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Promoting Interface and Knowledge Sharing: A Joint Project between General and Special Education Preservice Teachers

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Introduction

The American public schools are more diverse than ever. According to The Condition of Education 2011 report by U.S. Department of Education, about 95 percent of children ages 6-21 who were served under the Individual with Disabilities Education Act (IDEA) were enrolled in regular schools in 2008-09. Over 58 percent of these students spent most of their school day in general classes, compared to 33 percent in 1990-91. Besides students with disabilities, classrooms also consist of students not formally diagnosed with disabilities but nonetheless have special needs and students who are culturally and linguistically diverse.

One important approach to reaching diverse learners is through teacher collaboration in various forms. Co-teaching has been promoted as best practice and a viable service delivery model for inclusive education (Anderson, 2008). Effective teachers engage in ongoing professional dialogues and reflect on their practices through participating in learning communities rather than isolating themselves from their peers (Andrews & Lewis, 2002; Darling-Hammond & Richardson, 2009; Hudson & Glomb, 1997; O'Shea, Williams, & Sattler, 1999). Collaboration allows teachers to learn from their own and others' practices (Darling-Hammond, 2006).

Teacher preparation programs can play a vital role in promoting the importance of collaborative teaching and provide training in these skills for preservice teachers. Collaboration between general and special education teachers is essential to the success of Individual Education Plans (IEP). In teacher education programs, faculty can help preservice teachers gain knowledge in collaboration by modeling coteaching and creating opportunities for preservice teachers to share knowledge and expertise (Winn & Blanton, 2005).

In reality, many teacher preparation programs are characterized by departmentalization and inflexibility. For example, there is a lack of cross-pollination of students in teacher preparation courses that imped the development of interdisciplinary dialogues that help teacher candidates to explore and decide on effective practices for all learners (Kennedy, 1998). Specific collaboration preparation is lacking, especially in decision making and problem solving for special needs learners (Dynak, Whitten, & Dynak, 1997; Little & Robinson, 1997). In typical general education teacher certification programs, the only training or experience preservice teachers have regarding students with disabilities is found in one initial course in special education, which does not

adequately prepare them for the reality of inclusion (Shade & Stewart, 2001). The short exposure to diverse student population and special educators also does not allow general education preservice teachers to have sufficient time to understand the role of collaboration in inclusion, which further perpetuates the segregation between general and special education in PK-12 schools (Winn & Blanton, 2005).

As schools move to greater degrees of diversity and inclusion, it is important that teacher educators actively explore ways to promote greater interface between general and special education preservice teachers and to expand their capacity to teach all learners (Pugach & Blanton, 2009). One viable solution is to provide both general and special education preservice teachers with opportunities to engage in collaboratively planning and designing lessons for all students through collaborative joint course projects.

This paper reports the findings of a joint project involving two cohorts of preservice teachers enrolled in a Master's degree special education teacher education program and a Bachelor's degree curriculum and instruction general teacher education program at a private university. Prior to the study, the cohorts were registered for the courses taught by two faculty members from each of the programs respectively. One course was "*Assistive Technology*" and the other "*Methods for Teaching Elementary Mathematics*". The instructor of the former course was the author of the paper. The two instructors co-planned the joint project with a view to investigate its role in supporting the preservice teachers' understanding of how to create lessons for diverse classes and appreciation for the value of collaboration across the two disciplines.

Both courses lasted for 10 weeks according to the quarter system at the university. The two cohorts of preservice teachers were randomly divided into eleven teams. All teams consisted of two members, each from one of the cohorts, except for one team that had three members with two of them from the general education cohort and one from the special education cohort.

In the joint project, the preservice teachers worked collaboratively to critique and revise an existing math unit plan assigned to them. Their task was to revise the plan through the lens of Universal Design for Learning (UDL) principles, use of visual resources and technology to ensure the unit plans were accessible and appropriately challenging for all learners, especially students with disabilities and other special needs.

Specifically, the study was designed to address three questions:

1. What common affordances does this joint project have for the general and special education preservice teachers?

2. What unique affordances does this joint project have for each of the preservice cohorts?
3. What do the preservice teachers learn about the use of visuals, technology, and UDL principles to create accessible math lessons for all students?

