Measuring Universal Design for Learning in the Virtual School Landscape

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Abstract

The results of a study piloting a new UDL assessment instrument within synchronous online classrooms for K-8 students will be presented. Participation in online schools by students with special learning needs is prompting new research related to teaching and learning in online environments. In the study reported here, fifty-one general and special education teachers from a virtual K-8 school submitted video recorded lessons from synchronous online classes that included students with and without disabilities. Researchers examined the level at which teachers' instruction and students' actions aligned with the Universal Design for Learning (UDL) framework using a researcher-developed, 68-item UDL measurement instrument. Correlations between teachers' pedagogical practices and students' level of engagement suggest a strong potential benefit for using UDL in online school settings. Implications for practice and areas of future research are identified. The study provides teachers' current research about using UDL to enhance online classroom instruction. Teaching techniques, assessment considerations and the use of UDL to increase student-learning outcomes are included.

Keywords

Online education, Universal Design for Learning, synchronous learning environments, special education.

INTRODUCTION

Online education programs are a growing phenomenon in K-12 schools. For example, in 2011, 55% of public school districts reported nearly two million students who accessed online learning in grades K-12 (Queen & Lewis, 2011). This represented a 25% increase over the 2009-2010 school year. Approximately 250,000 of these students in 30 states attended online programs on a full-time basis (Watson, Murin, Vashaw, Gremin & Rapp, 2011).

In response to the growth of online instruction, the National Education Technology Plan (NETP) noted that U.S. schools need to use technology to develop and implement resources that allow full access to instructional materials anytime and anywhere (U.S. Department of Education, 2010). The NETP has contributed to the increased emphasis on technology-enhanced instruction and assessment and has encouraged public school districts to create their own online programs and to partner with private education companies such as Connections Academy, K12 Inc., Insight and IQ Academy.

Online education environments, including public and private K-12 schools, offer access to a variety of courses and degree options. This flexibility is appealing to a wide range of students. Recent trends indicate that students with learning disabilities and younger students in grades K-8 are increasingly choosing to be fully integrated into online schools (Thompson, Ferdig, Black, 2012).

Approximately 14% of students in K-8 education are identified with a disability. As such, they are particularly vulnerable during online instruction. The most prevalent group of students receiving services under the Individuals with Disabilities Education Act (IDEA) is Specific Learning Disability (SLD) (Aud et al., 2011). Students who qualify for educational services within this category have a learning disability that involves inefficiencies in language processing and/or mathematical understanding (U.S. Department of Education, 2012). Unfortunately, there is limited research examining the efficacy of online curricular materials and pedagogical practices for this group of students.

Current online learning environments are limited in the ways they serve students with SLD. For example, many online courses are predominately text-based, with dense reading materials and written assessments (Barbor & Reeves, 2009). In addition, many user interface platforms provide information using non-linear formats. Students who struggle with executive functions can have difficulty deciding what to read first and how to rank the importance of information (Grabinger, Alpin, & Ponnappa-Brenner, 2008). Other online environments are not interactive enough to help students with SLD to (a) access real time supports, (b) identify misconceptions about the content, and (c) obtain explicit comprehension strategy instruction based on individual learning needs and preferences (Keeler, Richter, Anderson-Inman, Horney, & Ditson, 2007). For example, online lessons may have callout boxes that provide visual representations and additional explanations of complex vocabulary but no specific instructions on how and when to use these supports. Without appropriate instruction, students' use of these cognitive scaffolds is often limited, even though they are more beneficial for students with SLD than their peers without disabilities (Marino, 2009).

Evidence suggests that teachers do not receive adequate professional development at the in-service level to teach and assess students with diverse learning needs in online environments (Capdeferro & Romero, 2012). As a result, teachers may provide untimely or inappropriate responses and ambiguous directions related to teacher and student responsibilities (Hodges & Cowan, 2012). Hathaway and Norton (2012) proposed that teachers should receive explicit preparation for online instruction that includes a comprehensive understanding of the assets and limitations available in online environments. Teachers also require the ability to work within virtual groups and manage participant interactions (Vasquez, Forbush, Mason, Lockwood, & Gleed 2011). When online communication is positive, students and teachers generally express satisfaction with the development of an online learning community in both synchronous and asynchronous environments (Finlay, Desmet & Evans, 2004; Harmon & Jones, 2001). However, evidence suggests that effective instruction in online environments is complex and multifaceted. Therefore, teachers may require specific professional development activities that provide a framework for their instructional design and pedagogical practices.

