

Promoting “Science for All” Through Teacher Candidate Collaboration and Community Engagement

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Abstract

The Next Generation Science Standards present a bold vision for meaningful, quality science experiences for all students. Yet students with disabilities continue to underperform on standardized assessments while persons with disabilities remain underrepresented in science fields. Paramount among the factors contributing to this disparity is that science teachers are underprepared to teach students with disabilities while special education teachers are similarly ill-prepared to teach science. This situation creates a pedagogical and moral dilemma of placing teachers in classrooms without ample preparation, thereby guaranteeing attitudinal and practical barriers. To address this challenge, the authors of this manuscript developed a novel project in which, through voluntary participation, members of Ohio University’s National Science Teachers Association student chapter co-planned and co-taught inclusive science lessons with members of the university’s Student Council for Exceptional Children at the Ohio Valley Museum of Discovery, a local hands-on discovery museum. This manuscript describes the motivation for, methods, and findings from the project, as well as recommendations for other programs wishing to implement a similar model.

Introduction

The *Next Generation Science Standards* present a bold vision for equitable and excellent science opportunities through a call for “All Standards, All Students” (Next Generation Science Standards [NGSS] Lead States, 2013, Appendix D). Following in the footsteps of the earlier “Science for All” efforts, the NGSS articulate a range of supports for marginalized groups in science, including students with disabilities. For those of us who have worked on issues of science equity and accessibility throughout our careers, it seems implausible that profound educational disparities and attitudinal barriers persist in the 21st Century. Yet despite decades of work on inclusive science research and practice, persons with disabilities continue to be underrepresented in science careers while students with disabilities underperform on science assessments (National Assessment of Educational Progress [NAEP], National Center for Education Statistics [NCES], 2011; National Science Foundation [NSF], 2013). Paramount among the factors contributing to this disparity is that science teachers are underprepared to teach students with disabilities in their classrooms, while special education teachers are similarly ill-prepared to teach science (Irving, Nti, & Johnson, 2007; Kahn & Lewis, 2014). An obvious solution is to have science and special educators co-

teach in the classroom, yet research suggests that without preparation and experience in such models, teachers face tremendous obstacles including lack of co-planning time, challenges with establishing roles and responsibilities, and simply lack of familiarity with discipline-specific accommodations (Moin, Magiera, & Zigmund, 2009). This situation creates a pedagogical and, as we believe, a moral dilemma of placing teachers in classrooms without ample preparation, a set-up for attitudinal and practical barriers.

We were therefore interested in developing flexible opportunities for science teacher candidates to interact and co-teach with special education candidates in an effort to provide meaningful experiences for all of our students, contribute to the research base in inclusive science teacher education, and support our greater community. To that end, we developed an Inclusive Science Day during which members of our Ohio University National Science Teachers Association (OU-NSTA) student chapter co-planned and co-taught inclusive science lessons with student members of our Student Council for Exceptional Children (SCEC) at the Ohio Valley Museum of Discovery (OVMoD), a local hands-on discovery museum. In doing so, our candidates learned about inclusive science practices, experienced co-planning, budgeting, and delivering science activities for a diverse audience, gained appreciation for the benefits of informal science community partnerships, and learned about themselves as future teachers of all students. This manuscript describes the motivation for, methods, and findings from our project, as well as recommendations for other programs wishing to implement a similar model.

Theoretical and School Context

Teacher Preparation and Science for Students with Disabilities

The Individuals with Disabilities Education Act, later reauthorized as the IDEIA (2004), guarantees a free appropriate public education in the least restrictive environment. For the more than 6 million students in American schools identified as having disabilities, this means that they are guaranteed opportunities for learning commensurate with their abilities across subjects, including science. While most science teachers at all levels will teach students with disabilities in their classrooms, most receive little formal education in inclusive science practices. In their nationwide survey of 1088 science teachers, Kahn and Lewis (2014) found that, while 99% of the participants had taught students with disabilities during their careers, nearly one-third had not received any training on the subject and of those who had “on the job training” was cited as the most prominent context for learning. Similarly, special education teachers receive little training in science education (Patton, Palloway, & Cronin, 1990), leaving them to frequently be marginalized in inclusive science settings, with science teachers taking the lead. It is perhaps, therefore, not surprising that students with disabilities underperform on standardized science assessments and are underrepresented in science fields. Without the benefit of teachers who have been adequately prepared to develop accessible lessons using inclusive pedagogical approaches, students with disabilities will continue to be underserved in the sciences.