Theoretical Frameworks

Good teacher education programs provide candidates as authentic a context for learning as possible through meaningful instructional and assessment activities (Darling-Hammond, 2006). The joint project was designed as a potentially authentic context to expand the preservice teachers' knowledge in teaching diverse learners. The project was grounded in the instructional activities centered on the role of visuals and technology in providing differentiated instruction and UDL in designing math lessons taught in both courses. The project also served as a way to assess the preservice teachers' understanding of the above-mentioned strategies and the importance of teacher collaboration.

The classrooms new teachers enter are increasingly diverse in terms of student demographics and abilities. To support the needs of all students, schools are placing a greater emphasis on inclusive practices that frequently require collaboration between general and special education teachers (Friend, 2008). General and special education teachers need to have collaborative skills necessary for them to discuss students' needs, problem solve, identify and implement adaptive teaching strategies and accommodations to reach all learners.

Collaboration is defined as a "style professionals select to employ based on mutual goals; parity; shared responsibility for key decisions; shared accountability for outcomes; shared resources; and the development of trust, respect, and a sense of community" (Friend & Cook, 1990, 2010, as cited in Cook & Friend, 2010, p. 3). Effective collaboration is a critical aspect of inclusive teaching that incorporates differentiated instruction and appropriate support to individual learners, especially students with disabilities in the general education curriculum (Baker & Zigmond, 1995). Collaboration between teachers has also been shown to be a feature of effective schools (Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010). Co-teaching, which is a specific service delivery model dependent on teacher collaboration, has become widely adopted by schools as a viable approach to ensure adequate support for all students (Hepner & Newman, 2010). Research shows that coteaching has benefits for both students with learning disabilities and general education students, in the areas of academic performance, social skills, and strengthened classroom community. For teachers,

coteaching leads to their professional and personal growth (Walther-Thomas, 1997). When teachers work collaboratively, they can learn from one another and continue to develop shared knowledge to meet a wide range of diverse learner needs (Darling-Hammond, 2006).

However, the structure of teacher training programs has not been well-poised to equip new teachers with strong collaborative skills as few courses on collaboration are offered or modeled in university coursework (Goddard, Goddard, & Tschannen-Moran, 2007). To remedy this situation, university coursework can design experiences that allow for preservice teachers to engage in "deliberate practice" related to professional collaboration (Erickson, 2002). When preservice teachers engage in collaborative projects, they are given opportunities to enact on and experiment with collaboration, albeit in a low-pressure context of university courses, so that they can begin to develop better understanding of what is involved in skillful teacher collaborations (Grossman, Compton, Igra, Ronfeldt, Shahan, & Williamson, 2009).

In this project, the preservice teachers were familiarized with UDL principles and ways to actualize UDL, particularly through differentiated instruction, integration of visual materials and technology. While utilizing effective differentiated instruction methods (Tomlinson, 2000), Built on the premise that learner variability is the norm, not the exception. UDL is a comprehensive and proactive approach to designing the whole curriculum through anticipation of learner needs and collaborative problem-solving on adaptive instructional features from the inception of the design process (Erlandson, 2002; Rose, Hasselbring, Stahl, and Zabala, 2009). UDL recognizes the educational value and active role of technology as tools for increasing curriculum accessibility for all learners (Edyburn, 2010; King-Sears, 2009). To maximize inclusion, assistive technology and UDL work complementarily like two sides of the same coin and advances in one approach can maximize the benefit of the other approach (Rose, Hasselbring, Stahl, & Zabala, 2005). Without certain technologies, a learning environment cannot expect to achieve its full accessibility potential. Without applying the UDL principles, technologies may not be considered and used in the most optimal and barrier-free environment.

UDL curriculum embraces rich learning goals and achievement standards supported by a variety of strategies, technologies, resources, activities, and assessments in order to meet the needs of diverse learners (Johnston, Beard, & Carpenter, 2006; Rose & Meyer, 2002). Central to the framework is the shared vision that general and special education teachers have a key role to play in constructing inclusive learning environments for all students through multiple means of knowledge presentation, engagement in learning and action, and

expression (CAST, 2012; Wu, 2010). These three principles contain useful guidelines and checkpoints that support teachers in their selection of lesson goals, methods, assessments, and materials adaptive and accessible to all learners (Hall, Strangman, & Meyer, 2009).

