TEACHER CANDIDATES IMPLEMENTING UNIVERSAL DESIGN FOR LEARNING: ENHANCING PICTURE BOOKS WITH QR CODES

By

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ABSTRACT

The purpose of this study was to investigate if teacher candidates could gain knowledge of the principles of Universal Design for Learning by enhancing traditional picture books with Quick Response (QR) codes and to determine if the process of making these enhancements would impact teacher candidates' comfort levels with using technology on both students with and without disabilities. Participants were undergraduate students seeking teacher certification for children from birth through grade six. Data sources included a pre and post survey, discussion forum, final presentations, and the enhanced picture books. Results indicated that the process of using QR codes to adapt a book resulted in candidates being significantly more comfortable in using technology with students with disabilities although there were no significant differences on their comfort level using technology for students without disabilities. In addition, teacher candidates were able to identify ways to use QR codes to adapt picture books for literacy development, but were limited in their ability to link text enhancements to the principles of Universal Design for Learning. Suggestions for using QR codes in teaching these principles to teacher candidates are offered as well as suggestions for future research.

Keywords: Teacher Education, Technology, Picture Books, Universal Design for Learning, QR Codes.

INTRODUCTION

The impetus of this investigation is to determine the effectiveness of using technology (in this case, QR, or Quick Response Codes) to help teacher candidates learn about Universal Design for Learning (UDL). UDL is a set of principles that provides a framework for educators to consider the goals, methods, materials, and assessments they are designing so that all students, no matter their learning needs, may have access to the curriculum (Meyer, Rose, & Gordon, 2014). Recently, UDL has become a prominent fixture in federal laws and reports. The Individuals with Disabilities Education Act of 2004 calls for making accommodations for students with disabilities so that they have more access to the general education curriculum, and it included provisions that students have access to digital text. UDL is also now a defined and required part of teacher education because of the Higher Education Opportunity Act (Hehir, 2009), and the National Education Technology Plan (Office of Educational Technology [OET], 2016). In the UDL framework, lesson and curriculum design is completed in advance instead of retrofitting for individual learners after their needs have been neglected (Evans, Williams, King, & Metcalf, 2010). Technology is an important part of UDL because of the flexibility that it provides in providing multiple means of representation, expression, and engagement. Access to digital media allows teachers to provide a variety of inputs to students which enables them to have different ways to express what they know and are able to do. One type of technology in particular, QR codes has the potential to provide opportunities to increase access for students with exceptionalities because of the ease by which users can link to multimedia supports.

1. Review of the Literature

In an effort to increase the achievement of a diverse group of students, teacher educators have been called to introduce the UDL framework across programs in both Special and General Education (Jimenez, Graf, & Rose, 2007; OET, 2016). While researchers in teacher education have not yet investigated QR codes in the ways being done

in this study, but they have investigated best ways to teach the principles of UDL to candidates. One hour of instruction on UDL principles has led to teacher candidates effectively planning lessons that utilize these principles (Spooner, Baker, Harris, Ahlgrim-Delzell, & Browder, 2007); however, the ability to write a lesson plan utilizing UDL principles is markedly different from the ability to use these principles to make adaptations to instructional materials. While other research has investigated teaching UDL to teacher candidates through Webquests (Yang, Tzuo, & Komara, 2011), online courses (Scott, Temple, & Marshall, 2015), and computer-mediated communication (Basham, Lowrey, & deNoyelles, 2010), a need for further research to focus on the application of the UDL framework with a variety of other technological tools by teacher candidates in and out of field experiences still exists (Evans, Williams, King, & Metcalf, 2010; OET, 2016). Undoubtedly, because of its power to eliminate textual barriers, it is critical to provide opportunities for teacher candidates to use technology for instruction. It is equally important, therefore, for teacher candidates to feel confident in using technology effectively to support all types of literacy learners. In terms of current trends, the use of QR codes in education is clearly on the rise as made evident by the numerous Livebinders, websites, teacher blog entries, and YouTube videos dedicated to this topic. The current investigation explored teacher candidates' use of QR codes to enhance picture books in order to learn about UDL and how to apply its principles for students' literacy development.

