



Results of a One-Day Seminar on Preservice Teachers' Incorporation of the Universal Design for Learning Framework in Lesson Design

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Abstract

Students with disabilities are increasingly receiving their instruction in inclusive classrooms. General education teachers continue to report a lack of preparation to address their needs. This study examined the impact of a 6-hour professional development seminar on the Universal Design for Learning (UDL) framework to determine if preservice general and special education teachers' overall performance in lesson design to reduce barriers, identified through increased attention to student variability, improved. Two lesson plans, preseminar and postseminar, from 242 participants were scored using a modified education field experience (EFE) rubric that included 19 evaluation criteria. A Rasch analysis was used to determine pretest and posttest scoring validity and to enable regression analysis with a continuous outcome variable. Results indicated that the seminar resulted in higher scores for the participants' postmeasures, controlling for the premeasure effects, as well as unique findings based on subject matter. These findings are presented, as well as implications for future research and practice.

Keywords: *universal design for learning, UDL, inclusive practice, lesson design, preservice teacher education*

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Introduction

Universal Design for Learning (UDL) is a scientifically validated framework that supports educators in proactively and iteratively designing curricula that address the variable needs of all learners by removing barriers within instructional experiences. The UDL framework provides guidance to support educators in redesigning curriculum (goals, methods, materials, and assessments) to support all learners (Meyer et al., 2014). While increasingly included in legislated United States educational policies, including the Every Student Succeeds Act of 2015, the U.S. National Education Technology Plan of 2016 (United States Department of Education, 2016), and the Higher Education Act of 2008, research on the framework's preparation, implementation, and evaluation in educational settings lags behind those policies (Rao et al., 2014; Smith et al., 2019).

The UDL framework has been used to support inclusion (Lowrey & Smith, 2018; Dunn & Perez, 2012). The framework, which includes three principles, nine guidelines, and 31 checkpoints, provides teacher candidates with flexibility for presenting content (multiple means of representation), designing pathways students can use to express content knowledge (multiple means of action and expression), and designing ways to engage students in the learning process (multiple means of engagement) (Ralabate & Berquist, 2020). The framework can help educators reduce barriers in the instructional environment and reduce (not eliminate) the number of specialized accommodations and modifications for students with disabilities, while maintaining high expectations for all students, including those with disabilities (Higher Ed. Act, 2008). Implementing UDL allows teachers to reach more students, by including those students in the margins. (To learn more about the basics of the UDL framework, please see CAST, 2018).

The UDL framework promotes the instructional design of a curriculum that moves beyond planning for the average learner and systematically addresses variability among learners, including those with disabilities (Ralabate & Berquist, 2020). This is a paradigm shift from prior curriculum design methods that focused on the average learner (Meyer et al., 2014). The inclusion of UDL in legislated policy marks the beginning of a shift in practice. However, minimal progress has been made in teacher education programs implementing UDL (Scott et al., 2017). Some researchers have begun initial inquiries into supporting preservice teacher education programs in preparing teachers to implement the UDL framework in practice. Rao et al. (2018) published UDL Reporting Criteria to aid researchers in designing UDL research and conveying the results with sufficient detail.

Preservice Teacher Education

Preservice teacher education continues to be an area in which explicit research is recommended (Smith et al., 2019). While some work has been completed, all research recommends more empirical measures with larger samples (Courey et al., 2013; Evans et al., 2010; Spooner et al., 2007). Scott et al. (2017) recently attempted to identify how many preservice programs were preparing teacher candidates to implement UDL. Using a survey with a mixture of fixed-choice and narrative responses, they received responses from 41 program coordinators at accredited universities. From this small sample, the majority (>80%) are preparing their future teachers to have knowledge and skill in the UDL principles. However, fewer than 25% of their participants reported applying their knowledge with students (particularly students with disabilities) while enrolled in their own teacher preparation programs.

Designing instruction through lesson planning is one skill all preservice teachers learn in their educational licensure programs. Learning how to implement the UDL framework while designing lessons may have an impact on how teachers design instruction for students in the margins (Meyer et al., 2014; Ralabate & Berquist, 2020). Several studies have looked specifically at teaching the UDL framework principles and implementing them in lesson planning procedures. For example, Spooner et al. (2007) evaluated lesson plans written by 72 preservice teachers after a 1-hour class on the UDL principles. Using a rubric researchers

developed to measure the inclusion of UDL principles, their results demonstrated positive gains in using the UDL framework in lesson plans. It is important to note that the rubric measures only the inclusion of UDL principles, not guidelines or checkpoints.

In additional efforts, a preservice teacher education program redesign was shared by Evans et al. (2010), detailing their attempts to embed the UDL framework within their rural program. They targeted both lesson planning and a requirement to teach at least one UDL-developed lesson in practice. However, due to the descriptive nature, measures were not taken to evaluate change in how preservice teachers implemented the framework. Extending Spooner et al.'s work from 2007, Courey et al. (2012) utilized a 3-hour module in their teacher education program with 45 preservice teacher participants. Using Spooner et al.'s rubric (2007) to evaluate the resulting lesson plans, their findings indicated positive gains in the number of UDL principles included. Maintenance probes conducted over time demonstrated that participants continued to include UDL principles in their planning.

Building on the previous work described above, Lowrey et al. (2019) conducted a pilot study to determine whether a UDL professional development seminar, focused on all principles, guidelines, and checkpoints included in the UDL Guidelines Checklist (CAST, 2018) and delivered during student teaching, would impact the way a preservice teacher planned, implemented, and reflected on a lesson. The pilot had eight participants and resulted in minimal changes overall in the way preservice teachers changed their implementation of the UDL guidelines and checkpoints after a UDL professional development seminar. However, some participants demonstrated more change than others, particularly in how they designed for and addressed the principle of engagement and its corresponding guidelines and checkpoints. This led the authors to ask additional questions, primarily around preservice teachers' understanding of student variability to plan intentionally for the removal of barriers to learning when designing instruction.