Universal Design for Learning (UDL): A Framework for Effective *Online* Instruction

The contribution of UDL in online education has the potential to improve content accessibility for students with SLD (Grabinger, Alpin, & Ponnappa-Brenner, 2008; King-Sears, 2009). Online schools by their very nature are steeped in technology, which allows a symbiotic relationship between the content and UDL features that can begin to address the needs of diverse learners (Basham, Israel, Graden, Poth, & Winston, 2010). To address learner variability, UDL offers three primary principles based on neuroscience research (Rose, Meyer, & Hitchcock, 2005).

The first principle is to provide students with multiple means of representation of information. Central to the first principle of UDL is the notion that learners have options to acquire information in a manner that most appropriately fits their personal learning styles. Examples of this principle in an online environment include class communication systems that use chat boxes, audio streams, and webcams. Teachers and students can experiment with concepts collaboratively using an array of virtual manipulates. Content can be presented using text, graphics, illustrations, and video representations. Reading materials can be delivered at multiple levels (e.g., Jen: The tiered webpage generator, Knowledge by Design, Inc., 2012) depending on the needs of the students.

The second principle is that learners have multiple means of interacting with content and demonstrating knowledge. Examples can be as varied as students producing audio recordings and videos, creating charts, graphs, and illustrations, or using interactive websites. Group work in virtual breakout rooms, as well as communicating through whole body movement using a webcam and Xbox Connect are other ways for students to engage with and control their learning.

The third principle calls for providing multiple means of engagement, which allow each learner to interact with materials in authentic ways that align with their learning preferences. Each student brings his/her own background knowledge, culture, and risk tolerance to every learning encounter. Online courses allow for these differences. For example, a native Spanish speaker could choose to have English audio from a course captioned in Spanish.

Need for Research

While UDL appears promising, there is no extant research addressing its efficacy in synchronous K-8 online classrooms. Recent studies indicated that students with SLD in synchronous online classes often failed to achieve at a level commensurate with their peers in traditional learning environments (e.g., Miron & Urschel, 2012; Thompson et al., 2012). Despite this, growing numbers of students with SLD continue to select online schooling. As a result, the Office of Special Education Programs (OSEP) (U.S. Department of Special Education, 2011) articulated a clear need for research and challenged the special education community to identify and improve the content, physical accessibility, and learning outcomes for students with disabilities who participate in online environments. Recently, the National Education Policy Center published similar conclusions, noting that additional research on efficacious practices is necessary before full time virtual schools become more prevalent (Miron & Urschell, 2012).

A STUDY EXAMINING UDL IN K-8 SYNCHRONOUS CLASSROOM

This study examined UDL in K-8 synchronous classrooms. Synchronous instruction is a prevalent curriculum delivery mechanism in online education today. The presented findings are a critical step toward understanding the factors necessary to promote effective teacher professional development so that online instruction can maximize learning outcomes for students with and without SLD.

Method

All participating teachers submitted recorded synchronous lessons from their K-8 classes. Data drawn from a suite of measurement instruments was used to quantify the level of UDL implementation during the lessons. This descriptive study employed a mixed-methods design that included quantitative analysis of the online environment, teacher practices and student actions during the online lessons. Qualitative analysis of field notes from professional development seminars were used to aide interpretations of the research findings.

The recorded synchronous lessons viewed by the researchers showed teacher and student actions available during each session. Use of the chat box, microphone, writing on the whiteboard, and video could be viewed on the recording. The only restriction was when students and teachers

worked in break out rooms. Of the recordings used in this study, the use of break out rooms was minimal.

Setting

This study involved K-8 teachers in a public virtual school in the western United States. School enrollment during the study was 2,758 students, of which 9% received special education services. The lead researcher was an employee of the school during the study.

Online asynchronous curriculum was delivered via a third party provider. Synchronous curriculum was teacher created. Within the synchronous classes conducted there were two processes by which students attended. Students with IEP's were assigned specific classes to attend based on their goals and service areas. These classes were taught by special education teachers. Students both with and without IEP's were invited to attend synchronous classes taught by general education teachers. Students were required to attend two classes per week and could choose from math, reading, writing, science, and art history. The general education teachers did not know which of the students attending had IEP's.

Participants

An a priori G*Power analysis indicated that 46 respondents were necessary to detect a moderate effect size in the correlational analysis model. Fifty-one general education and special education teachers were selected to participate from an initial convenience sample of 72. Invitation emails were sent to all teachers. Teachers who responded positively or asked for further information were sent an informational packet. Once a teacher accepted the invitation to participate he or she was asked to send a recorded lesson and to complete a demographic survey. One reminder email was sent if necessary.

