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Bridging Research and Practice: Investigating the Impact of Universally Designed STEM Curriculum on the Concept Acquisition of At-Risk Preschoolers

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Abstract. The purpose of this study was to investigate the impact of universally designed STEM curricular units on the concept and vocabulary acquisition of at-risk preschoolers attending a Head Start preschool program. A quasi-experimental control group design was utilized with the experimental group being exposed to the universally designed STEM curricular unit and the control group taking part in non-universally designed STEM unit. The control group and experimental group were randomly assigned to the morning and afternoon class of the Head Start center for the first unit STEM unit (plants) and then alternated for the second unit (insects). Participants were administered researcher created assessments to measure concept and vocabulary acquisition for each unit. Results of the first independent t-test (plants) indicated that there was no significant difference between the posttest scores of the experimental group and the control group ($p = .08$). Results of the second independent t-test (insects) also indicated that there was no significant difference between the posttest scores of the experimental group) and the control group ($p = .29$). Multiple factors may have contributed to these results, such as the complexity of collecting UDL efficacy data and measuring UDL, participant differences, and unit implementation. Though no significance was found, early childhood educators should be encouraged to still apply the framework to their curricular planning. Infusing UDL through centers, the use of teacher created eBooks, and student choice are recommended.

Keywords: Universal Design for learning; UDL; STEM; Early Childhood; At-risk.

Introduction

The diversity of students attending preschools today is ever growing. These students come to school with diverse learning abilities in the areas of cognitive, social, emotional, language, and motor development. At the same

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time early childhood centers are serving an increasing numbers of English language learners, and students with disabilities. The growing diversity in today's early childhood classrooms poses a challenge for the preschool teacher.

Though a challenge exists, educators still strive to set and meet rigorous goals. One goal of the preschool teacher is to create and implement a curriculum that promotes the growth and development of all children (Stockall, Dennis, & Miller, 2012). Likewise, early childhood educators note an essential goal is to create inclusive programs for all students and to begin to move away from specialized programs (Conn-Powers, Cross, Traub, & Hutter-Pishgahi, 2006). A framework that can help meet these goals and support all learners is universal design for learning (UDL).

UDL is a set of principles for curriculum development, instructional design, and assessment for PreK-12 settings that gives all individuals equal access to learning (Cast, 2011). Based on research in educational practices, cognitive science, developmental psychology, and neuroscience, UDL helps teachers respond to and address the diverse learning needs and differences of students present in today's classroom (Rose & Meyer, 2002). UDL takes a different approach to curricular planning. Educators using the framework for curricular and lesson planning consider the diversity of the students up front rather than as an afterthought that often happens with traditional planning. In other words, when designing curriculum and daily plans, the teacher thinks first how she can meet the needs of all of her students rather than making modifications and adaptations for students after the planning phase, which is often called "retrofitting."

The framework of UDL is guided by three main principles: (1) To support recognition learning, provide multiple means of presentation, (2) To support strategic learning, providing multiple means of expression and action, and (3) To support affective learning, provide multiple means for engagement. Instructional, material, curriculum, and assessment design that shadows these three principles can help increase the learning opportunities for all children who struggle to learn (Edyburn, 2005; Rose & Meyer, 2000).

UDL can easily be applied to the preschool setting. Often an early childhood educator is implementing ideas aligned with the UDL framework; however, with additional careful and purposeful planning and thought, more strategies can be applied resulting in greater access to the curriculum for all young students. The following examples highlight a few concrete application ideas of how a preschool teacher can implement the principles of UDL within her classroom. For example, an early childhood educator can apply the first principle, provide multiple means of representation, by using eBooks in centers or during shared reading, using multiple representations of a topic (book/eBook, poem, song, dramatic representation, stuffed animal/puppet, illustrations/photos, etc.), and the use of age-appropriate graphic organizers.

Application ideas for the second principle, provide multiple means of expression, can include providing students choice for how they want to share their acquisition of concepts (clay, drawing/painting, creating a story using an eBook, dramatic representation, etc.), the use of partial participation, or providing multiple opportunities for children to practice skills throughout the day (centers, small groups, shared reading, circle time, etc.) In the third

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principle, provide multiple means of engagement, the preschool teacher can offer various creation mediums in centers, use flexible and varied sized groups, provide multiple levels of challenges (puzzles, traditional games, technology games, etc.) or design an area in the classroom that limits distractions. Further application examples can be found on the Center for Applied Technology (CAST) website (www.cast.org.)