Ideally, instruction on UDL would occur throughout teacher education. However, as demonstrated by Scott et al. (2017) and Smith et al. (2019), content in preservice teacher programs has concentrated primarily on teaching the three principles of UDL. A design seminar in the student teaching phase of preservice education provided one last targeted opportunity to present the UDL framework consistently to all education majors in the program, utilizing adult learning theory (Knowles et al., 2015). Additionally, the placement of this design seminar allowed for optimal results for authentic lesson design, due to the candidates' need for information related to lesson implementation and the ability to draw from current student teaching experiences.

Purpose of the Study

Following primary procedures established in an initial pilot study (Lowrey et al., 2019), with increased attention to learner variability, the purpose of this study was to determine if a professional development seminar on using the UDL framework to design lesson plans, delivered midway through student teaching, would impact preservice teachers' overall performance on lesson planning assignments and their ability to include the UDL framework. Specifically, researchers wanted to know if participants, through the experience of a 1-day seminar, would design lessons through the UDL framework that better addressed instructional barriers and learner variability.

Methods

This study examines the impact of a 6-hour UDL seminar on preservice teachers' lesson plan development during their student teaching. Researchers collected quantitative data from a traditional lesson plan developed prior to the UDL seminar and a UDL lesson plan developed after the seminar. Researchers scored the preseminar and postseminar lesson plans using a modified, university-approved teacher education

program standard lesson plan rubric. The modifications made to the program's standard lesson plan rubric included additional measurement indicators operationalizing the nine UDL guidelines used on both premeasures and postmeasures. The Institutional Review Board (IRB) approved this study. Two researchers in the field of special education and one researcher in the field of educational statistics working at an R1: Very High Research Activity designated university in the southern United States conducted the study.

Participants

Preservice teachers were placed in two 8-week student teaching experiences, following the usual practice at the University of Southern Mississippi in the southeastern United States. As part of the regular schedule, professional development seminars were planned between the preservice teachers' first and second 8-week placements. Since the UDL seminar was planned into the existing scheduled seminars and student teaching requirements, participants had only to consent to the inclusion of their data as part of the research study. If they chose not to consent, they still participated in the seminar and lesson planning, as part of their requirements for student teaching. Willing participants signed a consent form indicating their permission to have their first placement traditional lesson plan and their second placement UDL lesson plan submitted as data. Those not wishing to share their data declined consent by checking a box on the form. In negotiation for the study with the office that controlled the educational field experiences, as a condition of access, researchers agreed to present the seminar to the entire group. This prevented us from creating a traditional control group, whereby we would withhold the seminar from a group of participants and/or require additional training time to present the information later. Therefore, statistical methods were selected that measured the validity of the instrument and offered controls within the measures.

A total of 249 preservice teachers participated by submitting all data components for measurement—two lesson plans, one from their first teaching experience and one from their second. Seven participants (less than 3%) from the original 249 subjects were removed from the integrated and subsequent analyses due to high infit- and/or outfit-mean measures, leaving a total of 242. Table 1 summarizes participant demographic information, including gender, whether they used the UDL template, instructed grade level, ethnicity, licensure area, and lesson plan content area.

Table 1. *Demographic Characteristics of Participants in Analysis (N = 242)*

Characteristic	<i>n</i>	%
Gender		
Female	210	86.8
Male	32	13.2
UDL template		
No	130	53.7
Yes	112	46.3
Grade level		
K–2nd	65	26.9
3–5th	92	38.0
6–8th	57	23.6
9–12th	28	11.6
Ethnicity		
Black, African American	14	6.1
Caucasian	222	97.4
Other	6	2.6
Licensure		
Elementary	161	66.5
Secondary	58	24.0
Music	20	8.3
PE	3	1.2
Content area		
English Language Arts (ELA)	91	37.6
Mathematics	77	31.8
History/science	39	16.1
Music/PE	28	11.6
Other	7	2.9

Required Items for Measurement

Standard products for evaluation of student teaching at this university included the submission of two lesson plans, two lesson videos, and two lesson reflections as assessments, one from the first 8-week experience and one from the second. Traditional lesson plans were defined as those meeting the university's teacher preparation criteria (Lowrey et al., 2019). Therefore, for this study's purpose, the university's Education Field Experience (EFE) coordinator required preservice teachers to submit a traditional lesson plan (e.g., Madeline Hunter style), Lesson Plan A, during the first 8-week student teaching placement, followed by Lesson Plan B during the second 8-week placement. Lesson Plan B was the only change in typically submitted materials made for the study. The measurement of that lesson plan remained the same, but a template for Lesson Plan B was provided during the UDL seminar, which preservice teachers had an option to use (but were not required to use). As with the pilot study, each participant submitted three specific items (lesson plans, videos, and lesson reflections). Due to the volume of submissions (484 lesson plans, videos, and lesson reflections) only lesson plans were analyzed for this study.

UDL Professional Development Seminar Plan

Following the first 8-week student-teaching placement, researchers conducted a UDL seminar to increase preservice teachers' UDL framework knowledge. Researchers presented the UDL seminar across three semesters, keeping times and content identical. As suggested in the UDL Reporting Criteria (Rao et al., 2018), researchers proactively and intentionally designed the UDL seminar to address barriers that could have arisen due to differences in participants' content area focus, grade level taught, demographics, and culture. Specific seating groups for small group activities were designed to allow candidates to work within and across their fields of expertise (e.g., physical education, elementary, secondary content areas, and special education). This 6-hour seminar introduced the UDL framework to participants, using the UDL Guidelines Checklist (CAST, 2018) to develop active, collaborative content that included (a) learner variability concepts resulting in barriers to learning; (b) modeling ways to use multiple means of engagement, representation, and action/expression with intentionality; and (c) providing UDL resources. Researchers guided preservice teachers through the UDL Guidelines Checklist in an instructional context and had participants focus on the guidelines and checkpoints during applied practice opportunities for each principle. Throughout the seminar, researchers integrated the UDL principles, embedded learner variability, provided instructional barrier examples, and presented resources preservice teachers might use during lesson planning (see Lowrey et al., 2019). Seminar attendees and participants were given multiple opportunities to experience and apply each UDL principle through various guidelines and checkpoints.