Of the 51 participating teachers, 41 completed a demographic survey. Participants averaged 12 years of teaching experience in brick and mortar schools and 3.6 years in online environments. The survey asked teachers to rate their comfort level working with the synchronous delivery platform used at the school during the study year. On a Likert scale from 1 to 5 with 5 being "very comfortable", teachers overall self-reported high levels of competency with all respondents scoring a 4 or 5. Additionally, the survey was designed to help the researcher identify teachers' prior knowledge of UDL. Only six teachers both indicated and demonstrated prior knowledge of UDL.

Each participating teacher, self-selected one recorded synchronous lesson to submit to the researcher. Of the lessons submitted, 15 special education and 36 general education lessons were evaluated. The lesson subjects included math, science, reading, writing, language arts, art history and study skills.

Instruments

Three instruments were developed using an iterative design protocol to measure UDL implementation. 1) An Environ-

mental Tool was developed to analyze synchronous learning environment/online platforms (see Appendix A). 2) Teacher Observation Tool developed to examine teacher interactions within the UDL framework (see Appendix B), and 3) Student Observation Tool developed to examine student interactions within the UDL framework (see Appendix C). These instruments were intentionally aligned with UDL Guidelines version 2.0 (CAST, 2011).

Instrument Development Process

As a first step, each UDL version 2.0 guideline was coded as "teacher control during the lesson", "online platform capacity", or "student control during the lesson". After coding, each online applicable guideline was transformed into a question or statement that could be quantified using a 5-point scale. Each question was examined for measurement parameters, checked for redundancy, and sorted into the most appropriate of the three instruments described previously. Questions were ordered and grouped to align with a typical lesson format. The instruments were then assessed to ensure continuity with the Teacher Performance Assessment Consortium (TPAC; 2011) framework.

During the iterative development process, the research team watched recorded lessons not targeted for use in the study, compared answers, and discussed the specific nature of behavior that occurred in the online synchronous lessons. In addition, they noted how the behaviors related to the UDL checkpoint were being addressed.

Validity. To establish content validity, the researchers aligned the instruments with the UDL V. 2.0 checkpoints. Criterion validity within the suite of instruments was addressed using predictive and concurrent correlations. Concurrent correlations were established through analysis between the Teacher Observational Tool and the Student Observational Tool. Construct validity was established using two external raters who are considered experts in the UDL field.

Reliability. The researchers addressed reliability through an inter-rater reliability process and an intra-rater reliability analysis. The intra-rater correlational analysis produced an alpha of .72. Inter-rater agreement for the suite of tools on a random 10% of recorded lessons was 76%. The potential influence of variability in scoring is addressed in the discussion section.

The final versions of the three instruments contained three subsets of items that aligned with the UDL framework guidelines 1) Representation, 2) Action and Expression, and 3) Engagement.

Environmental Measurement Tool

The Environmental Measurement Tool allowed the researchers to examine the level at which the online platform had the capacity to align with the UDL guidelines. Its' 26 items spanned the UDL guidelines and checkpoints. Items were scored on a 1-5 scale, with a score of one indicating that the construct was never available. The maximum pos-

sible score on the instrument, indicating 100% alignment with the UDL framework was 130 total.

Teacher Observation Tool
The Teacher Observation Tool contained 28 items, with a maximum possible score of 140 total. Scoring was also interpreted numerically using a 1-5 scale. Scoring metrics were designed to provide a high level of specificity in order to promote inter-rater reliability.

Student Observation Tool
The Student Observation Tool targeted the actions of the students to demonstrate UDL guidelines and checkpoints during the lessons. The tool contained 14 items with a maximum possible score of 70 total. Unlike a brick and mortar classroom, in the synchronous classroom the teacher must give students access privileges in order for them to participate in the session. The Student Observation Tool score was based on either the percentage of tools used, or the number of students who used the tools that were made available.

Procedures
Lessons were recorded using Elluminate Version 10 software. Each participating teacher submitted one lesson, which was reviewed twice by the researcher using the three previously described instruments. Each of the lessons lasted from 30 to 60 minutes.

The submitted recordings were scored over a two-week time period. Special education and general education submissions were viewed and scored in random order. All of the recordings were scored twice. The teacher observation tool was scored first and the student observation tool scored second. Scores were compiled by hand, entered into a spreadsheet, and then transferred to SPSS for analysis. Scoring anomalies between the researchers were held constant.

During the study, the lead researcher recorded field notes during teacher and staff discussions on preparation and planning for synchronous lessons. The researcher examined the notes for themes using a grounded theory approach (Creswell, 2008). The researchers used the themes to identify and contextualize the quantitative data and aide interpretation of the findings.

Analysis
All quantitative analysis was conducted using SPSS Version 20 (2011). The following research questions (RQ) were used to drive the analysis.