Children are exposed to visual images early in schools where they view illustrations in books, recognize patterns and shapes in math problems, and create artistic drawings to accompany their writings. Visual literacy as a unique form of literacy is an important skill that involves "seeing and at the same time integrating other sensory experiences" (Debes, 1969) and discerning important features in the forms of objects, actions and symbols that help communicate meaning to the viewer (Vasquez, Comer, & Troutma, 2010). Visual literacy helps students learn content area knowledge through critical examination of visual sources as well as written texts as essential modes of accessing information, but also uses visual study aids to facilitate students making sense of the content and communicating learning (Wu, 2006). In this study, we ask the preservice teachers to pay attention to the role of visual materials in math lessons (photos, drawings, objects, etc.) as a way to help students become more sensitive to and intrigued by math concepts. Viewing of visual images is an active process, in which the learner attends to and extracts meaning from images (Begoray, 2001). When visual images pertaining to the content are integrated in lessons, they should be used for active viewing and analyzing aimed to increase comprehension.

A key ingredient for successful implementations of UDL-based lessons is collaboration between general and special teachers which leads to the sharing of expertise in content, pedagogy, knowledge about disabilities and special needs, technology integration, and subject-specific methods of teaching (Marino, Sameshima, and Beecher, 2009).

Modes of Inquiry

The study is qualitative in nature as the focus is on "examining and interpreting data in order to elicit meaning, gain understanding, and develop empirical knowledge" (Corbin & Strauss, 2007). In other words, the study hopes to understand *what* can result from such a collaborative project. The author is interested in the unfolding of the collaborative process and knowledge construction among the general and special education preservice teachers.

Before and during the 10-week course project, the two instructors collaborated on setting goals and mapping out plans for the joint project via

weekly meetings and online conversations. The two instructors, like the cohorts of preservice teachers, were based in two different campuses of the university.

Procedure

The preservice teachers were provided with detailed instructions for completing the project, including guiding questions for considering visuals and technologies in the unit plans, a universal design for learning barrier analysis form, project evaluation rubric, and questions for reflection about the collaborative project. All project-related documents were made available to the preservice teachers both in hard copy and on the Wikispaces course site that was built for the special education course but also accessible to the preservice teachers in the general teacher education course.

From the beginning, the preservice teachers knew that this joint course project was designed to help them to: a) practice the important professional skill of collaboration, b) expand capacity to teach diverse learners, and c) apply technological, pedagogical, and content knowledge in math instruction, as well as universal design for learning principles.

Both cohorts had exposure to content related to use of visuals in teaching, including visual primary sources from the Library of Congress (LOC) digital archive. In the joint project, the preservice teachers revised the unit plans through meaningful integration of the Library resources, assistive and instructional technology, and other methods conducive to universal design for learning.

Since these two cohorts took courses on different campuses, it was impractical logistically to schedule face-to-face meeting times for the project teams. Instead, each course instructor spent time in the first two class sessions teaching the preservice teachers how to use the Wikispaces course site to access and post project-related documents, as well as communicate with their team members during the collaborative project. These skills were reviewed as needed during the term.

The instructor/researcher from the special education program gave an initial survey to the preservice teachers enrolled in her class to gather background information, such as their teaching experiences and previous training in technology. The survey revealed that only three out of the 10 preservice teacher participants in this course (Total N=11) who completed the survey had some experience teaching in regular schools or classrooms that were not self-contained. The rest of the preservice teachers taught in therapeutic day schools or self-

contained classrooms. At least half of them taught students with autism, multiple learning disabilities, or emotional disabilities. Although four of the preservice teachers held previous teaching certificates, the results of the initial survey indicates they had little to none experience teaching in regular schools or classrooms, which suggests that they possibly had little experience collaborating with general education teachers. Besides the survey, the researcher mentioned collaboration tips, particularly regarding the need to take initiatives to communicate with team members during the collaboration project and use of Wikispaces discussion threads to exchange information on a timely basis. Otherwise, the preservice teachers did not have explicit instruction on collaboration in these two courses.

Data Sources

In order to address the above-mentioned research questions, the author collected and analyzed two types of data: project narratives and the revised math unit plans. Project narratives consisted of the preservice teachers' written responses to "Guiding Questions for Considering Visuals and Technologies", the filled-out "UDL Barrier Analysis" form (CAST, 2012), and the their reflections on different aspects of the project, such as the collaborative process, universal design, and the use of technology and visuals to differentiate the unit lessons for all learners.

The author compared the preservice teachers' written narratives as mentioned above both within and across teams. The author read these documents repeatedly, asking questions and comparing them for similarities and differences as a way of "open coding" according to the grounded theory (Corbin & Strauss, 2007). The kind of data analysis was aimed at first identifying the preservice teachers' voices and then emergent patterns related to the research questions (Eisenhart, 2006).