Though the UDL framework can be easily implemented using low-tech methods, the framework still depends on flexible digital media. The use of digital media increases the ease of the implementation of the UDL principles (Rose & Meyer, 2000). For instance, an early childhood teacher can easily use technology to enhance a lesson using the book *Five Little Monkeys Jumping on the Bed.* The teacher can use an eBook version of this book that allows for enlargement of the text and pictures, which can result in all students having access to the book. Sound effects and music is often embedded in these eBooks, which can help keep the attention of students. The teacher than can make the eBook available later in the Reading center where students can independently listen to the book because of built in text-to-speech. Students may then decide to dramatize the book using monkey puppets and with the help of the teacher they record the play using the camera imbedded in the class iPad. The movie is then shared with the class during closing circle and emailed to parents. Though these are just a few examples, it is clearly evident that the use of technology can help increase access for all students and help improve engagement in comparison to only using traditional teaching methods.

There is a lack of empirical research concerning UDL in all educational settings. Few empirical studies can be located that directly measure the impact of universally designed curriculum on the outcomes of students. For instance, contributions to literature regarding UDL include only basic descriptions and principles of UDL (Brand, Favazza, & Dalton, 2012; Edyburn, 2005; Jimenez, Graf, & Rose, 2007; Spencer, 2011; Wehmeyer, 2006), Other literature centers on the application of the UDL framework to teacher practices in the elementary, middle, and secondary settings with few articles focused on the early childhood population. Specifically, the framework has been applied to literacy (Hall, Cohen, Vue, & Ganley, 2015; Kennedy, Thomas, & Meyer, 2014; Meo, 2008; Metcalf, Evans, & Flynn, 2009; Narkon & Wells, 2013) and math instruction (Hunt & Andreasen, 2011; Selmer & Floyd, 2012; Thomas, Van Garderen, & Scheuemann, 2015; Zydney & Hasselbring, 2014). The content areas of science (King-Sears & Johnson, 2015; Kurtts, Matthews, & Smallwood, 2009; Marino, Gotch, & Israel, 2014; McPherson, 2009; Rappolt-Schlichtmann, Daley, & Lim, 2013) and social studies (Bouck, Courtad, & Heutsche, 2009) also are a focus in the literature. Other focus areas are STEM education (Basham & Marino, 2013), the Arts (Darrow, 2015; Glass, Meyer, & Rose, 2013), and culturally diverse students (Chita-Tegmark, Gravel, & Serpa, 2012; Kavita, 2015; Rice, 2015).

Like in the areas of elementary, middle, and secondary education, there is little empirical research in the setting of early childhood classrooms. Specifically, no research could be located that directly investigated the effect of universally designed preschool curriculum on the learning outcomes of students. Likewise as in other educational settings, the literature in the early childhood domain primarily focuses on the application of the framework. For

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instance, one contribution discusses in general how the UDL principles can be applied to preschool curriculum development and the classroom environment (Stockall et al., 2012). Suggestions are provided in how to select appropriate classroom materials, write goals, set up centers, and integrate technology. Another author applies the principles to outdoor play and gives examples as to how early childhood educators can make outside play more accessible by applying the UDL framework (Harte, 2013). The UDL principles have also been applied to assessment in early childhood settings (Dalton & Brand, 2012). Specifically, using a variation of assessment methods, formats, and teacher feedback can lead to more authentic and accurate assessment results in young children. On the other hand, a final contribution takes more of a theoretical approach and discusses how early childhood, inclusive education, and UDL should be merged to form Universal Design for Early Childhood Education (UDECE; Darragh, 2007). Overall, the application of UDL principles to the early childhood settings has the potential to enhance the environment and student development, but little empirical evidence is available to support this claim.

The UDL framework can be applied to any subject area in the preschool; however, one area of interest is science. Science is one content area found in the well-known acronym STEM. The other content areas include technology, engineering, and mathematics. As a nation-wide initiative, teachers are encouraged to incorporate STEM into their curriculum in order to increase the necssary awareness and knowledge to benefit students in everyday situations as well as students' potential in obtaining jobs in STEM-related settings in the future. The United States hopes that increasing student performance in STEM will result in more students entering these STEM related professions (Lacey & Wright, 2009). Therefore, including STEM in the curriculum is beneficial for students of all ages, especially young children (Katz, Chard, & Kogan, 2013).