RQ 1: To what degree does an online synchronous learning environment have the capacity to align with the UDL framework?
Descriptive analysis of the Environmental Measurement Tool was used to gauge the capacity of the synchronous environment to align with UDL checkpoints. During the first phase of analysis, each of the items was disaggregated and grouped using the UDL topic guidelines (i.e., Repre-

sentation, Action and Expression, and Engagement). Subsequent analysis examined mean score differences and similarities across the topic guidelines.

RQ 2: To what degree do teacher actions during online synchronous lessons align with the UDL framework?
As with RQ 1, the UDL checkpoints were grouped by topic. Descriptive statistics including mode, mean and standard deviation were calculated to understand where teachers' actions clustered. Mode determined the frequency of the most common ratings, and mean combined with standard deviation allowed the researchers to understand the significance of the frequency and spread of the actions teachers displayed within the observed lessons.

RQ 3: During the implementation of an online synchronous lesson, is there a relationship between teacher's use of UDL principles and student actions? If so, what is the nature of the relationship?
Pearson product-moment correlation coefficient was used to determine whether there was a significant relationship or association between two variables: the observed actions by teachers during lessons and the student actions as measured by the Student Observation Measurement Tool. The null hypothesis stated that there was no relationship between teacher's use of UDL principles and student's actions. Due to the novelty of the measurement instruments, Cohen's (1992) guidelines were used with r as small (0.10), medium (0.30), or large (0.50). Analysis was conducted across the three UDL topic guidelines (i.e., Representation, Action & Expression and Engagement) to maintain analytical continuity. Student Representation data was omitted due to the lack of data generated by the small number of questions for this construct in the Student Measurement Tool.

RQ 4: Is there a relationship between teacher's certification (i.e., general education or special education) and the degree to which their lesson planning and implementation align with the UDL framework? If so, what is the nature of the relationship?
The three subsets (i.e., Representation, Action and Expression, and Engagement) of the Teacher Observation Tool served as the dependent variables for this question. Independent-sample t tests were used for group comparisons of each measure. A Bonferroni correction for three comparisons was used to determine significance. The assumption of homogeneity of variance was met as illustrated by Leven's test for Equality of Variances $F=0.499$, $p=0.483$. Because of this, the independent samples t-test was an appropriate analytic choice. The null hypothesis stated that special education teachers and general education teachers' use of the UDL framework did not differ significantly.

Results

The results relative to each of the research questions (RQ) are presented below.

RQ 1: To what degree does an online synchronous learning environment have the capacity to align with the UDL framework?

The Environmental Tool (see Appendix A) examined the potential of the synchronous platform using a 1 (no UDL) to 5 (high level of UDL) scale. The mean UDL score (M=3.9) revealed the current capacity for this environment to align with the UDL framework. Scores with a range (1, 5) across the three UDL topic guideline subsets within the tool indicate Representation (M=3.5), Action and Expression (M=4.6) and Engagement (M=4.0).

RQ 2: To what degree do teacher actions during online synchronous lessons align with the UDL framework?

The Teacher Tool used a similar 1-5 scale with 5 meaning that teachers implemented the UDL guideline with the highest efficacy.

Teacher actions indicated that teachers were more consistent providing multiple means of Representation (M=3.23, SD=0.55) than providing multiple means of Action and Expression (M=2.38, SD=0.55) and multiple means of Engagement (M=2.19, SD=0.41). While Engagement ratings on the Teacher Tool had the lowest mean score (M=2.19), some individual items such as, "heighten salience of goals and objectives", (M=4.47, SD=1.2) indicated a high level of UDL alignment. Other items, such as "optimize relevance, value and authenticity" were frequently scored at 1, the lowest level, with a wide variety (M=2.14, SD=1.13) across teachers.

Within the category of Representation, the teachers consistently provided alternatives for visual information (M=4.82, SD=0.55). More consistencies occurred in the categories of clarifying vocabulary and symbols (M=4.41, SD=1.32), syntax and structure (M=3.71, SD=1.76), and offering multiple means of highlighting patterns, critical features, big ideas, and relationships (M=4.55, SD=1.02). The least utilized UDL guidelines related to promoting understanding across languages (M=1.2, SD=0.57) and maximizing transfer and generalization (M=2.53, SD=1.31).

Item-level descriptive analysis indicated a wide range of teacher behaviors related to providing multiple means of Action and Expression (M=2.38, SD=0.55). For example, although 1 was the most common score in "vary the methods for responding and navigation", the mean score of 1.69 (SD=1.46) indicated a wide variety of teacher actions. More consistency occurred when teachers provided options for using multiple tools for construction and composition (M=2.76, SD=0.73).

RQ 3: During the implementation of an online synchronous lesson, is there a relationship between teacher's use of UDL principles and student actions? If so, what is the nature of the relationship?