Researchers then presented the CAST UDL lesson plan template (CAST UDL Exchange, n.d.). Throughout the seminar, UDL model lesson plans were embedded as exemplars. Researchers guided preservice teachers by comparing the traditional and UDL lesson plans during the seminar. As a closing application activity, preservice teachers worked collaboratively to design a sample lesson plan (Lowrey et al., 2019). At the close of the seminar, participants were informed that they could use the template for their next plan but that it was not mandated for them to do so. Groups were comprised of preservice teachers in similar grade levels (i.e., primary elementary, upper elementary, middle school, or secondary) plus peers representing different support specialties (i.e., music, PE, special education).

Data Collection Procedures

Following typical university EFE procedure, participants submitted all data components to Watermark, the online, password-protected, document storage system used by the university. Following each semester's end, the researchers sent the Watermark administrator a list of consenting preservice teachers. The Watermark administrator removed identifiable information, assigned each participant a code, and put all data in a shared, password-protected Office365 One Drive file. Data included two lesson plans, two videos, and two reflections for each consenting participant. As indicated above, only lesson plans were analyzed for the purpose of this study.

Lesson Plan A: Traditional Lesson Plan Data (Preseminar)

During the first 8-week student teaching placement, preservice teachers submitted Lesson Plan A, which included general demographic information, standards, learning objectives, assessment, differentiation/accommodations, anticipatory set, instructional procedures, instructional strategies, closure, and materials (e.g., traditional Madeline Hunter style). This lesson plan template had been used in the teacher education program for 19 years.

Lesson Plan B: UDL Lesson Plan Data (Postseminar)

During the second 8-week student teaching placement, the identical procedure was followed, except preservice teachers had participated in the 1-day UDL seminar prior to their second 8-week placement. During the seminar, participants practiced designing lessons utilizing the CAST UDL lesson plan template (n.d.), which included general demographic information, lesson description, state standards, lesson goals, objectives,

assessment (i.e., formative/ongoing, summative/end of lesson), variability of students, anticipatory set, introduction of new knowledge, guided practice, independent practice, and materials. Participants could choose to use this plan in their second teaching placement, but they were not required to do so.

Data Analysis

Lesson plans were scored using a modified EFE Rubric, which included 19 evaluation criteria. The original, non-modified EFE rubric had clearly defined measurements for seven lesson plan evaluation criteria. Researchers added three measures specific to planning for learner variability and also added the nine UDL guidelines, for a total of twelve additional criteria. Then, using the results from the pilot study, researchers further refined the UDL-enhanced items in the EFE Rubric. After items were refined, one researcher trained a graduate research assistant (GA) to code the lesson plans using the enhanced EFE Rubric by coding a sample together. Following this step, the researcher and the GA independently coded four preservice teachers' lesson plan sets of Lesson Plan A and Lesson Plan B (4/242, 1.6%). The researcher and GA wrote anecdotal notes while scoring the lesson plans for each category. After discussing the first four sets of lesson plans and agreeing on the coding scheme, the GA entered the EFE Rubric criteria into NVivo (2012) qualitative software and uploaded all lesson plans. Using a second set of four lesson plans, the GA and researcher independently assigned Likert-type ratings (i.e., unacceptable, marginal, mastery, and exemplary) within NVivo (2012). After independently coding the plans, the GA and the researcher met to discuss the codes, in order to establish reliability.

Interrater reliability was determined by using a point-by-point analysis of each score (Kelly, 1977). A discrepancy range of 2 points or more required a discussion between raters until agreement was reached. Initial interrater reliability for Lesson Plan A was 96%, with no 2-point discrepancies. Initial interrater reliability for Lesson Plan B was 94%, with two discrepancies that triggered a discussion and rubric adjustment for UDL guidelines 6 and 9 criteria. After the initial 8 sets were coded for the training, there were 234 lesson sets remaining to code. The GA coded 159 sets and the researcher coded 75 sets. At the end of the coding process, the researcher randomly chose 16 lesson sets to check interrater reliability. This reliability score was 97%.

The items relating to lesson planning mastery were scored using a rating scale response format with the following options, which represented raters' classifications of preservice teachers' lesson planning mastery: 1 = *unacceptable*, 2 = *marginal*, 3 = *mastery*, and 4 = *exemplary*. Prior to conducting statistical analyses assessing the effects of relevant predictor variables on preservice teachers' lesson planning ability levels, researchers conducted reliability and validity measurement diagnostics, as well as two separate calibrations of the premeasurements and postmeasurements, with the Rasch Rating Scale Model (RSM) (Andrich, 1978a, 1978b) as implemented in Winsteps (Linacre, 1999a).

The Rasch (1960/1980) models are a "specific class" of Item Response Theory (IRT) (Ostini & Nering, 2006). Andrich's RSM (1978a, 1978b) Rasch model is particularly suitable for scoring and assessment analysis to incorporate Likert or Likert-type response formats where the goal is to assess respondents' performance level on a typically unidimensional latent-class construct (Wright, 1994). The response options incorporated in the scoring instrument are assumed to be "inherently ordered" (Borooah, 2002), imply a monotonic progression on a scale from less to more (Bond & Fox, 2007), and are intended to probe various degrees of participants' level of mastery of the trait being considered, such as lesson planning proficiency (Linacre, 1999b). The Rasch RSM estimates an optimal set of parameters that maximize likelihood that a person/respondent b endorses an item d into a specific ordered performance level or category k (Wright & Masters, 1982).

To establish instrument reliability and validity, the diagnostics of the 19 evaluation criteria (Infit and Outfit items fit indices and ordering) and the rating scale function used in the assessment were conducted in an integrated analysis, which included both premeasurements and postmeasurements. Infit and Outfit fit indices measure model fit discrepancy, follow a chi-square distribution, and have an expected value of 1.0. The values

of these indices that fall between .5 and 1.5 are productive for measurement. Values below .5 or between 1.5 and 2 are less productive but not degrading to the measurement process, but indices over 2.0 are degrading to the measurement (Wright & Linacre, 1994).

Once the reliability and validity diagnostics demonstrated that the instrument functioned as intended, calibration was performed on the prescores first. The posttest measures were obtained through item calibration with anchored premeasure values, as well as anchored rating scale threshold values. Hence, the participants' postmeasures were calibrated with the premeasures frame of reference.