Although science and special education are often characterized as representing different philosophical stances (McGinnis & Kahn, 2014), contemporary frameworks like Universal Design for Learning (UDL; Meyer, Rose, & Gordon, 2015) can mediate these differences by capitalizing on the abilities and acknowledging the challenges of all students, thereby creating a cohesive approach to ensuring access for the greatest number of learners. We hypothesized that allowing candidates to co-plan and co-teach UDL activities would provide them with the unique opportunity to discover each other's strengths, assess their own weaknesses, and become exposed to different perspectives. As in most teacher education programs, however, these opportunities were scant for our candidates due to the structural requirements of their different programs of study and teaching placements. It seemed that a less formal opportunity was needed to explore possible benefits and challenges of collaborative inclusive programming. We decided to turn to the OVMoD for assistance.

Informal Science Learning

Informal science learning spaces, such as museums, zoos, aquaria, botanical gardens, provide unique opportunities for contextualized science learning for their visitors (Bell, Lewenstein, Shouse, & Feder, 2009). By providing materials and exhibits that are not otherwise readily accessible, allowing for open, unstructured discovery, and welcoming learners of all ages and backgrounds, these spaces offer incomparable resources to their surrounding communities (Fenichel & Schweingruber, 2010). Informal science learning spaces also provide powerful contexts for learning, not only for visitors but also for teacher candidates (Duran, Ballone-Duran, Haney, & Beltyukova, 2009). By providing candidates with teaching opportunities in such spaces, candidates learn to “think on their feet” as they are met by learners about whom they have no prior information, and must therefore anticipate challenges and respond quickly. They are also exposed to visitors representing a variety of ages, backgrounds, and abilities, thus necessitating a true “science for all” attitude and approach (McGinnis, Hestness, Riedinger, Katz, Marbach-Ad, & Dai A., 2012). Finally, bringing teacher candidates to informal science learning spaces allows them to learn about and serve their community, and of course, allows the community to become better acquainted with the programs and services available through the university, thereby promoting symbiotic learning opportunities (Bevan et al., 2010).

Our Programs

The Patton College of Education at Ohio University serves approximately 1600 undergraduate and 900 graduate students and uses a clinical model for teacher preparation, thus ensuring extensive in-school opportunities for students beginning in their sophomore year and benefitting from close relationships with partner schools (National Council for Accreditation of Teacher Education, 2010). Within our Department of Teacher Education, undergraduate and masters students can select from a wide swath of science teaching majors leading to certification in middle and secondary science areas. In addition, we have a thriving early childhood program that includes courses in both preschool and elementary

science methods. Likewise, our nationally-recognized special education program leads to multiple graduate and undergraduate licensures. Undergraduate licensures include programming for intervention specialists seeking degrees to work with students with mild-to-moderate or moderate-to-intensive educational needs.

As vigorous and comprehensive as our programs are, teacher candidates from science education and special education interact infrequently during school hours due to their divergent course and placement requirements. Fortunately, our college supports (both philosophically and financially) our professional organization student chapters which afford opportunities for flexible collaboration. Our Ohio University National Science Teachers Association (OU-NSTA) student chapter welcomes all students with an interest in science teaching and learning. This chapter experienced a renaissance recently with regular meetings, numerous fundraising activities, learning opportunities including attendance at a regional NSTA conference, and a concerted commitment to service learning in our community. This chapter currently has approximately 25 members representing both undergraduate and graduate programs, although most are undergraduate secondary (middle and high school) science education majors. Our Student Council for Exceptional Children (SCEC) boasts a large, consistent membership of approximately 35 to 40 teacher candidates who meet regularly, assist with functions held by the local developmental disabilities programs, and provide fundraising support for members of the community with disabilities as well as schools in need of resources for serving students with disabilities. This organization enjoys the leadership of a long-term and beloved advisor who has developed the group through many years of mentoring and modeling. In addition to our college of education, our university's center for community engagement provides small grants for service learning projects. We were fortunate to receive funding for our Inclusive Science Day project to cover the cost of training materials used with our teacher candidates, consumables for science activities, and refreshments. In addition, this grant provided funds for two of our students to attend a regional NSTA conference early in the year at which they interviewed various leaders in the science education community as well as publishers and science education suppliers about their inclusive science materials. This experience was eye-opening for our students, who presented their findings at subsequent group meetings, as it set the stage for our Inclusive Science Day planning.