Traditional text poses many barriers to a variety of learners and therefore, may not allow educators to choose the most appropriate methods to ensure the content and text are accessible. Traditional or printed text is a barrier for many readers in that it does not allow users to choose the appearance of the text (size, color, or spacing of text) or to access supplemental supports (i.e., text-to-speech, accent of voice, the speed at which it is read, access to definitions, etc.). The barriers presented by traditional text are more easily recognized when one considers the opportunities offered by digital text. For example, digital books offer more multimedia supports than traditional books in that they can offer links to videos, audio recordings, and other interactive elements which may assist readers in further developing their comprehension.

QR codes, which were first designed for the automotive industry, have recently become more commonplace in other industries due to their expanded storage capacity (Robertson & Green, 2012). In comparison to traditional barcodes, QR codes have the capacity to much more information. Typically, QR codes are black dots on a white background, however there are programs available which allow you to choose the color of your code and its background. These scannable images contain information leading to a URL which may link to text, video, or audio (Anderson, 2010), but also allow users to send messages, share contact information and maps, as well as gain access to social networks (Law & So, 2010; Young, 2011). QR codes can be created by anyone using free, user-friendly code generator programs. These codes need to be scanned by QR readers which are available as applications on a computer or mobile device. QR codes have become more popular in education because of the growing popularity in the use of mobile devices in education.

As QR codes have grown in use commercially, educators have come to see the benefits and ease by which QR codes can be used in schools. School librarians are using them to share student reviews of books, to let students sign up for new books that arrive in the library, and to provide links to library guides and other resources (Ahearn, 2014; Barack, 2010; Hicks & Sinkinson, 2011). Physical education and health teachers are using them to provide directions and examples at independent learning stations (Adkins, Wajciechowski, & Scantling, 2013; Shumack, Reilly, & Chamberlain, 2013). Other teachers are using them to help students self-correct their work, to differentiate assignments for students at varying levels, to provide directions for parents on how to help their children with homework, to enhance traditional posters or reports with multimedia elements, and to provide a quick link for students to comment on online blogs or journals (Center, 2015; Crompton, LaFrance, & Van't Hooft, 2012; Leahy, 2013; Robertson & Green, 2012; Romney, 2010; Siegle, 2015). Of most relevance to this study is the fact that instructors are using QR codes to enhance traditional

textbooks to support comprehension (Fayetteville Independent School District Career & Technical Education, 2012; Stansel, Quintanilla, Zimmerman, & Tyler-Wood, 2015), and to make easy and quick access for young users (DiBlasio, 2016). Publishers have picked up on this new technology and have begun enhancing printed books with QR codes on pages to lead users to online discussion forums, provide links to videos which will better illustrate the text, and to provide additional visuals such as maps that may support comprehension (Cohen, 2012; Ubimark, 2012; Uluyol & Agca, 2012).

Despite the growing use of QR codes by schools, there have been limited studies conducted on their use in schools and none of these studies have involved young children. Hau, et. al, (2013), conducted an analysis of research that was done involving QR codes over a 5-year period and reported that most of the studies were descriptive in nature and relied on self-reports and questionnaires as measures of effectiveness. Chen, Teng, Lee, and Kinshuk's (2011) research with college students using QR codes linked to digital media enhancements and scaffolded questions, indicated distractions when there were multiple QR codes on one page and suggested that one link be provided to several external resources of multiple codes instead. While Rikala and Kankaanranta (2014) and Rikala (2014) reported on their use with secondary students, they claimed student opinions of the technology were all positive, but concluded it was a "novel" experience and that might explain why. While students appeared to be engaged, they did not measure student achievement as a direct result of QR code use. While other studies have investigated the use of smartphones in student learning, none could be found investigating the impact of using QR codes with teacher candidates or elementary students; therefore, there is a great need for the current study.

Another emerging technology, which has received slightly more attention, has been the use of mobile devices in education. Some of the research on mobile devices so far have focused on the impact on student engagement and may shed light on why QR codes may be beneficial for struggling readers. Swan, van'tHoft, Kratcoski, and Unger (2005) reported that students' motivation to learn and engage in learning activities increased as a result of using mobile devices. In addition, teachers in their study reported that it also resulted in increased student productivity and improved quality of work. It was thought that mobile devices (in their case, e-book readers) might be good for reluctant readers because of the way they might enjoy interactions with digital text on a mobile device or computer more so than a traditional book.