The author also examined the final unit plans and evidences of each team's ongoing efforts to communicate with each other as recorded through threaded discussion on the Wikispaces website. For example, member postings in each team's discussion room served as a gauge of the level of communication between the members of each team. This data source, along with the final unit plans, provided triangulation with the preservice teachers' reflection narratives on collaboration and other aspects of their learning through the project (Lichtman, 2009).

Results/Discussion

Overall, this unique between-class project which allowed two cohorts of perservice teachers to collaborate has been a positive experience for all. It resulted in greater commitment and higher-quality work. At the end of the project, the preservice teachers expressed satisfaction with their revised unit plans and a sense of accomplishment in light of what they had learned and the efforts they put in to make the collaboration successful. The team members used track changes in Word to co-edit the unit plans and posted drafts of plans on the Wikispaces for each other. They also worked together on other parts of the project: the answers to the questions posed in the required guiding questions sheet, the UDL barrier analysis form, and their reflection narratives. In the words of one of the preservice teachers, the project was not the "cookie-cutter projects" he was accustomed to in the teacher education program. The following section discusses the findings for the three research questions in more detail.

Common Affordances

The first question posed in the study addresses the common affordances this joint class project has for the general and special education preservice teachers. The results of the study suggest that the cross-course project had a positive impact on both groups of preservice teachers in the following areas: collaboration, technology, and use of visuals in math lessons.

Collaboration.

The joint unit lesson critique project in this study allowed the preservice teachers to practice and understand the importance of professional collaboration. All teams except for the one comprised of three members, worked successfully together. It was interesting to note that the successful teams put both members' names as editors of the final unit plans and referred to themselves as "*we*" instead of "*I*" in the reflective narratives, suggesting shared ownership of and responsibility for the revised lesson plans.

Their reflections indicated that this project helped them see teacher collaboration as shared activity beyond simple addition of each other's expertise. They also learned potential roadblocks to successful collaboration, and the importance of making time for such collaboration. Overall, they felt that the collaborations went smoothly and was a worthwhile experience for them in spite

of some initial difficulties, such as not having an opportunity to meet with their partners and relying solely on the use of technologies to communicate with each other.

Data analysis further revealed that the key to the successful collaborations was to maintain a two-way communication throughout the project. The members of teams that worked truly as collaborative partners set out with a plan to build a shared understanding of all aspects of the project, including its goals, requirements, and various ways to maintain ongoing communication. The members took initiatives to contact each other as soon as possible and ironed out any barriers to collaboration. For example, one member from the special education cohort offered to support her general education partner with detailed information on how to get started with the Wikispaces website to access the discussion and chat functions as well as the required documents for the project.

To maintain ongoing communication, the teams used the Wikispaces website as the main platform for communication. Both a threaded discussion room and a Gabby Chat widget were available for asynchronous or synchronous discussions on the Wikispaces course site. The preservice teachers thought it was critical that they had access to Wikispaces to exchange drafts of the work for their team members to view. In practice, the successful teams did not rely on any single tool or media for their shared work. Instead, they used a variety of means to exchange information, including Wikispaces, Gabby Chat widget, and personal email.

Through this project, many preservice teachers realized that collaboration entailed a great time commitment and involved back-and-forth discussions about the topic at hand, compromises, equal contribution from each partner, and mutual respect for each other's expertise. This project provided the preservice teachers from two different departments an interface so that they could experience the nature of teacher collaboration and learn from each other in the process of developing satisfactory unit plans for all students. Below are reflections by two preservice teachers on collaboration:

> Completing this project has made me realize that it is important to have ongoing communication with other professionals. As my partner has experience with Special Education, I have benefits dealing with other aspects and it's important to talk with one another (General education preservice teacher).
>
> … So it is important to approach projects like this with patience, understanding, and willingness to compromise. In truth, if I had completed this project by myself, I may have done some things differently,

> and I may have felt more comfortable at times. But would I have learned as much without Jennifer? Would I have been as proud of the final result? I don't think so. I definitely think this is a project that should be offered to future classes.

Technology.