There is also a growing needed to incorporate STEM into school curricula due to recent international assessment data. Internationally, 8th grade students in the United States rank 10th and 4th grade students rank 7th in Science achievement (National Center for Education Statistics, 2011). Though this is an increase in ranking from 2007 there is still concern that students in the United States are not ranking higher. Likewise, because of these recent trends in international data, there is an ever growing need to design early childhood environments that address STEM (Aronin & Flyod, 2013).

Some educators hold the fallacy that STEM curriculum is too difficult to use in preschool settings; however, STEM encourages many key skills, such as helping children focus, increasing vocabulary, encouraging collaboration, and creating scientific relationships (Moomaw & Davis, 2010). Skills in STEM are a fundamental element of a balanced education and essential to effective citizenship (STEM Education Coalition, 2016). Preschool environments can easily incorporate STEM concepts throughout the school day. For instance, in the block center, students can build bridges, ramps, and houses (engineering and math) and research these structures in the computer center (technology). Outside, a water center can be set up where children experiment with various containers to fill and compare (science and math). Simply, a nature walk where students can collect almost anything, such as rocks, leaves, insects, seeds, etc. can encourage the development of STEM concepts. With these collections, students can

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practice counting, exploring differences/similarities, and possibly making hypotheses (math and science).

The design of STEM curricula using the framework of UDL could result in powerful outcomes. Increasing access to STEM concepts for *all* students is important and could lead to increased interest and achievement in this field, ultimately resulting in more students entering STEM related fields. However, after the examination of the literature, it is clear that further investigation of the efficacy of the application of the UDL framework in the early childhood classroom is needed, especially in Science. Therefore, the purpose of the study was to determine the impact of a universally designed science curricular units on the concept and vocabulary acquisition of at-risk preschoolers attending a Head Start preschool program.

Methods

Setting and Participants

The selected site for the study was a Head Start center in the North Eastern section of the United States. Traditionally, the goal of Head Start centers is to promote school readiness skills in low-income young children of the ages 3-5. Head Starts are family based programs that not only support the social and emotional support of the students, but also provides services and programs to families to help promote these key areas in a child's development. The Head Start center was located in a diverse and impoverished urban area with a high English language learner and transient population. The center consisted of two classrooms; however, the scope of the study was limited to only one classroom. The classroom was selected because the classroom teacher implementing the units was previously trained in the implementation of UDL; thus, enabling her to have a good working knowledge of the framework.

The selected classroom consisted of AM and PM sessions with approximately 17 students in each session. The needs of the students in each classroom were diverse with few meeting expected grade/age level targets. Thus, the researcher felt these students would benefit from universally designed STEM curricular units. Each class sized varied through out the entire study due to the transient nature of the area. The varying sample sizes for each curricular unit are identified in the results section. Assent was obtained by all participants included in the study along with parental permission.

Design and Implementation

A quasi-experimental control group design was utilized with the experimental group being exposed to the universally designed science curricular unit and the control group taking part in non-universally designed science unit. The control group and experimental group were randomly assigned to the morning and afternoon class of the Head Start center for the first unit. After the first unit, assignment of the control and experimental group was alternated. At the conclusion of the project, each class participated in one universally designed unit. The topic of unit one was plants with insects as the second topic. The duration of each unit was ten school days. Table 1 illustrates the class assignment for each unit and the total number of children who participated in the study for each unit.

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Table 1: Group Assignment

Class	Plants	Insects
AM	Control (n = 9)	Experimental (n = 8)
PM	Experimental (n = 8)	Control (n = 14)

Both the experimental and control group units were researcher created with some input from the classroom teacher. The control group units were designed using developmental appropriate practices that promoted the main domains of learning (cognitive, language, motor, self-help/adaptive language, and social development). The control group units reflected best practices in early-childhood education. In the creation of the universally designed units, in addition to the consideration of developmentally appropriate practice and the major domains of learning, the researcher used the framework and principles of UDL as a guide. Typical lessons for both the control and universally designed units consisted of a short teacher lead shared reading, demonstration, discussion and/or a teacher lead activity. Guided and Independent practice of the unit concepts occurred in the classroom's Science center. Though the researcher created the bulk of the units, the teacher was still consulted concerning different aspects of the units. For instance, the researcher gathered feedback regarding the appropriateness of specific strategies, such as the use of graphic organizers (KWL Chart, webbing, etc.) and the length and complexity of the shared reading, demonstration, discussion, or teacher lead activity.