2. Methodology

2.1 Research Questions

The authors designed the current study to answer two questions. First, does the process of teacher candidates adapting picture books with QR codes result in significant growth in their comfort level of using technology with students with and without disabilities? Second, what is the impact of adapting a traditional picture book on teacher candidates' knowledge of ways to use QR codes for literacy development and candidates' ability to connect these adaptations to UDL principles.

2.2 Participants

Participants were eight undergraduate sophomores seeking Childhood, Early Childhood, and/or Special Education certification at an urban, private, religiously-affiliated University in the Northeastern United States. Two males and six females, 18 and 19 years old, were part of this study. Seven participants were Caucasian and one was Black. One female participant did not successfully complete the course and therefore withdrew from the study. None of the teacher candidates reported having had experience using QR codes, however all of them claimed to have seen them before, but did not know how they could be utilized. Teacher candidates gave informed consent and agreed to participate in the investigation.

The course, Teaching Literacy in the Elementary School 1 and 2, was a robust, 6-credit course focused on the developing literacy teaching and learning of elementary school-aged children. Class content involved an intensive study of the developmental journey of young literacy learners, theories of language development, and instructional methodologies for the development of comprehension, vocabulary, fluency, word study, and

writing. In addition, the following areas were also addressed: data-based decision making, the UDL framework, culturally relevant pedagogy, evidence-based practices in literacy, and assistive technology. Teacher candidates spent the first five weeks of the literacy methods course on campus with their instructor, twice weekly for three hours and fifteen minutes. As a course requirement, teacher candidates were required to complete a 40-hour field experience in kindergarten and first grade classrooms at an elementary school in a first-ring suburban school district outside a large city.

2.3 Procedure

Before the field experience began, the instructor presented content about UDL using the materials from the IRIS module on UDL (IRIS Center for Training Enhancements, 2009) with an emphasis on the differences between traditional and UDL instruction. The three UDL principles were discussed in depth and the UDL Guidelines: Educator's Checklist (Center for Applied and Special Technologies, 2012) was reviewed. Candidates then used the checklist to evaluate an authentic literacy lesson plan that had been created by the class and candidates offered suggestions where modifications could enhance the implementation of UDL principles.

In the early weeks of their classroom placements, teacher candidates were asked to choose a focus student under the direction of their mentor teacher. The student could have been an English Language Learner, a student with an Individualized Education Plan (IEP), or any struggling or underperforming literacy learner who could benefit from using an enhanced text. Focus students were matched to selected informational or narrative texts (Walker, 2008). Candidates were then provided with step-by-step directions of how to create QR codes to enhance the text and thereby lessen barriers and increase accessibility of the text for that student.

Literacy lesson components (i.e., picture walk or previewing a text, activating prior knowledge, building background knowledge, developing vocabulary, etc.) and text enhancement options were modeled by the instructor with a sample QR code enhanced text. Candidates were guided to think about what they could do before, during, and after reading to support comprehension. In keeping with the UDL guidelines, candidates were prompted to provide multiple means of representation, expression, and engagement through the QR code text enhancements. The instructor modeled how to take before reading procedures and apply them to enhance a text using QR codes. A sample book was shared to demonstrate how QR codes could be used to preview a text, build background knowledge, activate prior knowledge, make predictions, and develop new vocabulary. Figure 1 is an example of a page in the modeled QR code enhanced text, and Figure 2 shows a candidate using her enhanced picture book with her student. The instructor modeled a web-based, interactive game as an after reading activity and then candidates brain stormed other possible activities using technology (movie trailers, videos related to book's content, self-correcting games related to the literacy skills or content of the book). The instructor modeled how to use recording tools for audio recording, and candidates

Figure 1. A Photo of a QR Adapted Picture Book used to Teach Candidates

Figure 2. A Photo of a Teacher Candidate using a QR Enhanced Picture Book with a Targeted Student

utilized this to narrate texts. Candidates explored technological options using recorded audio sound clips of their voices, Google application features (i.e., documents, presentations, etc.), and web-based sites featuring multimodal information and interactive games. Initially selecting books for student interest and reading level, candidates then enhanced each text utilizing QR code technology to support their students.

3. Data Collection

A case-study design was employed to gain an in-depth understanding of the process by which teacher candidates enhanced texts with QR codes (Merriam, 1998, p. 19). Data collected were central to teacher candidates' responses to their experiences with QR code technology and were prepared and organized for analysis. Throughout data collection, a spiraling, recursive analysis supported the development of codes. Given the types of data sources, codes in the database were counted to determine their frequency and themes emerged. A final classification procedure was employed to condense this set of themes for a narrative interpretation (Creswell, 1998; Miles & Huberman, 1994).