Instructional technology can be a great tool for leveling the playing field in education. It has the potential to differentiate and personalize instruction for all learners (Watson & Watson, 2011). For example, technology can represent mathematical concepts in different ways, making them more concrete and meaningful to all students. Technology can also provide support for students who have processing difficulties, for example, those with memory difficulties or whose fine motor skills make writing problems and drawing diagrams difficult. Technology can allow for more flexible ways for teachers to represent knowledge, for students to engage in learning process, and to express what they learn. The interactive features inherent in many technologies address a social function as well, and can help students learn from each other, thus becoming more motivated in their work. (Murray, Silver-Pacuilla, & Helsel, 2007).

Many graduates of teacher preparation programs feel inadequately prepared to utilize technology to support students with special needs, which implies that teacher education programs need to be more strategic about providing this kind of instruction (Abner & Lahm, 2002; Bausch & Hasselbring, 2004; Bouck et al., 2006; Edyburn, 2000).

In the between-class project, the preservice teachers were required to consider the role and appropriate use of technology as they revised the math lesson plans. To make the plans more inclusive to all learners, the preservice teachers were asked to use the instructor-created guiding questions and the UDL analysis form—a thinking device focusing on a range of potential learning needs of students and barriers they might encounter if the existing lesson plans were implemented. The guiding questions sheet included questions such as "what roles did technology play in the existing lesson plans?" "What technologies did you add to the existing unit plan and for what purposes? In what ways might the chosen technologies enhance learning by students with various levels of performances?" These documents guided the preservice teachers' efforts to revise the unit plans by focusing on how to use technology to anticipate barriers in curriculum and provide universally designed learning environment for all learners via multiple means of representation, multiple means of action and expression, and multiple means of engagement—the three basic premises of UDL.

The collaborative project allowed the preservice service teachers from both cohorts to develop a better awareness of and appreciation for the role technology could play in differentiating instruction for diverse learners. The preservice teachers made collaborative decisions about how to integrate a variety of instructional and assistive technologies in the final lesson plans, including: low-tech assistive technologies such as adapted paper for math work (bold line, raised line, enlarged spacing, and graph paper) instead of isometric paper, virtual manipulatives from the Internet (e.g., geoboard and congruent triangles), LCD projector to show visuals, and concept mapping software such as Inspiration and Kidspiration.

Notably, the preservice teachers emphasized that they chose technologies that could serve the two-fold purposes of providing learning support and a universally designed environment for the widest range of learners, and accommodating individual learners with disabilities. Their decisions about technologies were guided by elements and questions in the UDL barrier analysis form that helped the preservice teachers anticipate and remove all potential barriers against learners in the lessons. The two excerpts below from the reflective narratives by two special education preservice teachers illustrated their decision-making regarding the use of technologies in the lesson plans:

> I had to add a variety of assistive technology tools and hands-on materials to be appropriate for teaching students that have special needs. The use of technology might enhance the learning by students at various levels of performance by providing students with the appropriate tools they can adapt to easily and learn material from.
>
> We added the use of virtual manipulatives to help teach the characteristics of plane shapes, parallel lines, and congruency to the students. These programs could be beneficial for all students. We also included the use of the Geometer's Sketchpad software as another means of learning and practicing these concepts.

Visuals in mathematics.

In both courses, the preservice teachers were introduced to the concept of visual literacy and the use of images to create universally designed lessons. One source of visuals that could be tapped into was the visual primary sources from the digital archive on the Library of Congress website. The final unit plans developed by the preservice teachers showed that visuals played a great part and

served a variety of purposes in the unit lesson plans. The table below illustrates the use of visuals in the final lessons.

Table 1

Visuals used in the unit plans

Examples of Visuals/Images Used (Photos or real objects)	**Unit Focus**	**Use in the Lessons**
A photo of a door; A photo of chocolate	Concept of fractions	- Identify equal parts - Prompt questions: Is this picture divided into equal parts? Are these pieces equal fractions of the whole? - Is this picture divided into equal parts? Are these pieces equal fractions of the whole? - Using your chip markers, cover 1/10. Cover 2/10. Cover 3/10. Using your chip markers, cover one half of this picture.
A photo of teepee from an Indian tribe; A colored picture of geometric shapes	Geometry Symmetry	- Does anyone know what is in the picture?... Well, Indians lived in Teepees, which they would build themselves. Look at this picture. What geometric shape does it look similar to? - Name objects and show students a diverse collection of the geometric shapes –get students thinking in terms of real-life, not just in terms of geometric shapes being completely separate from the outside world - Identify different polygon figures in the photos
Primary source photos of architecture from the Library of Congress	Plane figures and their characteristics	- Name objects in the photos that fit into the shapes categories (e.g., triangle, rectangle, square, circle, hexagon, trapezoid, oval, etc.) - Analyze visual images and discover the characteristics of each plane shape
Primary source photos of scenes from different periods of time (from 19th to 20th century)	Graphing, creating timelines	- Help students understand what time line is and how they are used to represent information over time