The Intervention: Inclusive Science Day

In order to determine the potential for an Inclusive Science Day at an informal learning space, the OU-NSTA advisor raised the idea with a colleague from the College of Education, who is also on the board of the OVMoD to discuss possibilities. The colleague indicated that the museum had made concerted efforts to reach out to visitors with all abilities through use of universally-designed displays and a "sensory-friendly" day; she was completely open to the idea of having teacher candidates plan and teach at the museum but would need to discuss the idea with the museum's executive director and other board members. The OU-

NSTA advisor then met with the SCEC advisor, who was equally enthusiastic about the prospect of collaboration. Both the OU-NSTA and SCEC advisors then presented the idea to their respective executive board members who were highly receptive. Concurrently, the OU-NSTA advisor participated in an 8-week course on service learning offered by the university's center for community engagement in order to better understand the dynamics of collaborative endeavors with community entities and to consider in depth both the potential learning opportunities for the teacher candidates and the service opportunities for the museum. While it might have been possible for this project to come to fruition without that training, the advisor felt that it undoubtedly prepared her for the potential benefits and challenges. Once all parties embraced Inclusive Science Day, the two advisors began to plan the training and research.

Planning and Orientation

One of the most daunting tasks was simply identifying a day/time that students could meet for an orientation and training. As this was a voluntary endeavor, we knew that we would need to ensure that our meetings were highly efficient, focused, and would inspire our teacher candidates to collaborate on their own time to ensure availability and convenience. Once we had an announced orientation time, the two advisors met to plan the training. We determined that the 2 1/2-hour evening training would include the following agenda:

- Welcome, Refreshments, and Survey Invitation
- Why Inclusive Science Day? and “Can You Name This Scientist?”
- Collaborative Hands-on Simulation Activity (“Helicopters”) and Debriefing UDL
- Lesson Planning and Budgeting Activities
- Next Steps!

As we had decided to conduct research on teacher candidates' experiences and attitudes regarding inclusive science practice, we applied for and received IRB approval for a pre and post survey that was distributed anonymously online at the orientation (pre) and after the Inclusive Science Day (post). Students were recruited for the Inclusive Science Day and associated research via e-invitations sent to organization membership lists in advance of the orientation. Because of our desire to avoid exerting pressure on students to participate in either the research or project, we did not require students to RSVP. We were very pleased to see that 18 students attended the training (ten special education and eight science education, including one elementary science methods student). When the students arrived at the orientation, they created nametags, had the opportunity to complete the survey online, and enjoyed pizza. We then distributed students among five tables so that at least one special education candidate was at each table. After introductions, we engaged in a brief brainstorming challenge to identify why inclusive science education might be important. Candidates actively identified reasons including:

“There aren’t enough scientists with disabilities in the field.”

“Science is part of every child’s life and body.”

“You can teach science through different in different ways (e.g., visual, tactile, kinesthetic, etc...).”

“Knowing about science is important for everyone!”

“We need to know how to teach all students.”

We added three others to the list that students did not mention:

- Science benefits from having all students contribute to its advancement.
- There is a moral imperative for all students to have the opportunity to experience science.
- Science is beautiful!

We then engaged in a “Can You Name This Scientist?” game in which candidates viewed pictures of famous scientists with disabilities and were asked to identify them. Scientists included Alexander Graham Bell (Dyslexia), Thomas Edison (Hearing Impairment and Dyslexia), Temple Grandin (Autism), Geerat Vermeij (Visual Impairment), Jack Horner (Dyslexia), and Stephen Hawking (Motor Neuron Disease), among others. Most of our candidates were unaware that such accomplished scientists also had disabilities and that their disabilities, in some cases, may have enhanced the scientists’ interests and abilities in their fields. For example, Geerat Vermeij, a world-renowned paleobiologist attributes his nuanced abilities in identifying mollusks to his ability to feel and attend to distinctions in shells that sighted scientists might overlook (Vermeij, 1997). We were excited to see our students’ interests so piqued after this activity.