3.1 Instrumentation

Data for this study were gathered from a variety of sources. Pre and post test surveys with demographic, open-ended, and Likert scale questions were administered at the beginning and end of the semester. Candidates' final presentations were a Google Docs Presentation of five slides with a template provided by the instructor also served as a data source in addition to a reflective discussion forum focused on what candidates had learned from the experience.

Candidates were asked three open-ended questions on the pre and post tests. They were asked to identify (1) three ways they could use QR codes in the classroom, (2) three ways in which they could adapt a children's book for an exceptional learner, and (3) what they know about UDL. (Appendix shows a sample of the survey questions that were asked). Candidates were also prompted as part of the final class presentation to link their text enhancements to appropriate UDL principles and explain why they chose that text for their student. In addition, candidates were asked to respond to discussion forum questions about the use of QR codes in literacy development. Candidates were prompted to answer what they had learned about using QR codes with literacy development, what types of learners would benefit from QR code text enhancements, what other ways could they use QR codes in the classroom, and was the experience of making the text enhancements worth the time and effort.

4. Data Analysis

This study investigated if having teacher candidates adapt a picture book with QR codes for selected students with exceptional learning needs could result in significant growth in candidates' comfort level of using technology with students with and without disabilities. It also examined how enhancing a text impacted teacher candidates' knowledge of using QR codes for literacy development and how these adaptations met UDL principles.

4.1 Comfort Level using Technology

On the pre and post surveys, candidates were asked to rate how ready they felt using technology in schools with students with and without exceptional learning needs. A dependent or paired sample t-test was utilized to compare the differences from pre to posttest. This statistic is appropriate to use because the scores are independent of one another, the dependent variable was measured on an interval scale, and the differences are normally distributed in the population.

The variable for readiness to use technology in schools, showed no significant difference in the scores from pre ($M = 6.57$, $SD = 2.76$) to post ($M = 8.29$, $SD = 1.70$), $t = -2.121$, $p = .078$). Cohen's d (-0.75) reveals an effect size of -0.35, indicating a small effect. On their readiness to use technology in schools with students with exceptional learning needs, there was a significant difference in the scores from pre ($M = 5.86$, $SD = 2.61$) to post ($M = 7.86$, $SD = 1.46$), $t = -2.763$, $p = .033$. Cohen's d (-0.95) reveals an effect size of -0.43, indicating a small effect. Figure 3 displays the means from pre to posttest for both variables.

4.2 Growth in Knowledge of QR Codes

4.2.1 Using QR Codes in the Classroom

When candidates were asked to identify three ways they

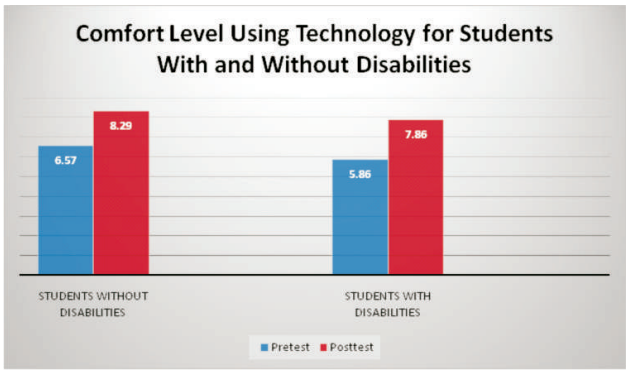

Figure 3. Self-reported Teacher Candidates' Comfort Levels using Technology with Students with and without Disabilities at Pretest and Posttest

could use QR codes in the classroom at pretest, only two responses acknowledged that students could use them when students are working without teacher assistance and/or reading independently. For example, responses included, "Teachers could use QR codes for independent reading in more difficult texts so students can receive assistance in reading books above their reading level without becoming frustrated", and "Teachers can use QR codes to gain more independence and responsibility and teachers do not have to repeat instructions". Only one candidate at pretest mentioned that QR codes could provide audio support for the traditional book. Three candidates erroneously perceived QR codes solely as an assessment tool: for example, they commented that QR codes could be used "to see where students stand in terms of reading and comprehension", "to test children's reading level", and "to understand what level the child is able to read without getting frustrated".