In order to promote consistency between both universally designed Science units, the researcher selected key strategies and materials that would be integrated throughout each unit. Both *high-tech* and *low-tech* materials and strategies were utilized. *High-tech* strategies and materials were defined as anything that was electronic, battery and/or Internet based. Conversely, *low-tech* was defined as strategies and materials that could be operated without the dependence on electricity, batteries, and/or the Internet. A summary of the key low-tech and high-tech materials and strategies utilized in the study can be found in Table 2.

Detailed unit timelines and plans were given to the classroom teacher for both the experimental and control group units. In the experimental units, the UDL components were highlighted to help the classroom teacher differentiate between the control and experimental units. The researcher maintained an open-line of communication with the classroom teacher throughout the study, but to encourage implementation fidelity the researcher checked in with the classroom teacher mid-way through each unit. The check-in consisted of a discussion of the implementation of the unit and the answering of any relevant questions. The researcher also re-demonstrated any high-tech strategies or materials as needed at the check-ins. All units were reviewed and explained to the classroom teacher prior to implementation. Technology was also demonstrated prior to unit implementation. Table 3 provides an overview of each unit.

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Table 2: *UDL High-Tech and Low-Tech Examples*

High Tech Examples

- Researcher and student made eBooks using Book Creator
- iPad apps such as Book Creator, Parts of a Plant, Life Cycles for Kids, Ladybug, Learn Fruit & Vegetables, Butterfly, Noisy Bug
- Internet-based videos such as Time Lapse Growing Plant, Song: "Head, Thorax, and Abdomen," Butterfly Life Cycle (Monarch)
- iPad camera to document growth cycle of student plants and choice of expression

Low Tech Examples

- Graphic organizers such as a KWL for each unit, Life Cycle organizers, and webbing to organize concepts
- The use of researcher made games that included multiple levels of play
- Use of picture vocabulary cards to highlight key terms for each unit in students' native language (Spanish) and English
- Ability grouping and choice of working independently or cooperatively during learning centers
- Choice of expression in each unit where students could select how they wanted to demonstrate their learning. E.g. Life Cycle of Insect Extension: Students had the choice of making a book (print or eBook), illustrating a picture, utilizing a graphic organizer, acting out the life cycle (record using iPad), or using modeling clay
- Multiple opportunities to practice skills occurred across the unit primarily during the learning centers where students could review information using the selected iPad applications, eBooks, and learning games
- Ability grouping and choice of working independently or cooperatively during learning centers

Table 3: *Overview of Units*

Day	Plant Unit	Insect Unit
1	What is a plant? Types of Plants	Introduction to the Unit: Insects
2	Types of Plants	What makes an insect an insect?
3	Parts of a Plant Overview	Insects All Around Us
4	Parts of a Plant: Roots & Stems	Life Cycle of an Insect/Butterfly
5	Parts of a Plant: Leaves & Flowers	Ladybugs
	Researcher Check-In	
6	Seeds	Ants
7	Where do seeds come from? (Fruit)	Grasshoppers
8	Life Cycle of Plant	Bumblebees
9	Life Cycle of Plant	Fireflies
10	Life Cycle of a Plant & Closure	Closure & Review

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Instruments

Data were collected using researcher created instruments that measured the concept and vocabulary acquisition of each participant. The concept acquisition of the instruments consisted of the participants demonstrating their understanding of the life cycle of plants and insects. In addition, the researcher defined vocabulary acquisition as the participants'' ability to use key unit vocabulary in their oral responses to questions. A list of key vocabulary terms was generated for each unit, such as parts of plants and insects and types of insects and plants. An early childhood science curricular expert reviewed each instrument for content validity.

Each instrument was designed and administered using developmental appropriate practices. Each instrument relied on the use of pictures. Some questions required participants to point to an appropriate picture, while other questions participants verbally gave their responses. For instance, in the plant unit pretest and posttest, participants were asked to talk about what a life cycle is (concept acquisition) and a plant that has a life cycle (vocabulary). Participants were also asked to point to each stage of the plant life cycle and talk about what they knew about it (vocabulary and concept acquisition). In the insect unit pretest and posttest, the participants, where asked to name an insect they knew (vocabulary), as well as what makes an insect an insect (vocabulary and concept acquisition). After being presented with various insect pictures, the participants were asked to name them.