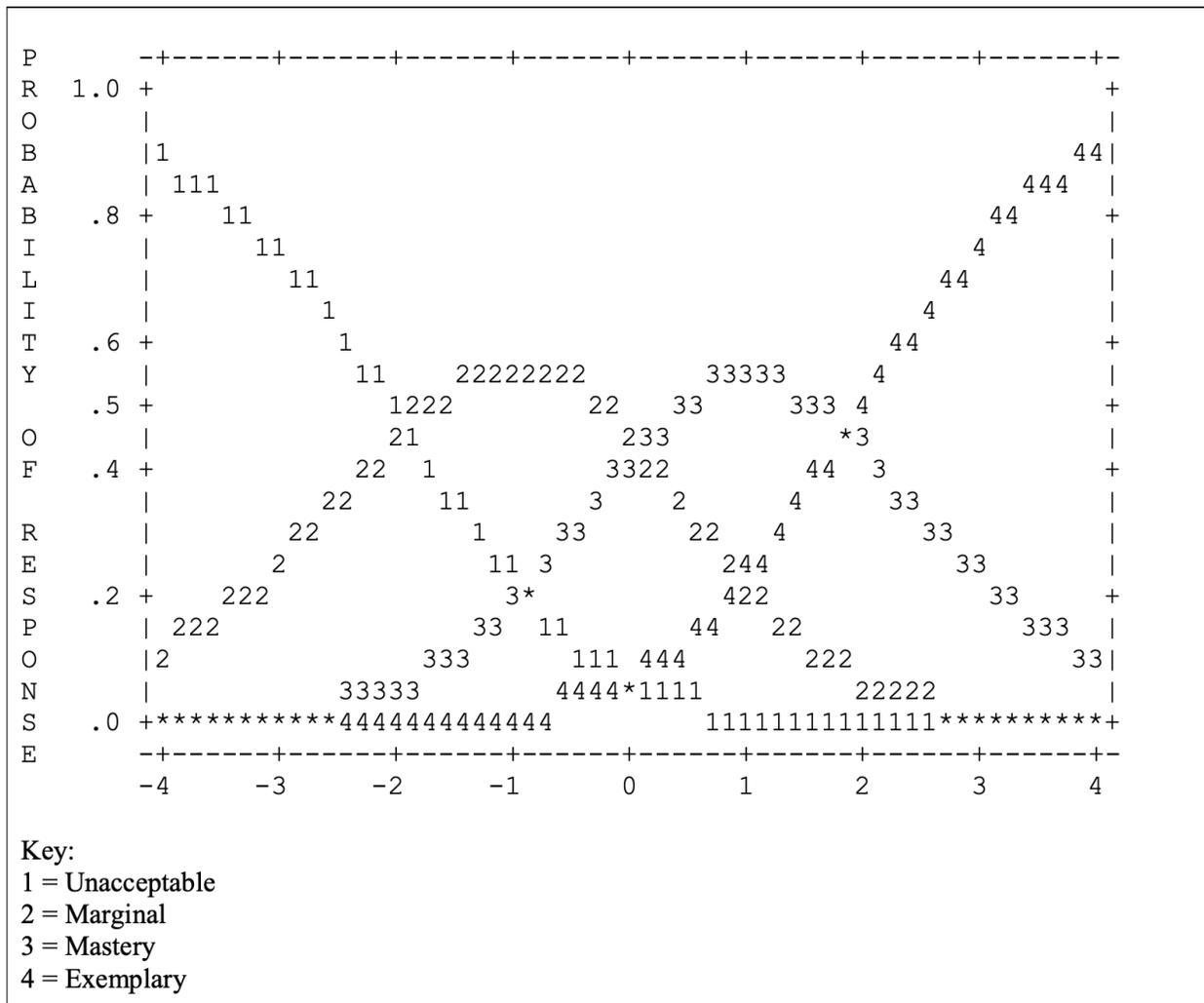
Once a linear measurement of participants' lesson planning mastery overall was achieved, a mixed regression model as implemented in the R (R Core Team, 2019) *nlme* package (Pinheiro et al., 2018) was used to assess the effects of the following unordered factors: gender (levels: male, female), usage of UDL template (levels: used, did not use), grade level (levels: K–2nd, 3rd–5th, 6th–8th, 9th–12th), ethnicity (levels: African American, Asian, Caucasian, Hispanic), licensure program (levels: elementary, secondary, music, PE), content area (levels: ELA, mathematics, history/science, music/PE, other), and finally the measurement occasion (levels: pretest, posttest). The outcome variable was the Rasch-model calibrated logit-unit-based linear measure of preservice teachers' overall lesson planning score.

Results

The Rasch Rating Scale Model (RSM) Model Results

The results from the Rasch analysis that included both the pretest and posttest scores indicated that the instrument's scoring format functioned as intended. The Infit and Outfit mean square values or discrepancy measures interpreted as χ^2 (Wright & Stone, 1979) were productive for measurement. The rating scale performance for all items collectively is presented visually in Figure 1. In Figure 1, one can observe that all category ratings (*unacceptable*, *marginal*, *mastery*, and *exemplary*) achieved at least 50% of being observed (probability of being observed in given category is depicted by the Y axis), given a calibrated participants' level minus the calibrated difficulty level of an item/lesson plan category on which the subject is evaluated (X axis).