At posttest, all candidates were able to identify three appropriate ways in which QR codes could be used in the classroom. After enhancing the texts, candidates recognized that QR codes can be used to support comprehension in stating they could be "used for unfamiliar vocabulary," "used for activities before and after reading," and "use(d) to build background for a story, ask questions during a story, and for post reading comprehension activities." None of the candidates indicated QR codes could be used to support independent reading events, but two mentioned how in keeping with the principles of UDL, QR codes "could help students to read a book that may be above their reading level," and could "enhance texts for both the struggling and non-struggling reader." The most significant change was number of responses in the area of linking outside sources using QR codes. Candidates articulated that QR codes could be used to "provide activities such as online games and YouTube videos related to the text," "show other media related to the text," "be used for movie clips," and "as a link to a Google doc, as a link to a website that could be used as review, or as a link to a voice recording..." One candidate's response indicated QR codes can be used "to give instructions."

4.3 Adapting a Picture Book

When candidates were asked to name at least three ways in which a picture book could be adapted for an exceptional learner at pretest, two out of eight candidates' responses aligned with comprehension support. They mentioned "doing a picture walk" and that a "teacher could use QR codes in books to give students background information or vocabulary." Only one candidate's response mentioned QR codes and instructional support stating, "Teachers could use QR codes to read along for a child, which will help exceptional learners link the relationship between printed text and spoken language." Other examples of how to adapt a book for an exceptional learner attended more to the physical text itself noting that text could be enlarged for easier reading.

At post test, all but one candidate provided three ways to adapt text for an exceptional learner which included targeted instructional activities for literacy development. One candidate went beyond noting that text could easily be adapted by building background knowledge and developing unfamiliar vocabulary prior to reading by describing how one could, "Add an attachment (Google Doc) that goes over difficult vocabulary and add a YouTube video that relates to the book to activate prior knowledge." Four out of eight candidates described how QR codes could be used to narrate the text. In addition, four candidates noted how QR codes could be used for activities to support comprehension after reading (i.e., "games or activities," "provide supplementary activities (games, YouTube) after reading," and "add a review

activity").

4.4 Knowledge of UDL Principles

Candidates were asked at pre and post test to define UDL. Despite their experience creating text enhancements and the presentations given by their instructor, their definitions were at a rudimentary level and demonstrated minimal change at post test. Candidates' definitions of UDL seemed only to reflect knowledge of one of the three main UDL principles: Principle 1 - Providing Multiple Means of Representation. For example, at pretest one candidate thought UDL was "using different ways to learn in the classroom and having different opportunities for children to learn" and at post test stated UDL is, "different ways to help students learn. Adapting learning for all students in the classroom." Another candidate described UDL at pretest as "making learning/teaching more universally friendly; less black/white, more holistic approach," and at post test, further elaborated, "UDL is learning that is not just auditory centered. UDL also incorporates tactile and visual aspects. It targets different students and how they learn. UDL gives everyone equal opportunity to succeed." At pretest, another candidate thought UDL was about "making necessary adaptations so that all students can learn the material," but at post test demonstrated noticeable change stating that UDL was "using differentiated ways to teach children. Teachers should use more than one part of VAKT (Visual, Auditory, Kinesthetic, and Tactile) for each lesson they teach."

4.4.1 Final Presentations

When candidates were asked to identify which UDL principles were reflected in their text enhancements in their final presentations, they were able to do so readily. In fact, most candidates recognized that their text enhancements met the UDL principle involving presenting information and course content in multiple formats. One candidate recognized UDL's connection to interest by stating "presenting the clip of the trailer before reading was a different way to present information and also stimulated the student's interest in reading the story." Another candidate seemed to understand how the text enhancements could not only provide multiple means of representation, but also allow for multiple means of expression; for example, the candidate used the web-application 'Voice thread' to allow the student to "hear the comprehension questions, and respond to them [orally], instead of writing the answers down."

4.4.2 Discussion Forum Reflections

An online discussion forum on the course management learning system was provided for teacher candidates to reflect on their experiences using QR codes. They were also able to report many ways in which QR codes could be used for literacy development. For example, one candidate reported, "I learned that QR codes can be used for more than just reading a text. I used QR codes to help with activating background knowledge, vocabulary, picture walk, activities after reading like online games, and review questions/answers." Another candidate stated, "I have learned that students are not only motivated to learn using this different method, but it also provides children with background information that they would not have been presented with if they were to read without QR codes."