The coefficient of determination was used to interpret the six relationships. All correlations were positive. The weakest correlations were between Teacher Representation and Student Action and Expression (r=0.30, p<.05), with 9% shared variance, and Teacher Representation and Student Engagement (r=.37, p<.01), with 14% shared variance. The strongest correlations were between Teacher Action and Expression and Student Action and Expression (r=0.64, p<.01), with 41% shared variance, and Teacher Engagement and Student Engagement (r=0.62, p<.001) with 37% shared variance. Other correlations indicated a relationship between Teacher Engagement and Student Action and Expression (r=0.54, p<.01), accounting for 30% of the shared variance, and Teacher Action and Expression and Student Engagement (r=0.56, p<.01), accounting for 31% of the shared variance.

RQ 4: Is there a relationship between teacher's certification (i.e., general education or special education) and the degree to which the lesson planning and implementation align with the UDL framework? If so, what is the nature of the relationship?

In the Representation category, special education teachers (M=30.5, SD=4.8), range of scores (100, 62) and general education teachers (M=28.5, SD=4.9), range (96, 63) showed no significant difference: t(49)=-1.3, p=.19. On average, special education teachers (M=18.8, SD=3.0) demonstrated significantly higher levels of UDL alignment in the areas of Action and Expression during online instruction than general education teachers (M=15.8, SD=3.5). The statistical was t(40)=-2.9, p=.006. The effect size of 0.89 with Cohen's d indicates a large statistical variance explained. On the Engagement subscale, on average, special education teachers (M=21.9, SD=3.6) demonstrated significantly higher levels of UDL alignment than general education teachers (M=18.9, SD=3.2). The statistical significance was t(49)=-3.0, p=.005, d=0.9. The effect size was large.

Discussion

The online synchronous environment examined in this study demonstrated the capacity to align with the UDL framework. For example, the synchronous learning platform demonstrated the capacity for communications in multiple ways, such as with the entire class, one-on-one, in small groups, etc. This finding is consistent with previous research indicating that synchronous learning supports collaborative learning activities (Anastasiades et al., 2010).

This study revealed that teachers were more likely to provide multiple means of Representation than the other UDL guidelines. Teachers' lessons included a high level of Representation and lower levels of Action and Expression and Engagement.

The consistency with which teacher actions aligned with the UDL framework during individual lessons varied. Some teachers reported that chat emoticons, polling features, and checkmarks functioned as continuous ways to engage students in a class dialogue. For example, one teacher remarked she used video when "wearing a wig or (playing a) musical instrument and for demonstrations such as Bernoulli's principle for airfoils". Other teachers held opposing perspectives. For example, one teacher remarked, "We are not teaching, we are presenters. We cannot do the feedback loop".

There are several possible reasons for the inconsistency observed in harnessing the potential of UDL in the synchronous platform. One is that individual teacher's alignment with the UDL framework varies depending on the content and students involved in each individual lesson. A more consistent result might have occurred had this study included a wider variety of individual teacher's lessons. Previous research indicates that teachers need to be comfortable with technology first, before showing students how to use communication systems and technology-based tools effectively (Cadeferro & Romero, 2012; Fernandez, 2007). It is possible that some of the teachers in this study had varied technological skill levels.

Positive correlations were found between teacher's use of UDL principles and student actions during the synchronous lessons. Thus, synchronous settings provided powerful interaction opportunities for teachers and learners similar to those experienced in brick and mortar settings.

A relationship was found between teacher certification (i.e., special education and general education) and the degree to which their lessons aligned with the UDL framework. In particular, the areas of Action and Expression and Engagement were significantly higher in special education teachers. This might be attributed to the special education teachers having approximately two more years of experience teaching synchronous lessons than the general education teachers within this online school. Students' higher engagement in special education classes is possibly due to their required attendance in order to fulfill their direct instruction minutes as outlined in each IEP. The special education teachers also emphasized collecting student data during lessons, which likely increased interaction.

Implications for Online Practice
This study has implications for practice in online education programs. One association is seen in the comparison between special education and general education. When teachers have high expectations for student interactions, such as the special education teachers requiring students to both attend consistently and participate for data gathering, students responded.

Implications for Communities of Practice
A component of the research dissemination process included presenting the data and preliminary results to the virtual school staff. This occurred during four staff development sessions, which occurred following data collection. In the presentations, the researcher discussed UDL, the structure of the study, and the results of the research questions. The staff then met in smaller Professional Learning Community (PLC) teams to discuss the focus of their own professional development during the 2012-2013 school year. Of the eight PLC teams, seven decided to focus on student engagement in synchronous lessons for the remainder of the school year. One team selected the teacher and student tools as the basis for self-evaluation and discussion to increase teacher and student engagement.