All pretests and posttests were administered individually, in English, and in a quiet area of the classroom. The researcher used a data collection sheet to record the participants' responses during the administration of the tests. Participants' responses were manually recorded onto the data collection sheets for later analysis. Identical pretest and posttest were administered. The early childhood science curricular expert scored all tests.

Results

Participation in the units varied for each class. Parental consent was not given for all children. A number of children were not present for both the pretest and the posttest. The researcher made numerous attempts to collect data without success. At the conclusion of the first unit (plants), the control group had nine viable data sets and the experimental group had eight. The second curricular unit (insects) resulted in 14 viable data sets for the control group and eight data sets for the experimental group.

In order to control for differences between the control and experimental groups, caliper matching was utilized with a caliper width equal to the pretest score 1. For the first curricular unit (plants) five of the eight possible pairs of data (62.5%) remained after matching. For the second curricular unit (insects), Five of the eight possible pairs of data (62.5%) remained after matching.

After caliper matching, an independent one tailed t-test was conducted for each unit to determine if any significance difference existed between the control group and experimental groups posttest scores. An independent t-test can be deemed appropriate with a sample size as small as two (de Winter, 2013). However, generalizability of results decreases as sample size decreases. Thus, it

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can be concluded that a t-test is appropriate in the current study, but results should be reviewed with caution.

Results of the first independent t-test (plants) indicated that there was no significant difference between the posttest scores of the experimental group ($M = 2.6$, $SD = 2.42$) and the control group ($M = .6$, $SD = .80$), $t(8) = 1.57$, $p = .08$. Results of the second independent t-test (insects) indicated that there was no significant difference between the posttest scores of the experimental group ($M = 7.6$, $SD = 3.24$) and the control group ($M = 8.8$, $SD = 2.79$), $t(8) = 0.57$, $p = .29$. It can be concluded that the universally designed units did not significantly change the posttest scores of the experimental group. Multiple factors may have contributed to these results and will be analyzed in the following discussion.

Discussion

The purpose of this study was to investigate the effect of universally designed STEM curricular units on the concept and vocabulary acquisition of at-risk preschoolers attending a Head Start Preschool Program. Overall, the results indicate that the universally designed STEM units did not significantly affect posttest scores of the experimental group. However, a slight increase of posttest scores was reported for the experimental group in the insect unit. Though, no significance differences were found in each unit, the value of this study comes from the additional questions that arose about the implementation of UDL and how to measure its effectiveness.

UDL is a complex and multifaceted framework (Basham & Gardner, 2010) that is subjective in nature. The framework is made up of three principles and under each principle there are three main guidelines. Each guideline then has anywhere from three to five checkpoints. These principles, guidelines, and checkpoints provide guidance in the development of universally designed curricula, assessments, and materials; however, there is no standard that states how much of each component should be incorporated within a lesson, curriculum, etc. Essentially, student interests, strengths, and needs and the content that is being taught drive the implementation of UDL. Thus, UDL operates on a continuum based on these factors with implementation occurring in varying degrees across various settings resulting in the difficulty of narrowing down the focus as to what elements are the most beneficial. In the present study, it is difficult to determine if the most appropriate UDL elements were selected. Other selected elements may have resulted in different outcomes.

Another important point that arises concerns the use of student measures. Simply the use of only pretest and posttest scores may not give researchers enough data to determine the effectiveness of UDL. Besides test scores, other areas of assessment should include improved fluency, expression, problem solving, and collaboration (CAST, 2008). Though test scores of vocabulary and concept acquisition did not improve, it cannot be discounted that other areas may have improved, such as engagement in the STEM subject area or greater access to the material.

Besides the complexity of UDL, other factors may have contributed to the results of the current study, such as participant characteristics and the study implementation. Even though caliper matching was utilized to help control for differences between the control and experimental group, all differences could

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not be controlled for. For instance, the PM class had greater cognitive ability, as reported by the classroom teacher. In other words, students in the PM class had more potential in learning, applying, and generalizing the concepts being introduced in the plant and insect units. Posttest scores were higher in both the insect (control group) and plant (experimental group) units for the PM class. The PM class also had fewer English Language Learners, fewer absences during the units and a lower subject mortality rate, which all possibly influenced the results. Moreover, the high subject mortality and absentee rates resulted in a smaller sample size limiting the generalization of the results.