Even though candidates targeted their enhancements for a student having difficulty accessing the text, they were able to see the benefits for all learners, including those who are skilled readers: "All types of learners can benefit from text enhancements using QR codes. The QR codes help struggling learners to be able to read a book that may be too difficult to read alone. The QR codes can also challenge readers who may be ahead of their classmates by including extra work and more comprehension related activities." One candidate recognized the supportive nature of QR codes by stating that it was a form of "extra scaffolding".

When asked how they could see themselves using QR codes in their teaching in the future, candidates were able to see extensions in other content areas. One candidate stated, "They could be used in math to go to a link where the teacher shows the students step by step how to solve problems," while another candidate saw a possible application in science or social studies: "I would add QR codes for extra help and in science/social studies to attach media that relates to what we are studying." Another saw the potential to be used for "review sessions and giving the students extra help and assistance and [therefore] more

confidence," while yet another candidate recognized that they could be used "at different centers to give students instructions both visually with worksheets, and with an auditory narration with the QR code." All teacher candidates reported that the process of enhancing picture books with the QR codes was worth the time and effort and was beneficial to their selected student.

5. Limitations

The authors would like to acknowledge the limitations of this study. First, this case study had only eight participants and a control group for these purposes was not possible. In addition, no data on student comprehension or engagement with the text and the QR codes were able to be collected. Since it was the first time the instructor used QR codes for text enhancements, creativity was encouraged and candidates were not prompted to adapt the books in all three of the UDL networks. If they had been, candidates may have shown knowledge of the other two networks. Another limitation was the fact that the books were enhanced for primary students in kindergarten and first grade. Candidates may have focused on enhancing texts for readability given the developmental levels of the students and missed opportunities to have the students respond to texts. This would have given teacher candidates experience with providing multiple means of action, expression, and engagement. The length and targeted reading levels of the texts may have also limited opportunities for candidates to create enhancements following the UDL guidelines. For example, the UDL guidelines of increasing mastery-oriented feedback and developing self-assessment and reflection may be difficult to do with primary reading level texts, but with more sophisticated texts, this may come more naturally.

6. Discussion

It was hoped that teacher candidates' comfort level using technology would be significantly different for both students with and without disabilities after making the text enhancements to the picture books with the QR codes. The fact that candidates only grew significantly more comfortable in using technology with students with special needs was surprising yet promising. Candidates may not have been confident in their knowledge of using technology with students with disabilities at the pretest, as it was their first field experience in the program and most had little or no experience with students with disabilities. After adapting the picture book with QR codes, candidates reported feeling more confident in using technology with these students in the future. This is important since research has indicated that teachers are more likely to use technology when they believe it will help their students and are comfortable doing so (Jones, 2001; Mayo, Kajs & Tonguma, 2005; Miranda & Russell, 2012; Velasquez-Bryant, 2003).

As expected, at post test candidates were able to identify a greater number of ways in which QR codes could be used in a classroom, and their descriptions were more accurate and sophisticated than they were at pretest. At pretest when asked how they would adapt a children's book for an exceptional learner, only two candidates were able to identify ways in which QR codes could be used and the rest of the candidates' adaptations were limited to enlarging font size. However, at post test, candidates were able to identify that QR codes could be used to narrate the text and that it could also be used for both before and after reading activities. Furthermore, they were able to describe how this could be accomplished with this technology. Their responses, including the use of Google docs and YouTube as enhancements, demonstrates that they recognized the potential of these technologies as a comprehension support rather than just a read aloud support.

It was surprising that candidates did not grow substantially in their ability to define UDL despite the attention paid towards these principles in course instruction and the assignment. Previous research has indicated that candidates have grown in the ability to adapt lesson plans using UDL principles with minimal training (Spooner, Baker, Harris, Ahlgrim-Delzell, & Browder, 2007); however, in the current study, even with practice adapting instructional materials and learning out the UDL framework, candidates were unable to provide a complete and sophisticated definition of UDL at the end of the course. While it was clear that they understood the relevance of the text enhancements to the UDL network involving multiple means of representation, they failed to mention the other two networks at all (Multiple

Means of Action & Expression and Multiple Means of Engagement) in their survey answers. It was concluded that, this occurred due to the assignment's natural fit with the particular UDL principle of providing multiple means of representation and the fact that candidates were not prompted to address all three. This was also likely due to the fact that candidates were focused on adapting a children's book with QR codes for only one of their students. Essentially, what they were doing was differentiating instructions instead of planning ahead using an UDL framework. If they were enhancing the text for an entire class of learners, candidates may have not only been focused on making the text accessible, but also on ways in which they could have addressed the barriers for different learners regarding goals, methods, and assessments.