Figure 1. *Participants Minus Items Measure*



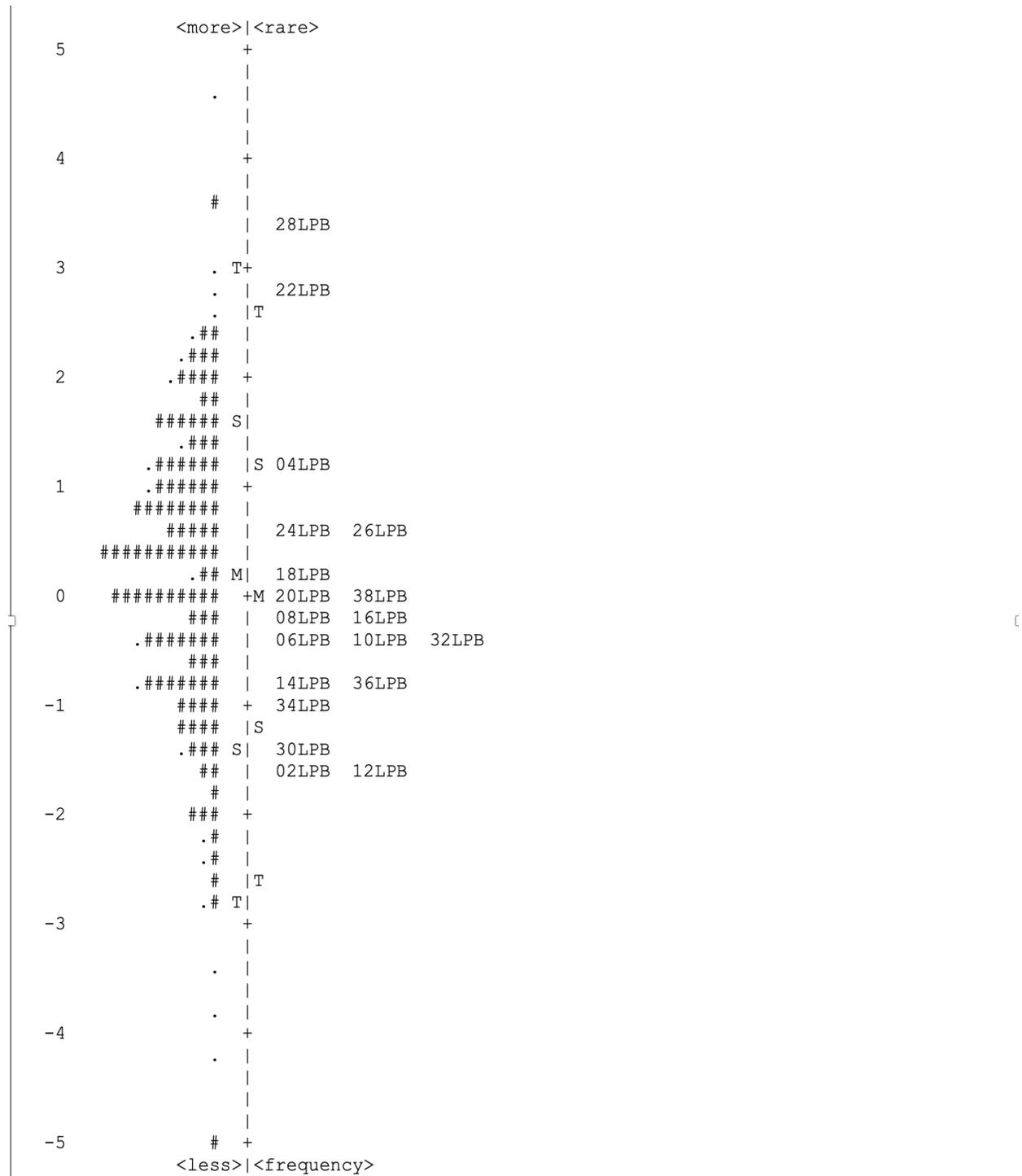
Note. Each category has a higher than .50 probability of being the most probable choice, meaning that the minimum required probability peak is satisfied, and the category can be considered as functioning adequately.

The summary statistics for 242 (see Table 1 for demographics detail) measured participants had .93 and .94 Rasch reliability indices for real data (all data are modeled to contradict the Rasch model) and model data (all data conform to the Rasch model), respectively. The Rasch reliability for the items was .99 for both real and model data. These indices indicate that both the persons and items measures were calibrated with very high precision. As noted above, seven participants (less than 3%) from the original 249 subjects were removed from the integrated and subsequent analyses due to high infit- and/or outfit-mean measures—these preservice teachers had unusually high accumulations of aberrant ratings that were within (infit) or outside (outfit) their overall ability levels.

The pretest Rasch calibrations yielded Rasch participants’ reliability indices of .91 for real and .92 for model data. The extreme and non-extreme participants’ mean performance on the linear composite measure was -1.07 ($SD = 1.55$) logit units. There were two preservice teachers observed in the extreme low scores or *unacceptable* ratings across all 19 items. The items’ difficulty measure was set to 0 ($SD = 1.28$) logit units (default in Rasch measurement). The anchored posttest Rasch calibrations yielded reliability indices of .91 for real and .93 for model data. The participants’ mean performance on the linear composite measure was 0.15 ($SD = 1.46$) logit units. The visual distribution of participants and items scaled scores on one common logistic

ruler (domain or construct defined by the assessment of participants on the 19 items) for the postassessment is presented in Figure 2. This visualization of the items' and persons' relative positions is known as a variable or Wright map in Rasch measurement (Engelhard, 2013).

Figure 2. *Participants Map Items: Rasch Variable Map for Respondent and Item Measures of Lesson Planning Performance Based on a Postmeasure*



In the variable map, we observe that the distribution of calibrated persons measures (the left side of Figure 2), stretching from the most able (at the top) to the least able (at the bottom), closely follows a normal distribution. The relative positions for the items (the right side of Figure 2), ordered from the most difficult (at the top) to the easiest (at the bottom), also stretch nicely along the distribution of the participants, with the mean for the items and participants being almost equal, suggesting the assessment was about the right difficulty level for the participants.

Results From the Non-Factorial Mixed Regression Model

Once the instrument reliability and validity were established, researchers analyzed the participants' performance across multiple predictor variables. The reference category in the model (the intercept value in the regression equation) was set to an African American female preservice teacher in an elementary licensure program teaching ELA content for K–2nd grade, who did use the UDL template on Lesson Plan B. The choice for this particular reference category was primarily driven by higher counts of teachers associated with these particular variable levels. For example, more female than male teachers participated. More teachers also did not use the UDL template, and there were also higher counts of teachers in elementary licensure programs whose content area was ELA. The choice of the K–2nd-grade level, although associated with a smaller count of teachers than in the 3rd–5th grade level, was a natural choice, given it was a first-grade level. The subjects ($N = 242$) served as a grouping factor (two measurement occasions with the same subjects were used); a random-intercept model was the model of choice. The unstandardized regression weights (fixed-effects) representing the amount of difference in logit units between variables' levels values in comparison to the reference category are presented in Table 2.