Limitations
While this descriptive study was a critical first step toward understanding the role of UDL in online classrooms, it did have limitations. For example, the study asked teachers to self select the lessons they submitted for analysis. Time and resource constraints prevented analyzing more than one lesson per teacher.

Conclusions
This study indicated the strong potential for synchronous online classes to align with the UDL framework. However, research related to UDL is still emerging and limited in terms of efficacy studies. It is important to compare the educational outcomes of students who attend school in all environments including full time online, full time brick and mortar as well as those combining both environments. Understanding the impacts of UDL, school environments, parent participation, student and parental support from the schools, and the structure of the school on student achievement is a necessary part of future research. Finally, examining the differences in student achievement in both online and brick and mortar schools, based on qualifying disability, could lead to the provision of optimal information for families and schools deciding how to best serve all students.

There is a clear need for special education leadership in this area. The Center for Online Learning and Students with Disabilities is examining several elementary students, their families, teachers, and additional service providers to gain insights into the online educational experience of students with disabilities. Future research should align with the goals of the Center for Online Learning and continue to explore UDL implementation and learning outcomes for students with learning disabilities.

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Appendix A. Synchronous Environmental Evaluation

	Synchronous Teaching Environment	1 - 5	UDL Guideline
1	To what degree does the environment provide opportunities for students or teachers to use multiple tools for construction?		Use multiple tools for construction and composition
2	To what degree are tools intuitively designed and easy to use?		Optimize access to tools and assistive technologies
3	To what degree are multiple types of media included?		Use multiple media for communication
4	To what degree does the environment allow for the teacher to customize the display?		Offer ways of customizing the display of information
5	To what degree is auditory and visual information available through multiple modalities, such as a read aloud option for text or spoken language presented as text?		Offer alternatives for auditory information
6	To what degree can the environment support students with a primary language other than English?		Promote understanding across languages
7	To what degree does the environment provide opportunities to promote understanding across languages?		Promote understanding across languages
8	To what degree are vocabulary words and symbols supported with pronunciations and definitions?		Offer alternatives for visual information
9	To what degree does the environment provide for language, mathematics and symbols using multiple media?		Illustrate through multiple media
10	To what degree does the environment provide options for language, mathematical expressions and symbols?		Clarify vocabulary and symbols Clarify syntax and structure Support decoding of text, mathematical notation and symbols
11	To what degree does the environment provide opportunities for students or teachers to heighten the salience of goals and objectives?		Heighten salience of goals and objectives
12	To what degree does the environment provide options for students or teachers to support planning and strategy development?		Support planning and strategy development
13	To what degree does the environment provide opportunities for students or teachers to guide information processing, visualization and manipulation?		Guide information processing, visualization and manipulation
14	To what degree can the environment provide students with help (e.g., tutorials) when determining their next course of action?		Enhance capacity for monitoring progress
15	To what degree can the environment help students manage information and resources?		Facilitate managing information and resources
16	To what degree can the environment provide opportunities for teachers to collect and interpret meaningful data?		Enhance capacity for monitoring progress
17	To what degree can the environment provide graduated levels of support and challenge?		Build fluencies with graduated levels of support for practice and performance
18	To what degree does the environment provide opportunities for students or teachers to vary demands and		Vary demands and resources to optimize challenge

	Synchronous Teaching Environment	1 - 5	UDL Guideline
	resources to optimize challenges?		
19	To what degree does the environment provide opportunities for students or teachers to highlight patterns, critical features, big ideas and relationships?		Highlight patterns, critical features, big ideas and relationships
20	To what degree does the environment provide options for students or teachers to activate or supply background knowledge?		Activate or supply background knowledge
21	To what degree does the environment provide opportunities for students or teachers to maximize knowledge transfer and generalization?		Maximize transfer and generalization
22	To what degree is there variation in the way students navigate and respond to prompts?		Vary the methods for response and navigation
23	To what degree do students have the autonomy to make their own choices?		Optimize individual choice and autonomy
24	To what degree can the environment provide feedback to struggling students, which helps them master objectives and academic content?		Increase mastery-oriented feedback
25	To what degree can the environment minimize the threat of failure and provide opportunities for meaningful victories?		Minimize threats and distractions
26	To what degree can the environment foster collaboration and communication among participants?		Foster collaboration and community