The parameters put in place at the Head Start center may have influenced results. Other programs needed to be implemented at the same time due to the nature of the Head Start program, such as a unit on Dental Awareness. This unit took place at the same time as one of the UDL units, which resulted in time taken away from the unit. Participants also self-selected centers and were not required to take part in the Science center, which is a common practice in early childhood classrooms. The classroom teacher could only encourage students to visit the Science center. Much of the practice and application of the unit concepts occurred in this center. Thus, some students may have frequently visited the center and others may have never chosen it. Data was not collected on the student frequency or use of the center, though this data may have been useful in explaining results.

At the conclusion of the study, the researcher gathered informal data from the classroom teacher in relation to the unit design. The classroom teacher remarked that some of the activities were too lengthy and complex for her students' attention spans and abilities. The researcher did consult with the teacher regarding the appropriateness of the unit lesson, activities, etc. prior to implementation. However, it may have been beneficial to encourage flexible unit implementation. In other words, the daily unit lessons may have been changed based on the effectiveness and appropriateness of previous lessons. This flexibility more closely mirrors daily instructional practices of classroom teachers, as well as the framework of UDL. The rigidity of the unit implementation may have skewed the study results. Future research should allow for more flexibility of teacher unit implementation.

Finally, the units were not researcher implemented, which may have also impacted the results of the study. The researcher provided detailed lesson plans for each topic of the unit and explained each lesson thoroughly to the classroom teacher. However, implementation of these units was dependent on the integrity of the teacher. Even though mid-unit checkpoints were put in place, researcher fidelity checks did not occur. Because fidelity checks did not occur, it is unknown to what extent the units were implemented as planned. Furthermore, the classroom teacher was versed in the UDL framework due to taking a graduate level course on this topic; however, additional researcher feedback may have been beneficial in regards to how the teacher was implementing the UDL principles. Ideally, researcher implemented units would have been the most effective and would have reduced threats to internal validity.

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Implications for Early Childhood Educators

Though significant results were not found at the conclusion of the study, there are still implications for early childhood educators. Early childhood educators should continue to design early childhood environments and curricula using the UDL framework. Benefits of using the UDL framework other than improved test scores are apparent, such as the possibility of improved engagement and increased access to the curriculum and classroom environment. Early childhood educators may consider implementing the following ideas drawn from the implementation and results of the current study, as well as UDL best practices in the literature. Implications should be viewed with caution being that no significance was found in the current study. Further research should be conducted before these suggestions can be considered evidence-based practices in the early childhood classroom.

First, classroom centers are the ideal place to implement UDL principles. Centers are the best place to encourage persistence with students on a concept across time. Centers also allow for multiple exposures on a concept and give students multiple opportunities to practice a skill. Student needs can easily be met in centers by using flexible grouping and changing or adapting materials. At the same time, STEM concepts can seamlessly be integrated into centers.

The use of eBooks, especially teacher made, is recommended. The use of teacher created eBooks allow for educators to explain any topic in the manner that they decide. The use of eBooks is appropriate for various student abilities. Books can be shortened or adapted for those students with shorter attention spans, lower cognitive ability or for those learning English and easily made more complex for those students more advanced. Videos and engaging photos can be incorporated into the eBooks. Likewise, the classroom teacher can provide the audio recording of the text being read. The eBooks can be placed in a center where students can independently review the topic. Recommended book creation Apps are Book Creator, Book Writer, and Scribble My Story.

Finally, it is recommended that teachers implement student choice. Students should be given a choice in how they want to show their knowledge, which benefits various ability levels and student interests. In the current study, students were given the choice in how they wanted to demonstrate their knowledge of the plant life cycle by either drawing, making an eBook, completing a graphic organizer, using clay, or dramatizing the cycle. These choices can be placed in a Science Center. Some students may be overwhelmed with the number of choices; therefore, the teacher should make modifications where needed. Two choices may be appropriate for some students, while other students may be able to handle five. Choice is both powerful and engaging for students.

Recommendations for Future Research

It is recommended that researchers collect additional data besides student outcomes when investigating the efficacy of UDL. This additional data may yield useful information regarding the best implementation practices of UDL. Specifically, it is recommended that classroom level data should be collected. For instance, researchers should collect observational data on the actual implementation of UDL and to what extent UDL is being implemented in

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the classroom. Researchers can observe classrooms and rate the level of UDL using tools such as The Universal Design for Learning Measurement Tool 1.0 (Basham & Gardner, 2010). This information can then be correlated with student outcomes and level of engagement. Classroom level data may give greater insight into what level of UDL is most effective. At the same time, classroom observations may yield richer student outcome data. Observational data may allow researchers to determine more closely if proposed student outcomes were effectively reached in comparison to solely using closed and open-ended instrument formats.