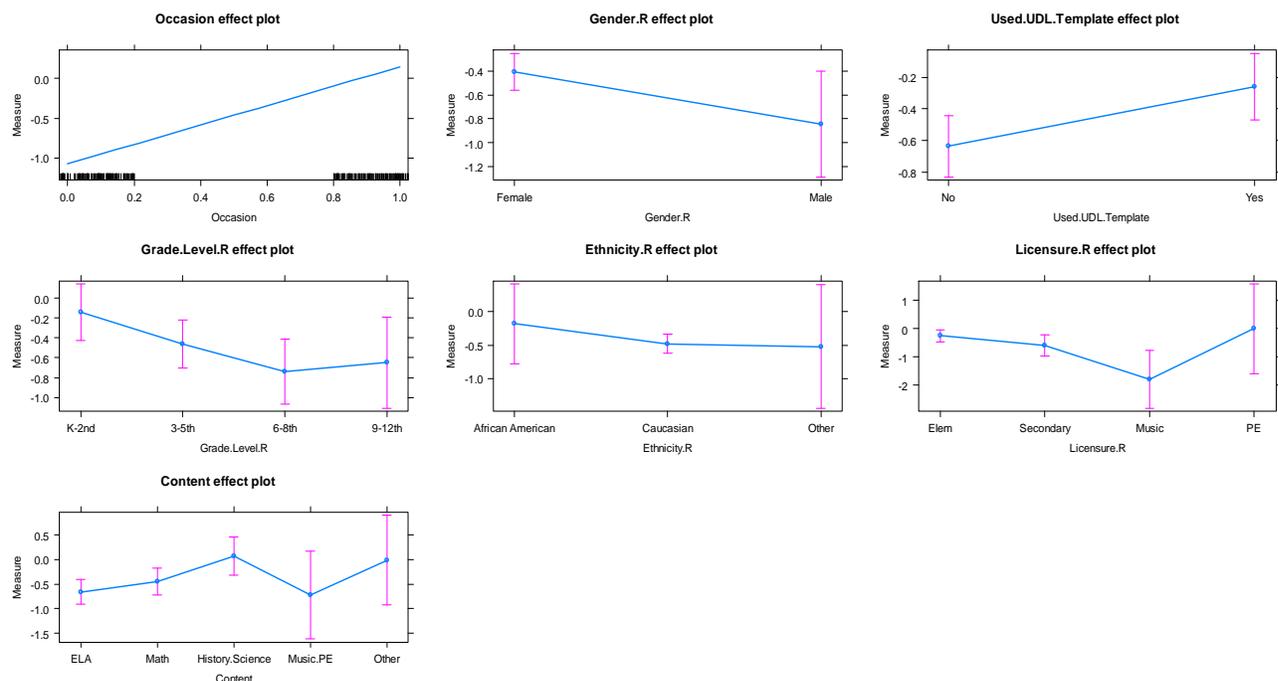
Table 2. *Mixed-Effects Regression Analysis Summary for Variables Predicting Student Teachers' Lesson Planning ($N = 242$)*

Variable	<i>B</i>	SE (<i>B</i>)	<i>t</i> value	<i>p</i>
Intercept	-0.580	0.35	-1.66	.099
Posttest	1.222	0.10	12.23	< .001
Gender: male	-0.436	0.25	-1.75	.081
Used UDL template (Yes)	0.384	0.15	2.57	.011
Grade level				
3rd–5th	-0.305	0.18	-1.67	.097
6th–8th	-0.601	0.23	-2.59	.010
9th–12th	-0.504	0.29	-1.75	.081
Ethnicity				
Asian	-1.060	1.16	-0.91	.361
Caucasian	-0.299	0.31	-0.95	.341
Hispanic	-0.184	0.60	-0.31	.759
Licensure program				
Secondary	-0.340	0.23	-1.50	.135
Music	-1.547	0.57	-2.69	.008
PE	0.201	0.84	0.24	.812
Content				
Mathematics	0.207	0.17	1.19	.234
History/science	0.720	0.23	3.15	.002
Music/PE	-0.072	0.52	-0.14	.890
Other	0.642	0.48	1.33	.184

The modeled intercept value -0.58 represented the performance of preservice teachers in the reference category in logit units. The statistically significant fixed effects were observed for posttest measure with 1.22 logit unit increase relative to the premeasure, controlling for all other factors in the model (*ceteris paribus*). The usage of a UDL template on Lesson Plan B was associated with an increase of 0.38 logits. Generally, a decrease in the performance was observed with the increase in the grade level; however, only a 6th–8th grade range was associated with a statistically significant decrease of 0.60 logits on the performance measure. In terms of the licensure program, participants in music demonstrated a decrease of 1.54 logit units. In addition, preservice teachers in the history and science content areas demonstrated an increase of .72 logits relative to the reference group, again, controlling for all other factors in the model (*ceteris paribus*). The effects of gender, ethnicity, and other grade-level groups were not statistically significant. In terms of the modeled random-variance components, subjects accounted for 34.1%, and the residual variance was 65.9%.

Effect displays (Fox, 2003) are presented in Figure 3. These effects (marginal means) represent model-based fitted values that allow one to examine how the outcome variable changes at different levels of the predictor variables included in the model, while other predictors are held at their typical values. For factor variables, the proportional distribution of the factor variable is set to the distribution observed in the data, which provides the same effects for the factor variable, regardless of a specific contrast set up to compare the specific groups or levels in a factor variable (Fox, 2011, 2019). These effects were prepared with the help of R *effects* package (Fox, 2003).

Figure 3. Effect Plot Assessing the Average Effects of Predictor Variables on Preservice Teachers' Lesson Planning Performance



In summary, the modified EFE rubric used to score lesson plans was found to be valid and reliable. Both the persons and items measures were calibrated with a very high level of precision. Rasch parameter calibrations provided composite, linear, and equal-interval performance measures of participants' lesson-planning abilities, suitable for regression analysis with a continuous outcome variable.