Appendix B: Teacher Observation Tool

	What does the teacher do?	UDL Guideline and Checkpoint
	Objectives: Setting up the lesson	
1	Learning objectives are made explicit to students: 1 points = Teacher does not provide 2 points = One modality 3 points = Two modalities 4 points = Three modalities 5 points = Three modalities plus revisited at the end of the lesson Modalities: orally, in writing, graphically, multimedia, musical, kinesthetic	
2	Relevance and value of objectives are made explicit to students 1 points = Teacher does not provide 2 points = One modality 3 points = Two modalities 4 points = Two modalities and asks for student input 5 points = Two modalities and asks for student input and revisits at the end of the lesson Modalities: orally, in writing, graphically, multimedia, musical, kinesthetic	3.1 Activate or supply background knowledge
3	Percent of learning objectives that are measurable: 1 = 0-19% 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	8.1 Heighten salience of goals and objectives
4	To help support learning for students with a primary language other than English, how does the teacher include language objectives that support social and language demands in the main lesson objectives: 1 points = Teacher does not provide 2 points = One modality 3 points = Two modalities 4 points = Three modalities 5 points = Three modalities and asks for student input Modalities: orally, in writing, graphically, multimedia, musical, kinesthetic	2.4 Promote understanding across languages
5	Teacher provides clear behavior expectations: 1 points = Teacher does not provide 2 points = One modality 3 points = Two modalities 4 points = Three modalities 5 points = Three modalities and asks for student input (e.g., orally, written, example, multimedia, kinesthetically, musically)	7.3 Minimize threats and distractions
6	Teacher attempts to engage students by soliciting input regarding the value of the lesson 1. No attempt 2. Teacher tells the students to explain why this is important 3. Teacher asks questions of students to explain why this is important 4. Teacher asks questions, offers response time, documents responses 5. Criteria from 4 plus validates student responses	9.1 Promote expectations and beliefs that optimize motivation
7	The teacher supports student metacognitive planning by: 1. Teacher does not provide any support 2. Teacher gives one strategy 3. Teacher gives two strategies 4. Teacher solicits strategy from students 5. Teacher provides opportunity for collaboration among students	6.2 Support planning and strategy development

	What does the teacher do?	UDL Guideline and Checkpoint

8	Students are guided to set goals with the help of the teacher
	   1. Teacher does not guide or set goals
	   2. Teacher sets goals for students
	   3. Teacher invites students to set goals
	   4. Teacher invites students to set goals and incorporates those goals into the lesson
	   5. Teacher invites students to set goals, incorporates goals into the lesson, invites students to reflect on goals
		6.1 Guide appropriate goal-setting

	Content Area Direct Instruction	
10	Teacher uses multiple modalities when presenting information: 1 = 0-19% of the time information is presented 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA (e.g., orally, written, example, multimedia, kinesthetically, musically)	1.3 Offer alternatives for visual information

11	Teacher provides graduated levels of support and challenge during lesson activities
	   1. No activities
	   2. One option that teacher mandates
	   3. Two options
	   4. Three options
	   5. Student creates own option
		5.3 Build fluencies with graduated levels of support for practice and performance

12	Teacher provides guidance for managing information during the lesson 1 points = Teacher does not provide 2 points = One modality 3 points = Two modalities 4 points = Three modalities 5 points = Three modalities and asks for student input (e.g., orally, written, example, multimedia, kinesthetically, musically)	6.3 Facilitate managing information and resources
13	When new patterns, critical features, concepts and relationships are introduced they are defined, described and/or illustrated: 1 = 0-19% of the time 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	3.2 Highlight patterns, critical features, big ideas and relationships
14	When new vocabulary words, symbols or notations are introduced they are defined, described and/or illustrated 1 = 0-19% of the time 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	2.1 Clarify vocabulary and symbols
15	When new language, syntax and sentence structure are introduced they are defined, described and/or illustrated 1 = 0-19% of the time 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	2.2 Clarify syntax and structure