By considering visual materials and strategic use of them in the unit plans, the preservice teachers learned to appreciate various functions visuals can serve to support learning, such as making real-life connection with mathematics, activate background knowledge, grabbing students' attention at the outset of the lessons, and allowing all students to participate in the learning process. Below are excerpts from two teams' reflections on using visuals in the lesson plans:

> Both the two-dimensional shapes and the teepee will enhance comprehension of the geometry lessons with which they are linked among students whose capacity for abstract thinking is still emerging.
>
> Use of visual elements, particularly given the abstract nature of geometry, greatly enhances the comprehension of students who are more visually oriented than verbal-linguistic oriented. Use of visual elements also enhances comprehension for students with processing deficits, particularly younger students whose capacity for abstract thinking is not yet well developed.

The teams also collaborated on the application of the universal design for learning principles to ensure that the visuals were accessible to all students, including those with disabilities. For example, some teams revised the lessons by incorporating enlarged images, software programs to help visually impaired students to maximize the size of the materials, and high-quality photos that benefited every student in the class. The project not only allowed the preservice teachers to develop a better understanding of how visuals could be used as a teaching strategy in math lessons, but also how they could be used in ways that were universally accessible to all learners.

Unique affordances

The second research question addresses the unique affordances the joint project has for the two groups of preservice teachers, particularly in their broadened perspectives on how to plan for instruction for all students in the classroom. Through the collaborations, the general and special education preservice teachers shared their expertise areas unique to their background and training, which resulted in unique learning outcomes for each group.

Affordances for the Special Education Preservice Teachers.

This joint project was helpful to the special education preservice teachers in developing more confidence and skills related to technology, content, and pedagogy in math instruction. Some special education preservice teachers reported that this project helped them to be more focused on all students' needs in planning for instruction and to see their responsibilities as beyond accommodating the special needs students in their case load. They realized that they could also play an active role attending to the needs of other students without disabilities.

Others felt that this project allowed them to be more comfortable with teaching the content area of math.

> After reading the lesson plan, I was a bit worried about applying the concepts learned in class because of my limited knowledge of the topic and my limited teaching experience However, the revision my partner prepared gave me a better insight and helped me analyze the unit from a different angle.

> I enjoyed critiquing our math unit, even though it was primarily the responsibility of my partner (I did post my "initial" evaluation of the unit). As it turns out I've become almost obsessed with the art of teaching math since being assigned to teach in a self-contained classroom. Math has always been my weak subject, and I've have been working to improve my math teaching skills. Hence, I was in equal measure pleased and intimidated to learn that our final project would be a math unit. I actually gained some helpful tips from the unit itself.

This project also allowed the special education preservice teachers to develop a new appreciation for the continuum of assistive technologies ranging from low-tech to high-tech, and that low-tech could be as valuable as high-tech computer-based learning tools in math lessons. The following reflection from a special education preservice teacher illustrates this point:

> In addition to ZoomText for our visually impaired student, we also would incorporate that often overlooked piece semi-high technology, the overhead projector, which would serve a function similar to that of ZoomText for "offline" work… I was reminded while contemplating the materials list in our lesson plans that some of the best tools for accommodating different styles of learning are the most humble – yarn, cloth, popsicle sticks, buttons. These are tactile, versatile, familiar artifacts. These are artifacts that help keep a student grounded in the familiar world he or she knows while being acclimated to the sometimes daunting world of the computer and the Internet

In addition, the preservice teachers in special education also were able to reinforce their knowledge in differentiating lessons for students with disabilities by examining an existing unit plan, identifying the potential barriers, and making changes to the plan to make it more inclusive to students with special needs. This has been a worthwhile preparation for their future teaching responsibilities. For example, one special education preservice teacher reflected:

> Some of the curriculum barriers against students with potential special needs throughout the five day lesson plan my partner and I were faced with was the fact that some of the lessons seemed too challenging for students to learn new material when the lesson did not express any reviews or activities to get an understanding of students background knowledge on the topic being discussed. The lessons were written out for students fit for a general education classroom and did not seem to have alternatives for students that had special needs. The lessons had to be altered in order to include the appropriate modifications necessary to help educate students that had different learning abilities.