In reviewing overall results, participants demonstrated statistically significant growth in their scores when comparing their first submitted lesson plan to their second submission, which was written after the UDL

seminar. The mixed regression results demonstrated that the 1-day implementation seminar on UDL resulted in higher scores on participants' lesson planning postmeasure, controlling for the premeasure effects. These scores reflected that, overall, participants included multiple methods and materials in their second lesson plan aligning to the UDL guidelines. Gender and race variables were not significant. Further analysis by group demonstrated more UDL framework components were included by elementary teachers and fewer by secondary (middle/high school) teachers. Results from the content areas showed music/PE had the least positive effects while history/science marked the most positive effects. While increases were shown in most of the UDL guidelines, guidelines on expert learning (guidelines 6 and 9) were found to be the most difficult (Figure 2). While no experimental control group of participants was used, instrumentation demonstrates valid and reliable results showing variability in scores, which are useful for understanding the effects of this 1-day seminar on different groups of teachers and/or content areas.

Discussion

The UDL framework has increasingly been included in teacher preparation programs across the United States (Scott et al., 2017; Smith et al., 2019), although this has largely been limited to the inclusion of the three main principles. Studies with smaller samples (predominantly of special education teachers) have shown that lesson planning is improved by implementing professional development focused on UDL (Courey et al., 2013; Owiny et al., 2019; Spooner et al., 2007). While lesson planning is not the only measure of teaching, it is a simple, discrete measure that can easily indicate change in teachers' instructional design. The simplicity of this intervention allows for effective and efficient intervention to improve lesson design with little investment of resources. Researchers wanted to explore if similar results could be effected with a much larger and more diverse pool of teacher candidates. The purpose of this study was to replicate the study performed by Lowrey et al. (2019) with a much larger and more diverse sample of future teachers, to determine if a professional development seminar, delivered midway through student teaching and focused on using the UDL framework to design lesson plans, would impact the overall performance of preservice teachers' lesson planning by addressing learner variability to a greater extent and attempting to remove instructional barriers in the design of lessons. Results from this study indicated the UDL professional development seminar did significantly impact the lesson planning process across all guidelines except 6 and 9. Participants' lessons included a significantly wider range of methods and materials in their second plans.

UDL guidelines are the broader categories under which checkpoints (specific steps to improve practice) are grouped (CAST, 2018). To score higher on the nine UDL guideline measures, participants had to increase their inclusion of strategies and supports used to meet those multiple measurement criteria. It is important to note that the participants were not responding to written guidelines within the plan, even on the template. Their gains were measured by increased means of representation of content, efforts to engage students, and variable ways provided for students to respond. Results from this study indicate participants' lesson plans after the UDL seminar did increase the depth and detail in strategies and supports used to promote student learning. Unlike the measures used by Spooner et al. (2007), measures of this study went beyond determining whether participants simply referenced a UDL guideline or checkpoint; instead, measurement determined that participants demonstrated their ability to design instruction utilizing strategies and activities that addressed these UDL guidelines and checkpoints. UDL did not need to be mentioned in planning in order to score higher. The scoring of plans indicated how many strategies, materials, reinforcers, etc. were included in the design of the plan on both Lesson Plan A and B. Participants showed stronger attempts to address individual and group student needs through the multiple means included in their lesson design after the UDL seminar.

More importantly, the results of this study demonstrate that in addition to addressing a wider variety of instructional strategies and materials, student response formats, and the inclusion of student preference and choice preservice teachers (general and special education) scored better overall on their traditional

performance ratings conducted by their university supervisor, who was untrained in UDL, before and after the UDL seminar (i.e., anticipatory set, introduction, content teaching strategies, procedures, assessment, and closure). Their second experience ratings by university supervisors were higher overall. This demonstrated that attempts to address learner variability by implementing UDL may have positively impacted the more traditional criteria measured, as was reported by teachers in Lowrey et al., (2017). A 1-day professional development seminar lasting 6 hours was enough to show significant change when applied directly to the planning process preservice teachers (general and special education) are required to use. This finding is the first of its kind to show that general education teachers across all grade levels can enhance their planning process through instruction in designing learning experiences with the UDL framework.

The professional development seminar provided a template for UDL planning, so it might appear that the identified growth stemmed from using the template rather than from changing how participants planned (i.e., addressed variability, strategy and support detail, and content). However, participants were not mandated to use the CAST template form, and results showed that 134 participants (55%) did not. Additionally, supervisors were not trained in UDL and did not prompt preservice teachers to use the UDL framework, the provided planning template, or any of the materials from the seminar. They were instructed to keep their coaching the same across both 8-week periods. Therefore, the additional depth measured by addressing a greater number of representations for content, engagement strategies, multiple means of instruction, and multiple means of learner responses more than likely resulted from the additional training and work provided through the UDL seminar. We do see in Figure 3, however, that using the UDL template increased the likelihood of a better score. Therefore, when teaching preservice teachers how to use the UDL framework in lesson planning, a template may increase their ability to apply the framework appropriately. This aligns with the findings of Owiny et al. (2019), who used a UDL lesson planning template when they studied general educators' improvements in planning for inclusive practices.

While the overall study results demonstrate that a seminar on the UDL framework can promote deeper planning by both general and special education teachers that may address students' needs better, analyzing the results by specific categories yields additional information. Given the sample size, analyses were conducted by category to identify unique findings. Data were analyzed by gender and race. No significant differences were found in performance, but the sample reflected minimal diversity across race and gender. Data were not collected on ethnicity, SES, region, or other characteristics that might inform practices. A more in-depth examination of the practices employed by diverse participants might demonstrate variance in planning with UDL as it relates to different races, ethnicities, and cultures in teacher candidates. It may be that some cultural groups are more likely to put supports in place that align with UDL. For example, Evans et al. (2010) shared a case-study model from their rural university demonstrating their UDL preparation for candidates training to teach in rural schools. As they recommended, more explicit study is needed to tease out specific factors within UDL preparation and training for different groups. There has been increased traction in examining UDL as a culturally responsive practice (James, 2018; Kieran, 2019), but no studies were identified examining how diversity may affect teacher candidate understanding and application of UDL.

