components of UDL (i.e., representation, expression, and engagement) developed by CAST to help teachers make the curriculum more accessible for students with disabilities. Although there has been evidence of students with severe disabilities having access to the general education curriculum (e.g., Kennedy et al., 1997; McDonnell et al., 2001), there has been a paucity of data-based studies focusing on UDL. Our outcomes support the work of CAST by providing teachers with a way to use the components of UDL to create access to the general education curriculum for all students.

Furthermore, we found that when general education teachers are taught the three components of UDL, they can write modified lesson plans involving representation, expression, and engagement. Although previous investigators (e.g., Cawley et al., 2003; Schumm & Vaughn, 1995) found that many general education teachers believed they were unable to modify instruction due to lack of training, time constraints, classroom management, and student levels, our results show that these teachers were capable of successfully modifying lesson plans with only a 1-hour lecture on the concepts of the three components of UDL and how to apply these three components to modify instruction to create access (intervention).

Many earlier contributions to the literature on the concepts of UDL have focused on basic descriptions and principles of UDL, whereas others have presented audiences with suggestions on how to implement them (Hitchcock, 2001; Hitchcock et al., 2002; Rose, 2001). Several authors have focused on examining the current limitations of traditional teaching practices and providing alternative methods for emphasizing a broader curriculum access for students with disabilities (O'Connell, 2001; Rose & Dolan, 2000). Based on our findings, we suggest that future data-based research,

using experimental designs, can be implemented with UDL. Future investigators should focus on the impact of UDL planning and instructional methods that tailor materials and assessments to meet the demands of all students.

Limitations

Some limitations should be mentioned about this research study. First, there were only four college courses selected for this study, with a total of 72 participants; however, the participants in each class were randomly assigned to the control or experimental groups. Future studies may look at a larger population of teachers so that the results can be generalized. Second, some of the teachers in this study were lateral-entry teachers (i.e., teachers who do not hold a teaching license but have a 4-year college degree) at local public schools, and some were graduate students with little teaching experience. Additional research could focus on lateral-entry teachers to examine the effects of UDL training and knowledge on their lesson plan development to include students with disabilities or physical limitations into their classrooms. Furthermore, supplementary studies may examine special education and general education teachers who hold valid teaching licenses and look at the effects of UDL training on their previous ways to write a lesson plan. These studies may also examine the longitudinal effects of UDL lesson plans in order to investigate if teachers are continuing to use these concepts in the classroom. Fourth, the teachers were only allowed 20 min to write their lesson plans. Many teachers indicated that more time was needed to make the lesson plan more descriptive. Prospective studies should examine the effects of allowing more time on UDL lesson plan development. Finally, it should be noted that a few of the mean scores and standard deviation scores appeared the same from pretest to posttest. This may be due to the low scoring scale on the scoring rubric or to the absence of knowledge about UDL among the participants (e.g., 18% had never written a lesson plan, 87% were unfamiliar with UDL, and none of the participants had written a lesson plan considering the concepts of UDL). All in all, the results of this study should be taken with caution due to the possibly unique success of the intervention with this particular situation or instructors.

In conclusion, this study adds to the database of experimental studies investigating the impact that UDL has on improving access to the general education curriculum. Based on the current teacher shortages in special education across the nation, many people are hired and hold a teaching position but have very little if any experience. More research is needed on the principles and application of UDL and teacher training. This study serves as a building block for additional research on UDL. Future investigations using the concepts of UDL during teacher training to provide more opportunities for students with various disabilities to be included and have access to the general education curriculum appear warranted.

Practical Implications

During our intervention, we did not focus only on the technology side of UDL but, rather, focused on the definition of universal design as used in IDEIA. For example, a teacher may have a student who has a learning disability in math. The teacher may use representation by presenting the material using concrete manipulatives (e.g., base-10 blocks, algebra tiles, geoboards, or multisensory touch points). This use of concrete manipulatives will also assist in engaging students by allowing them to use different modalities than the traditional written problems. Next, the teacher will use expression by considering the multiple ways in which the child can express him- or herself (e.g., if a student is unable to compute 2-digit by 2-digit multiplication problems with decimals, then the teacher may want to simply give the student the answer and then have him or her place the decimals correctly within the answer).

Although it appears that UDL principles depend on the knowledge and use of technology, this is certainly not the case. This study shows that even without the use of expensive technology, talented teachers can create lesson plans that involve students on all levels (i.e., mild, moderate, or severe cognitive disabilities). Rather than continuously using traditional instructional methods, it is important that both general and special educators begin to use methods of teaching that mimic real-life problem situations (e.g., calculating mileage for a trip, solving a mystery in a book, ordering from a restaurant menu, and calculating tips or taxes). Examples of how to include students with disabilities may involve having students work in cooperative groups, having students listen to tape-recorded information, allowing students to draw or paint sequenced steps from a book, having students make up a song summarizing information learned, or actively involving students in a science experiment. The use of creativity in problem solving can help students to see overall representations of objectives without feeling overwhelmed by a multitude of written instructions. ■

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REFERENCES

Assistive Technology Act of 1998, 29 U.S.C. § 3001 *et seq.*

Blum, H. T., Lipsett, L. R., & Yocom, D. J. (2002). Literature circles: A tool for self-determination in one middle school inclusive classroom. *Remedial and Special Education, 23,* 99–113.

Browder, D., Ahlgrim-Delzell, L., Flowers, C., Karvonen, M., Spooner, F., & Algozzine, R. (2005). How states implement alternate assessment for students with disabilities. *Journal of Disability Policy Studies, 15,* 209–220.