The collection of teacher level data is also recommended. For instance, collecting perceptual data regarding how teachers implement UDL and how they change their instruction and classroom environments based off of student strengths, needs, interests and lesson content would be useful in uncovering information about what elements of UDL are the most feasible and appropriate to implement in the early child classroom. Nevertheless, results of the current study indicate more research needs to be conducted to determine the efficacy of UDL in early childhood environments. This research can only occur with a strong partnership between early childhood educators and researchers.

References

Aronin, S. & Floyd, K. K. (2013). Using an iPad in inclusive preschool classrooms to introduce STEM concepts. *TEACHING Exceptional Children, 45*(4), 34-39.

Basham, J. D. & Gardner, J. E. (2010). Measuring universal design for learning. *Special Education Technology Practice,* 15-19.

Basham, J. D., & Marino, M. T. (2013). Understanding STEM education and supporting students through universal design for learning. *TEACHING Exceptional Children*, *45*(4), 8-15.

Bouck, E. C., Courtad, C. A., Heutsche, A., Okolo, C. M., & Englert, C. S. (2009). The virtual history museum: A universally designed approach to social studies Instruction. *TEACHING Exceptional Children*, *42*(2-), 14-20.

Brand, S. T., Favazza, A. E., & Dalton, E. M. (2012). Universal design for learning: A blueprint for success for all learners. *Kappa Delta Pi Record*, *48*(3), 134-139.

Chita-Tegmark, M., Gravel, J. W., Serpa, M. B., Domings, Y., & Rose, D. H. (2012). Using the universal design for learning framework to support culturally diverse learners. *Journal Of Education*, *192*(1), 17-22.

Conn-Powers, M., Cross, A. F., Traub, E. K., & Hutter-Pishgahi, L. (2006). The universal design of early education: Moving forward for all children. *Beyond the Journal: Young Children on the Web*. Retrieved from http://journal.naeyc.org/btj/200609/ConnPowersBTJ.pdf

Dalton, E. M., & Brand, S. T. (2012). The assessment of young children through the lens of universal design for learning (UDL). *Forum On Public Policy Online*, *2012*(1),

Darrow, A. (2015). Differentiated instruction for students with disabilities: Using DI in the music classroom. *General Music Today*, *28*(2), 29-32.

DEC (Division for Early Childhood) & NAEYC. 2009. "Early Childhood Inclusion: A Joint Position Statement of the Division for Early Childhood (DEC) and the National Association for the Education of Young Children (NAEYC)." Chapel Hill: The University of North Carolina, FPG Child Development Institute. www.naeyc.org/fi les/naeyc/fi le/ positions/DEC_NAEYC_updatedKS.pdf

Edyburn, D. L. (2005). Universal design for learning. *Special Education Technology Practice, 7*(5), 16-22.

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Glass, D., Meyer, A., & Rose, D. H. (2013). Universal design for learning and the Arts. *Harvard Educational Review*, *83*(1), 98-119.

Hall, T. E., Cohen, N., Vue, G., & Ganley, P. (2015). Addressing learning disabilities with UDL and technology: Strategic Reader. *Learning Disability Quarterly*, *38*(2), 72-83.

Harte, H. A. (2013). Universal design and outdoor learning. *Dimensions Of Early Childhood*, *41*(3), 18-22.

Horn, E., & Banerjee, R. (2009). Understanding curriculum modifications and embedded learning opportunities in the context of supporting all children's success. *Language, Speech, and Hearing Services in Schools*, 40, 406-415.

Hunt, J. H., & Andreasen, J. B. (2011). Making the most of universal design for learning. *Mathematics Teaching In The Middle School*, *17*(3), 166-172.

Katz, L., Chard, S., & Kogan, Y. (2013). *Engaging children's minds: The project approach.* Westport, CT: Greenwood Publishing Group.

Kennedy, M. J., Thomas, C. N., Meyer, J. P., Alves, K. D., & Lloyd, J. W. (2014). Using evidence-based multimedia to improve vocabulary performance of adolescents with LD: A UDL approach. *Learning Disability Quarterly*, *37*(2), 71-86.