A key finding in our study was that elementary and secondary teachers differed. More UDL framework components were included by elementary and fewer by secondary (middle/high school) preservice teachers. Researchers hypothesized that elementary teacher methods already rely on multiple means of representation, engagement, and action/expression due to much of their content occurring at the acquisition level. Secondary teachers more often use text-based learning and lecture. Additional inquiry examining how the UDL framework can be applied in the design of secondary curriculum is needed. A somewhat contrasting finding was that music and PE, two fields that rely on activity-based learning, had the least positive effects, while history and science had the largest effects. Inquiry into specific content area curriculum planning may provide details to support better UDL application within those areas.

Growth was noted as significant across seven of the nine guidelines. However, no significant change was noted on guideline 6, “Provide options for executive functions,” or guideline 9, “Provide options for self-regulation” (CAST, 2018). Both guidelines fit into the most complex UDL framework area, which is the “Internalizing” guidelines and checkpoints. As CAST’s hierarchy demonstrates, these are considered the most difficult for learners on their journey to expert learner status. This study’s results show “Internalizing” guidelines (e.g., UDL guidelines 3, 6, and 9, [CAST, 2018]) and accompanying checkpoints may also be the most difficult for teachers to plan for without additional or specific supports. Utilizing the UDL framework should support learners to become experts in their learning process (Rose et al., 2018). However, results from this study suggest preservice teachers are not including enough supports directed at these comprehensive activities, such as executive functioning and self-regulation, to support development in these areas.

Implications for Future Research and Future Teacher Education

UDL is under-researched in the area of general education but is widely considered a useful tool for inclusive practices (Smith et al., 2019). Findings from this study suggest many diverse options for future study of UDL in the larger realm of education. First, coaching support was not available for participants applying the UDL framework, as university supervisors were not trained in implementing it. Coaching has been determined to be an important accompaniment to professional development in education (Israel et al., 2018; Kucharczyk et al., 2012). Utilizing coaching across content area field placements during student teaching may have a significant benefit in supporting preservice teachers in implementing UDL in their lesson planning and design. Replicating the same model with coaching from university supervisors in the second 8-week session might result in greater growth.

Researchers identified that designing for learner variability was a pronounced and important shift in focus for the professional development seminars between the initial pilot and this study (Lowrey et al., 2019). Supporting participants in identifying variable learning characteristics and practicing removing barriers seemed to have a direct impact on the results. Concentrated focus in research is needed here (at all grade levels) to support preservice teachers’ ability to identify learner variability and removal of barriers that prohibit access, participation, and progress in the curriculum. Capp (2020) suggests a 7-step plan utilizing the UDL framework in lesson design. Research on this and other plans would be beneficial in determining if increasing a teacher’s ability to plan for greater variability actually results in the removal of barriers that prohibit students’ access, participation, and progress in the curriculum.

While this study did not find substantial differences in the preservice teachers’ performance based on race, gender, or subject area, targeted investigations using methodology that allows for individual and small group examinations may show different results. Because elementary education is dominated by white, female, middle-class teachers, it is critical to look at the experiences of those other than this majority population. Answering questions such as, “What are their experiences with UDL? How can they be supported to better implement UDL? How do they perform when designing for variable learners?” may lead professional development designers and preservice teaching faculty to support less represented teachers better. Additionally, educators may learn new strategies and tools that are more culturally aligned by studying the practice and application of these teachers. More investigation is needed.

Additionally, secondary teachers did not show as much change as elementary teachers. Professional development models specific to secondary teachers should be explored. Linking specific planning processes to current practice may help them implement the UDL framework better. Providing models specific to secondary classrooms and to specific secondary content areas may be beneficial in increasing preservice teachers’ ability to implement UDL with depth and detail.

While this study allowed participants to choose whether or not to use the provided UDL template, using the template had a positive impact on scores. Exploring a practical UDL lesson plan template that is effective for

lesson design across grades and content areas is necessary for UDL to be applied in practice. One finding showed that preservice teachers struggled most in planning and designing for internalizing or expert learning components. Requiring a specific planning template that drives preservice teachers to plan for expert learning components may assist in building skills to address those areas.

Limitations

Some growth in participants' performance may be attributed to maturation or growth in overall competence in their second placement. However, the UDL-specific items used would not have been susceptible to growth based on maturation. Differences within the grade levels and content areas were not subject to maturation.

Lesson plans were analyzed by the content area the plans covered, not by the preservice teachers' major. While placements reflected their training, elementary teacher data may have had an impact on that analysis, as elementary teachers are trained across all content areas. An analysis confined to secondary teachers may have demonstrated stronger differences across content areas.

This analysis was limited to lesson plans only. Comparing videos and reflections to actual practice would have enhanced the overall findings. While video and reflective data was collected, it was not included in this analysis. A cross-analysis using all three may yield additional information.

In order to conduct this study with access to all preservice teachers, researchers had to agree to deliver the 1-day seminar simultaneously to all. This eliminated the possibility of an experimental control group. While data analysis methods were chosen specifically to counteract the lack of a control as much as possible, a study with a traditional experimental control group is needed.

Conclusion

Students with disabilities are increasingly placed in inclusive settings (Office of Special Education and Rehabilitative Services, 2020). General education teachers routinely say they do not have enough training to confidently support students with disabilities in their classrooms (Hernandez et al., 2016). The purpose of this study was to evaluate whether a brief 6-hour UDL professional development seminar, delivered midway during student teaching, when teacher candidates are at a place in their journey where they have a need for the information, are ready to learn it, and can assimilate it with prior knowledge (Knowles et al., 2015), would change preservice teachers' planning to more comprehensively address student variability by making use of the components embraced in the UDL Guidelines Checklist (CAST, 2018). This is the largest study to date examining preservice teachers' ability to integrate the UDL framework in their planning process. In addition, this study has attempted to use the UDL Reporting Criteria (Rao et al., 2018) to bolster replication and interpretation. This study's results indicated significant change across participants in their ability to comprehensively plan to meet the learners' needs by applying the UDL framework. Results of the study indicate the difference the UDL framework can make in instructional design to support teachers in developing better inclusive design for those learners in the margins, including students with disabilities.

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