16	The teacher helps students interpret notation and symbols: 1 points = Teacher does not provide 2 points = One modality 3 points = Two modalities 4 points = Three modalities 5 points = Three modalities plus revisited at the end of the lesson Modalities: orally, in writing, graphically, multimedia, musical, kinesthetic	2.3 Support decoding of text, mathematical notation and symbols
	Collaborative Communication	
17	Teacher provides guidance for manipulating and processing information: 1 points = Teacher does not provide 2 points = One modality 3 points = Two modalities 4 points = Two modalities and asks for student input 5 points = Two modalities and asks for student input and revisits at the end of the lesson Modalities: orally, in writing, graphically, multimedia, musical, kinesthetic	3.3 Guide information processing, visualization and manipulation
18	The percentage of communication tool that are active for collaboration and communication among participants 1 = 0-19% of the class 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	8.3 Foster collaboration and community
19	The percentage of user interface tools the teacher uses for expression and communication (see tool options) 1 = 0-19% of the tools 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	5.2 Use multiple tools for construction and composition
	Assessment	
21	Is there evidence during the lesson that the teacher is familiar with the student's ZPD: 1. There is no evidence that the teacher alters the lesson in any way based on the student's ZPD 2. Teacher provides content or skill based scaffolding to enhance prior knowledge 3. Teacher checks for understanding to see if students are ready for the next step 4. Teacher alters instruction to meet students' current needs 5. Teacher also provides alternatives based on evidence for assessment NA	8.2 Vary demands and resources to optimize challenge
22	Teacher checks for understanding to attempt to identify struggling students: 1 points = Teacher does not check for understanding 2 points = One modality 3 points = Two modalities 4 points = Three modalities 5 points = Three modalities and asks for student input (e.g., emoticons, polling, chat box, written demonstration)	8.4 Increase mastery-oriented feedback
23	When a struggling student is identified, the teacher provides feedback by 1. Continues with lesson without addressing student misconceptions 2. Repeats previous explanation 3. Provides feedback using alternative explanation 4. Teacher uses examples relating to the student's prior knowledge and interests 5. Prior 4 and teacher checks for understanding again	7.2 Optimize relevance, value and authenticity

24	Students are guided to conduct self assessment and reflect: 　1.　No self assessment or reflection 　2.　One choice of self assessment 　3.　Two choices of self assessment 　4.　Three choices of self assessment 　5.　Teacher choice and students guide their own self assessment/reflection NA	9.3 Develop self-assessment and reflection
25	Content area literacy strategy objectives are assessed in diverse ways: 　1.　Not assessed 　2.　Teacher mandated assessment 　3.　Teacher gives choice of two 　4.　Teacher gives three choices 　5.　Teacher gives choices and students generate own ideas for assessment	7.1 Optimize individual choice and autonomy
26	Teacher gives students options during assessments 1 = 0-19% of the class 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	4.1 Vary the methods for response and navigation
27	Teacher demonstrates how information learned in the lesson can be transferred or generalized to other contexts: 　1.　No transfer or generalization 　2.　One example 　3.　Two examples 　4.　Three examples 　5.　Three examples and student's own example of transfer and generalization NA	3.4 Maximize transfer and generalization
28	Teacher collects assessment data from: 1 = 0-19% of the class 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA	6.4 Enhance capacity for monitoring progress

Appendix C. Student Tool

	What does the student do?	UDL Guideline Checkpoint
1	To what degree are students setting their own goals when given the opportunity? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	6.1 Guide appropriate goal-setting
2	To what degree do students use tools provided to manage information and resources? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	6.3 Facilitate managing information and resources
3	When given the opportunity, to what extent do the students use multiple tools for communication? 1 = 0-19% of tools used for communication 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	4.2 Optimize access to tools and assistive technologies
4	To what extent do the students foster communication and communication among each other? 1 = 0-19% of students use these tools 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	8.3 Foster collaboration and community
5	To what degree do students use multiple media (written, spoken, visual) to demonstrate lesson objectives? 1 = 0-19% of tools 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	5.1 Use multiple media for communication
6	To what degree do students use multiple tools (i.e. chat, whiteboard, microphone) to demonstrate lesson objectives? 1 = 0-19% of tools 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	5.2 Use multiple tools for construction and composition
7	To what extent do students demonstrate self-assessment and reflection when given the opportunity? When asked by the teacher, or given the opportunity in the lesson to demonstrate self-assessment and reflection 1 = 0-19% of students respond 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	9.3 Develop self-assessment and reflection
8	To what degree do the students use their opportunities to make their own choices? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100%	7.1 Optimize individual choice and autonomy

	What does the student do?	**UDL Guideline Checkpoint**
	NA = No Opportunity Given	
9	To what degree do students demonstrate understanding of the lesson objective when the teacher invites students to give data to the teacher for later interpretation and potential progress monitoring? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	8.4 Increase mastery-oriented feedback
10	To what degree do students demonstrate their understanding of lesson objectives and academic content? Students demonstrate understanding by using smiley faces, check marks, polling tools, verbally with microphone, in chat box and whiteboard or multimedia 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	7.2 Optimize relevance, value and authenticity
11	To what degree do the students respond with multiple types of media to provide information to illustrate a topic or concept? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	2.5 Illustrate through multiple media
12	To what degree do the students respond with multiple types of media for communication? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	5.1 Use multiple media for communication
13	To what degree do students share outside resources? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	3.1 Activate or supply background knowledge
14	To what degree do the students participate in determining their next course of action? 1 = 0-19% of students 2 = 20%-39% 3 = 40%-59% 4 = 60%-79% 5 = 80%-100% NA = No Opportunity Given	6.2 Support planning and strategy development