Affordances for the General Education Preservice Teachers.

For the general education preservice teachers, one of the most unique affordances this collaborative project has was a better understanding of assistive technology and its use in supporting diverse learners in differentiation lessons. As there was little exposure to assistive technology content in course work, let alone related course projects like this one, the general education preservice teachers reported that they learned a great deal about assistive technology devices and programs that could help all students to be successful in school. Many preservice teachers in the general education cohort said this was the first time they became aware that there was so many different assistive technologies as well as websites that they could use to assist students with special needs.

Another affordance this joint project had on the general education preservice teachers was the growing knowledge about meaningful integration of technology, as shown by the following reflections:

> Through this experience I learned technology integration is not all about using technology just to use technology but to have technology serve a purpose in the learning environment. I have learned that printing picture images for the Library of Congress may be helpful for some students, but for those students with visual impairments images may still need to be described to them verbally. I've learned even with the use of technology a teacher will still have to do much talking, describing, and offering tactile clues for those students with visual impairments.

> I learned that when creating curriculum/lessons that meet the needs of diverse learners, advanced planning is essential for the lesson to be beneficial for all students. I have learned that too much excitement can distract some students from the learning experience. Some students can

> feel overwhelmed by all the new concepts. I have also learned that the teacher needs to talk aloud everything she/he is doing, drawing, writing, and showing to the class loud and clear so all students can be successful.

As illustrated by the above accounts, this project has enabled the general education preservice teachers to know more about differentiated instruction. They have developed a greater appreciation for using technologies and visuals to make lessons more appealing to different types of learners.

In addition, as a result of the project, many general education preservice teachers reported that they ended up loving math and the teaching profession more than before.

> In terms of math, I learned that I truly love the subject and would love to take these experiences to teach math someday. I had always wanted to teach Language Arts, but I have since changed my mind and added math as my second concentration.

Another important affordance of this collaborative project was that it helped the general education preservice teachers come to a realization that special education was relevant for them as future general education teachers and they also had a very active role to play in educating students with special needs in the general education classroom:

> I originally thought that special education students would have a teacher assistant for additional help or I would possibly make my worksheets vary for students that require additional help. Through this experience I have learned that I need to plan for breaks during my lesson for those students who cannot stay focused for long periods of time. I need to say aloud in a clear and concise voice everything that I write or draw on the chalkboard or overhead transparencies.

What do the preservice teachers learn about designing UDL-based math lesson accessible to diverse learners?

The joint project required the preservice teachers to apply the UDL principles in their revision of the unit plans and reflect on lessons learned about universal design for learning. Specifically, they employed the UDL barrier analysis form (CAST, 2012) as a guide to revise the unit plans.

Below is an example of a filled-out UDL analysis table:

Table 2

UDL Analysis Form—An Example

Characteristics & Special Needs of Students Considered	**Materials & Methods**	**Potential Barriers/Missed Opportunities**	**UDL Solutions**
Attention Deficit/Hyperactivity Disorder	Students may hang their own pictures on the timeline; Lesson is segmented to reduce restlessness and maintain student focus.	Students with ADHD may struggle to remain focused through entire lesson.	Succession of short-term activities allows students to take breaks in between. Curriculum provides multiple means of expression, representation, and engagement.
Learning disabilities	Overhead projector worksheets from various internet sites Access to internet sites for online work Textbook glossary for vocabulary words	Too much was covered within one weekly unit. If the unit had been strictly on geometric shapes and not perimeter and area, then the concepts of geometry and geometric shapes would have been solidified with the use of additional methods and materials.	Use websites with simple shapes for geometric understanding. Use words with pictures programs for instructions and/or worksheets. Project actual worksheets on an overhead projector while using a pointer/erasable marker on a surface that can be manipulated during instruction.