As candidates enhanced texts for individual students, they did not focus on all of the learners that could access a book which may have limited their thinking about providing additional ways for the student to interact with the text. Their responses focused on how multi-modalities were related to UDL and that is probably due to the fact that they completed a module on UDL which included this information (The IRIS Center for Training Enhancements, 2009). While candidates were able to adapt a book, which is the goal of this study, they were not able to fully explain the principles behind it. Does this mean they would not be able to implement it in the future or does it simply indicate they need to hear it spoken about multiple times before they can articulate it in a sophisticated way? The unintended focus of the text enhancements was on making the text accessible rather than addressing all of the UDL networks. This could explain why many of their definitions lacked attention to action and expression and engagement and why in their final presentations they only identified principles that fell under the network of Multiple Means of Representation.

Recent investigations of the use of QR codes in education have primarily focused on practical ways to support instruction; however, none of the studies to date investigated their use by teacher candidates or young children. While research using QR codes to support comprehension was found, it was limited to enhancing traditional textbooks for older, rather than younger, learners. This research sheds new light on the possibilities that QR codes have for text enhancement and for use with primary-aged children and its utility as a tool in teacher preparation programs. Future research needs to be done in this area to examine the academic and engagement impact of using QR codes specifically on young learners so that recommendations for practice can be shared. In addition, future research should continue to look at teacher candidates' knowledge and skill utilizing UDL principles to increase outcomes for students.

7. Recommendations for Teacher Education

The authors present the following recommendations based on their work with teacher candidates and the use of QR codes to enhance picture books. Modeling the process of creating QR codes and recording audio was more effective than simply providing written directions and explaining them orally. To better align with the Common Core Learning Standards, candidates should also be encouraged to use informational texts rather than mainly narrative texts. An additional benefit of enhancing informational text is that candidates would have greater awareness of the content area curriculum. Instead of enhancing a text for an individual student, it may be more beneficial to have candidates enhance a text for the entire class. This may help provide a focus on planning for a group of diverse learners instead of for individual students since this is the overarching goal of UDL. Although teacher candidates were comfortable using UDL in practice, they were not able to identify the specific principles when asked to define it. Therefore, teacher educators may want to provide increased opportunities for candidates to articulate the framework and principles of UDL so they are more likely to transfer these principles across future practice. Takamae (2015) reported that when candidates were exposed to UDL in multiple ways throughout their teacher education program, they were able to demonstrate complex understanding of the UDL framework. Teacher educators need to work together to determine the minimum amount of exposure to UDL that will lead to changes in instruction and assessment as well as continue to identify course assignments and experiences

that lead to UDL practices being implemented by classroom teachers.

Conclusion

As the principles of UDL are an integral component of many professional teaching standards, teacher educators need to ensure that candidates have a strong knowledge of the principles and are able to apply them in their classrooms. Having candidates make text enhancements with QR codes is just one form of technology that teacher educators can use to demonstrate the principles of UDL. Teacher educators should continue to experiment with other forms of technology (i.e. Livescribe pens, iPads, tablets, etc.) to determine new and effective ways to provide candidates with rich experiences in reaching all learners. As this research demonstrates, having candidates use technology impacts their comfort level positively and therefore, may increase the likelihood that they will use technology to meet the needs of all learners. Researchers should take advantage of the common use of QR codes right now and investigate how this technology can best help students at all levels. As future research is conducted on the impact of QR codes and other assistive technologies, it is imperative that teacher education incorporate those practices into their programs ensuring that candidates have the confidence to use these tools effectively to meet the needs of all students.

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Appendix

Pre and Post Survey for Teacher Candidates

Enhancing Children's Texts With QR Codes

Four-digit code (Last four digits of social security number):

_____

(Used for tracking purposes from pre to posttest only.)