King-Sears, M. E., Johnson, T. M., Berkeley, S., Weiss, M. P., Peters-Burton, E. E., Evmenova, A. S., & ... Hursh, J. C. (2015). An exploratory study of universal design for teaching chemistry to students with and without disabilities. *Learning Disability Quarterly*, *38*(2), 84-96.

Kurtts, S. A., Matthews, C. E., & Smallwood, T. (2009). (Dis)Solving the differences: A physical science lesson using universal design. *Intervention In School And Clinic*, *44*(3), 151-159.

Lacey, T. A., & Wright, B. (2009). Occupational employment projections to 2018. *Monthly Labor Review, 132*(11), 82-123.

Marino, M. T., Gotch, C. M., Israel, M., Vasquez, E. I., Basham, J. D., & Becht, K. (2014). UDL in the middle school science classroom: Can video games and alternative text heighten engagement and learning for students with learning disabilities?. *Learning Disability Quarterly*, *37*(2), 87-99.

McGuire, J., Scott, S., & Shaw, S. (2006). Universal design and its applications in educational environments. *Remedial & Special Education, 27*(3), 166-175.

McPherson, S. (2009). "A dance with the butterflies:" A metamorphosis of teaching and learning through technology. *Early Childhood Education Journal*, *37*(3), 229-236.

Meo, G. (2008). Curriculum planning for all learners: Applying universal design for learning (UDL) to a high school reading comprehension program. *Preventing School Failure, 52*(2), 21-30.

Metcalf, D., Evans, C., Flynn, H. K., & Williams, J. B. (2009). Direct instruction + UDL = access for diverse learners: How to plan and implement an effective multisensory spelling lesson. *TEACHING Exceptional Children Plus*, *5*(6),

Moomaw, S. & Davis, A. (2010). STEM comes to preschool. *Young Children, 65*(5), 12-18.

Narkon, D. E., & Wells, J. C. (2013). Improving reading comprehension for elementary students with learning disabilities: UDL enhanced story mapping. *Preventing School Failure*, *57*(4), 231-239.

National Center for Education Statistics. (2011). Highlights from the Trends in International Mathematics and Science Studies (Rev. ed.). Washington, DC: U.S. Department of Education.

Rao, K. (2015). Universal design for learning and multimedia technology: Supporting culturally and linguistically diverse students. *Journal Of Educational Multimedia And Hypermedia*, *24*(2), 121-137.

Rao, K., Ok, M. W., & Bryant, B. R. (2014). A review of research on universal design educational models. *Remedial And Special Education*, *35*(3), 153-166.

Rappolt-Schlichtmann, G., Daley, S. G., Lim, S., Lapinski, S., Robinson, K. H., & Johnson, M. (2013). Universal design for learning and elementary school science:

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Exploring the efficacy, use, and perceptions of a web-based science notebook. *Journal Of Educational Psychology*, *105*(4), 1210-1225.

Rice Doran, P. (2015). Language accessibility in the classroom: How UDL can promote success for linguistically diverse learners. *Exceptionality Education International*, *25*(3), 1-12.

Rose, D. H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning.* Cambridge, MA: ACSD Publishing.

Selmer, S. J., & Floyd, K. (2012). UDL for geometric length measurement. *Teaching Children Mathematics*, *19*(3), 146-151.

Spencer, S. A. (2011). Universal design for learning: Assistance for teachers in today's inclusive classrooms. *Interdisciplinary Journal Of Teaching And Learning*, *1*(1), 10-22.

STEM Education Coalition (2016). Retrieved from http://www.stemedcoalition.org/wp-content/uploads/2010/05/One-pager-on-STEM-Ed-Coalition.pdf

Stockall, N. S., Dennis, L., & Miller, M. (2012). Right from the start: Universal design for preschool. *TEACHING Exceptional Children, 45*(1), 10-17.

Thomas, C. N., Van Garderen, D., Scheuermann, A., & Lee, E. J. (2015). Applying a universal design for learning framework to mediate the language demands of Mathematics. *Reading & Writing Quarterly*, *31*(3), 207-234.

Winter, J. C. F. (2013). Using the student's t-test with extremely small sample sizes. *Practical Assessment, Research, and Evaluation, 18*(10), 1-12.

Zydney, J. M., & Hasselbring, T. S. (2014). Mini anchors: A universal design for learning approach. *Techtrends: Linking Research And Practice To Improve Learning*, *58*(6), 21-28.

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