The UDL barrier analysis form allowed the preservice teachers to approach the diverse needs of a classroom by addressing three aspects of teaching:

- Characteristics and special needs of students considered
    - Think of a typical diverse classroom that has students with various needs and strengths; Think about how these characteristics can

influence the building of curriculum and revision of this existing curriculum

- Materials and methods
  - Examine the existing materials (including visual and technology) and methods; How do they enhance a differentiated curriculum? What changes or adjustments are needed to improve the clarity and effectiveness in the use of the materials and methods?
- Potential barriers/missed opportunities
  - Related to materials and methods, examine potential barriers and missed learning opportunities this current unit poses for diverse learners
- UDL solutions
  - Propose your UDL-based solutions and give examples

The UDL principles provided the preservice teachers with guidelines on how to structure their math lessons and incorporate technology and visual methods for multiple means of representation, engagement, and expression in the lesson plans. In their reflections, the preservice teachers pointed out the importance of UDL in creating optimal lessons and learning environment for all students:

> The educational goals, methods and materials incorporated in the UDL principles are designed to enable all individuals to gain different skills by increasing the quality of learning and reducing barriers in the curriculum. It is extremely important to maintain high achievement standards, throughout the implementation of such principles, in order to avoid watering down the curriculum. The revised lesson plan incorporates some of these principles. In particular, the third unit's original material was supported by pictures that I thought were confusing for diverse learners. I believed that the substitution of some of them with more visually-friendly ones, would help students with disabilities (such as those with ADD and/or auditory/visual impairment) as well as learners without disabilities. Also, the integration of the unit with technology tools was another example of UDL applications. The software recommended would be especially beneficial to students who have ADD and those with auditory disabilities because it presents a visual representation of the fraction and offers immediate feedback that the answer is correct or not.
>
> I believe that utilizing universal design necessitates differentiated instruction. This unit could not be strictly lecture. Multiple types of content must be used, such as visual presentations, internet worksheets, and visual-oriented paper worksheets. Although lecture may be used, it

should be intertwined with the use of the overhead projector and photographs of real life forms. Product varied from class participation to completed worksheets. All these tools enhanced knowledge transfer.

Through applying UDL principles, the preservice teachers gained a deeper understanding of the varieties of needs within any classroom. Both the general and special education preservice teachers learned the importance of anticipating all students' needs at the outset of the lesson planning process in order to create lessons that are beneficial to learners with different kinds of learning styles, whether it is kinesthetic, auditory, or visual, and with different abilities and disabilities.

Conclusion

Overall, the joint project in the study yielded positive results for the general and special education preservice teachers in terms of their understanding of how to incorporate UDL, technology, and visuals to teach math concepts in ways that were accessible to all learners. This study suggests potential benefits for creating a greater interface between general and special education preservice teachers within a teacher preparation program. The joint class project described in the study could be a model worth replicating by other higher education faculty who desire to overcome the inflexible departmental structures and to create collaborative learning opportunities across departments for general and special education preservice teachers.

The study has implications for building greater flexibility in teacher education programs so that preservice teachers have more opportunities to engage in collective problem-solving and collaborative dialogues that mirror the demand of PK12 school settings. Interestingly, the study's finding concerning the need for better coordination of time and schedule as a contributor to successful collaboration was the reflection of what real teachers experience when engaged in collaborative teaching (Murawski and Dieker, 2004). The earlier the preservice teachers have an opportunity to identify potential obstacles to effective collaboration through projects such as the joint project in the study, the more likely they become more prepared and resourceful in dealing with related problems in their future teaching.

In addition, this study found that technology integration and use of more visual materials allowed the preservice teachers to realize that there were many ways to reach out to diverse learners through designing UDL-based lesson plans.

This study has limitations. Some members felt that they would have benefited from knowing their partners before launching the collaboration. A face-to-face meeting at the beginning of the course would have been very helpful but it was not practical due to the distance between the two campuses where the two cohorts took their courses. This constraint posed some barriers for the preservice teachers initially in the collaboration process. But in the end, the teams said they learned to rely on a variety of technologies (emails, Wikispaces, and phone calls) to communicate with each other.

More training of how to use Wikispaces would also have helped. As one preservice teacher said in his reflections, "I did eventually figure it out, and now I feel more computer savvy than I felt ten weeks ago. I felt a similar rush (or more accurately, tricklet) of satisfaction in figuring out how to create a link from one Wickispaces page to another Wickispaces page.

The project would also have had a higher level of authenticity had the preservice teachers had an opportunity to implement the lesson plans with real students.

Methodologically, the study could be improved by using pre- and post-surveys to provide both qualitative and quantitative look at the results concerning the preservice teachers' perceptions about and knowledge gained in technology, visuals, and UDL. Selected interviews would be another great tool for further investigating the preservice teachers' views on the impact of the project.

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