Burgstahler, S. (2001). *Universal design of instruction.* Retrieved October 10, 2004, from http://www.washington.edu/doit/Brochures/Academics/instruction.html

Burns, M., Storey, K., & Certo, N. J. (1999). Effect of service learning on attitudes towards students with severe disabilities. *Education and Training in Mental Retardation and Developmental Disabilities, 34,* 58–65.

Campbell, D. T., & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research on teaching. In N. L. Gage (Ed.), *Handbook of research on teaching* (pp.). Chicago: Rand McNally.

Cawley, J. F., Foley, T. E., & Miller, J. (2003). Science and students with mild disabilities. *Intervention in School and Clinic, 38,* 160–172.

Center for Applied Special Technology. (1998). *What is universal design for learning?* Wakefield, MA: Author. Retrieved July 11, 2005, from http://www.cast.org/research/udl/index.html

Hitchcock, C. (2001). Balanced instructional support and challenge in universally designed learning environments. *Journal of Special Education Technology, 16,* 23–30.

Hitchcock, C., Meyer, A., Rose, D., & Jackson, R. (2002). Providing new access to the general curriculum: Universal design for learning. *Teaching Exceptional Children, 35*(2), 8–17.

Huber, K. D., Rosenfeld, J. G., & Fiorello, C. A. (2001). The differential impact of inclusion and inclusive practices on high, average, and low achieving general education students. *Psychology in the Schools, 38,* 497–504.

Hunt, P., & Goetz, L. (1997). Research on inclusive educational programs, practices, and outcomes for students with severe disabilities. *The Journal of Special Education, 31,* 3–31.

Individuals with Disabilities Education Act of 1997, 20 U.S.C. §1400 *et seq.*

Individuals with Disabilities Education Improvement Act of 2004, 20 U.S.C. §1400 *et seq.* (2004) (reauthorization of the Individuals with Disabilities Education Act of 1990)

Kennedy, C. H., Shukla, S., & Fryxell, D. (1997). Comparing the effects of educational placement on the social relationships of intermediate school students with severe disabilities. *Exceptional Children, 64,* 31–47.

Mancini, K. G., & Layton, C. A. (2004). Meeting fears and concerns effectively: The inclusion of early childhood students who are medically fragile. *Physical Disabilities: Education and Related Services*, *22*(2), 29–48.

McDonnell, J., Mathot-Buckner, C., Thorson, N., & Fister, S. (2001). Supporting the inclusion of students with moderate and severe disabilities in junior high school general education classes: The effects of classwide peer tutoring, multi-element curriculum, and accommodations. *Education and Treatment of Children, 24,* 141–160.

McLeskey, J., Henry, D., & Axelrod, M. I. (1999). Inclusion of students with learning disabilities: An examination of data from reports to congress. *Exceptional Children, 66,* 55–66.

McLeskey, J., Waldron, N. L., So, T. H., Swanson, K., & Loveland, T. (2001). Perspectives of teachers toward inclusive school programs. *Teacher Education and Special Education, 24,* 108–115.

Mu, K., Siegel, E. B., & Allinder, R. M. (2000). Peer interactions and sociometric status of high school students with moderate or severe disabilities in general education classrooms. *The Journal of the Association for Persons with Severe Handicaps, 25,* 142–152.

National Center on Accessing the General Curriculum. (1999). *CAST universal design for learning: Policy and practice.* Wakefield, MA: Center for Applied Special Technology. Retrieved February 9, 2006, from http://www.cast.org/policy/ncac/index.html

O'Connell, K. (2001). Looking at textbooks: Universal design for learning: Associate editor's column. *Journal of Special Education Technology, 16,* 57–58.

Odom, S. L., Brantlinger, E., Gersten, R., Horner, R. H., Thompson, B., & Harris, K. R. (2005). Research in special education: Scientific methods and evidence-based practices. *Exceptional Children, 71,* 137–148.

Orkwis, R. (2003). *Universally designed instruction.* Arlington, VA: Council for Exceptional Children. (ERIC Document Reproduction Service No. ED468709)

Praisner, C. L. (2003). Attitudes of elementary school principals toward the inclusion of students with disabilities. *Exceptional Children, 69,* 135–145.

Polloway, E. A., & Bursuck, W. D. (1996). Treatment acceptability: Determining appropriate interventions within inclusive classrooms. *Intervention in School and Clinic, 31,* 133–144.

Rose, D. (2001). Universal design for learning. *Journal of Special Education Technology, 16,* 66–67.

Rose, D., & Dolan, B. (2000). Universal design for learning: Associate editor's column. *Journal of Special Education Technology, 15,* 47–51.

Rose, D., & Meyer, A. (2002). *The future is in the margins: The role of technology and disability in educational reform.* Washington, DC: Department of Education, American Institutes for Research. Retrieved October 15, 2004, from http://www.cast.org/udl/UniversalDesignforLearning362.cfm

Ryndak, D. L., Jackson, L., & Billingsley, F. (2000). Defining school inclusion for students with moderate to severe disabilities: What do experts say? *Exceptionality, 8,* 101–116.

Schumm, J. S., & Vaughn, S. (1995). Meaningful professional development in accommodating students with disabilities: Lessons learned. *Remedial and Special Education, 16,* 344–355.

Shavelson, R. J., & Towne, L. (Eds.). (2002). *Scientific research in education.* Washington, DC: National Academy Press.

Smith, M. G. (2000). Secondary teachers' perceptions toward inclusion of students with severe disabilities. *NASSP Bulletin, 84,* 54–60.

Spooner, F., & Browder, D. M. (2003). Scientifically based research in education and students with low incidence disabilities. *Research and Practice for Persons with Severe Disabilities, 28,* 117–125.

Waldron, N. L., & McLeskey, J. (1998). The effects of an inclusive school program on students with mild and severe learning disabilities. *Exceptional Children, 64,* 395–405.

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practice, 18,* 121–131.