1. Name at least three ways that you could use a QR code in the classroom:
2. Name at least 3 ways in which you could adapt a children's book for an exceptional learner:
3. Can you explain what Universal Design for Learning (UDL) is?
4. Using the scale below, rate how ready you feel to use technology in schools with children:

   Unprepared Somewhat Prepared Totally Prepared

   1 2 3 4 5 6 7 8 9 10
5. On a scale of 1 to 10, rate how ready you feel you are to use technology in schools with children with exceptional learning needs:

   Unprepared Somewhat Prepared Totally Prepared

   1 2 3 4 5 6 7 8 9 10
6. Which characteristic best describe your high school setting:

   _____ Urban public high school (non-charter)

   _____ Urban charter high school

   _____ Suburban or rural public high school

   _____Urban private high school (non-religious affiliation)

   _____Urban private high school (religiously affiliated)

   _____Suburban/rural private school (non-religious affiliation)

   _____Suburban/rural private school (religiously affiliated)

   _____ Home schooled/Distance Learning

   _____Other
7. What is your certification area?

   _____Childhood Education only

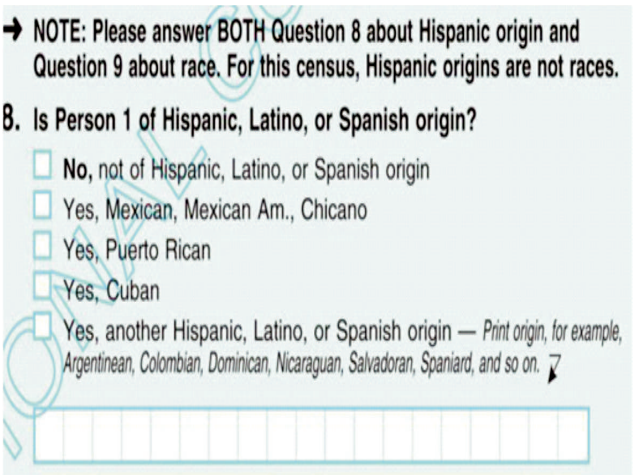
_____ Early Childhood Education only

_____ Early Childhood and Childhood Education

_____ Special Education/Childhood Education

_____ Special Education / Early Childhood Education

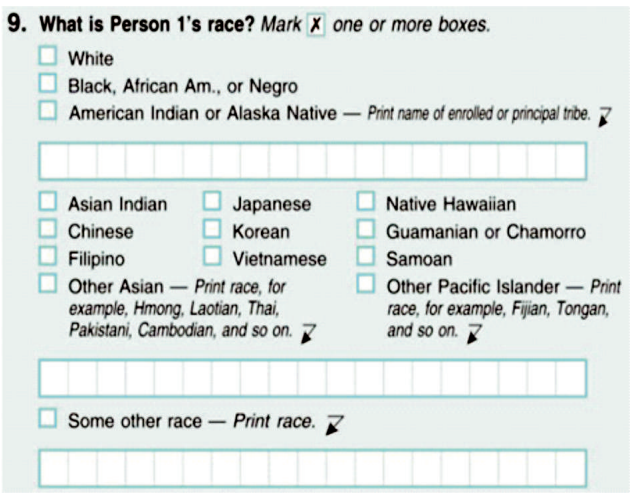
_____ Other (Please explain in the space below)



➜ NOTE: Please answer BOTH Question 8 about Hispanic origin and Question 9 about race. For this census, Hispanic origins are not races.

8. Is Person 1 of Hispanic, Latino, or Spanish origin?

- No, not of Hispanic, Latino, or Spanish origin
- Yes, Mexican, Mexican Am., Chicano
- Yes, Puerto Rican
- Yes, Cuban
- Yes, another Hispanic, Latino, or Spanish origin — *Print origin, for example, Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.*



9. What is Person 1's race? *Mark ✗ one or more boxes.*

- White
- Black, African Am., or Negro
- American Indian or Alaska Native — *Print name of enrolled or principal tribe.*
- Asian Indian
- Japanese
- Native Hawaiian
- Chinese
- Korean
- Guamanian or Chamorro
- Filipino
- Vietnamese
- Samoan
- Other Asian — *Print race, for example, Hmong, Laotian, Thai, Pakistani, Cambodian, and so on.*
- Other Pacific Islander — *Print race, for example, Fijian, Tongan, and so on.*
- Some other race — *Print race.*

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