We then introduced the Universal Design for Learning (UDL; Meyer, Rose, & Gordon, 2014) framework, which allows teachers to develop lessons that meet the needs of the most number of learners thereby reducing the need for specific disability accommodations. The three principles of UDL are: 1) Multiple Means of Engagement (How students access the lesson or materials); 2) Multiple Means of Representation (How teachers present the material to the students); and 3) Multiple Means of Action and Expression (How students interact with the materials and show what they know). To help teacher candidates to better understand the potential barriers that students with disabilities might have in science class, we co-led a science activity in which students followed written directions for making and testing paper helicopters while assigning students equipment that helped them to simulate various disabilities. For example, some students received handouts that had scrambled letters to simulate Dyslexia, while others wore glasses that limited their vision. In addition, some students wore earplugs to simulate hearing impairments while others listened to conversations on headphones to simulate psychiatric disorders. Finally, some students had

tape placed around adjacent fingers to simulate fine motor impairments, while others utilized crutches or wheel chairs. Students progressed through this activity for several minutes and then discussed their challenges as a class. We chose the helicopter activity because it required reading, cutting with scissors, throwing and observing the helicopters, and retrieving them; thus, this activity required a variety of intellectual and physical skills. We found that our students were quite impacted by this activity, as many indicated that they had never really thought about the perspective of students with these disabilities. In particular, the student who utilized a wheelchair said that she had never realized how much space was needed to accommodate the wheelchair easily during an active investigation. This led the group to discuss the need for us to set up our tables at the museum with sufficient space for all visitors to comfortably traverse the museum. Of course, we were careful to remind students that this type of simulation cannot accurately represent the true nature and complexity of anyone's experiences, and that people with disabilities, like all individuals, develop adaptations for addressing challenges. However, this brief experience prompted our students to think about how they could redesign the lesson to ensure that as many students as possible could access it without specific accommodations.

We then informed the groups that they were each to develop plans for two activities that would be presented at the Inclusive Science Day. Based on discussions with museum administrators, we decided that having several "make and take" activities was desirable, in part because it allowed the learning to continue at home, but also because our university is in a very rural, high poverty region thus making these types of materials a particularly welcome benefit for many families (United States Census Bureau, 2014). Together, we reviewed the lesson plan document which was less formal than our typical lesson plan document (due to the informal nature of the museum activity stations format) but nevertheless, had specific learning outcomes, considerations for diversity (including gender, socioeconomic status, English language proficiency, and ability), and a budget (See Figure 1 for a Sample Lesson; a blank lesson plan template is available for download at the end of this article in supplemental materials). We then informed teams that, thanks to the grant we had received, they had \$50 to spend on their two lessons and that they should anticipate approximately 50 visitors to their tables (based on prior museum visitation counts). Teacher candidates then used their laptops and various resource books we provided to identify activities and develop materials lists with prices. We decided the easiest way to ensure that all materials would be received in time, and to avoid dealing with reimbursements and other financial complexities was to have students submit their final budget sheets to us during the week following the orientation. We would then order all the materials using one account and notify students once the materials were received. Students were responsible for bringing in "freebie" materials such as newspaper, aluminum cans, matches, etc. Once materials were received, student groups came to the central storage room at their convenience to check and prepare their materials in ample time for the program. We also encouraged students to create table signs for display at the Inclusive Science Day. They did this on their own time as well. Some of the activities that students developed were:

- Fingerprint Detectives
- Creating a Galaxy in a Jar
- Chemical Reactions in a Pan (using baking soda and vinegar mixed with food coloring)
- Exploring Static Electricity with Balloons
- Egg Drop
- Making and Testing Kazoos
- Blobs in a Bottle (with vegetable oil and Alka-Seltzer tablets)
- Inflate a Balloon Using Chemistry

Figure 1 (Click on image to enlarge). Sample lesson plan for “Inflate a Balloon Using Chemistry.”

Science Day Lesson Plan Template	
Names of Instructors:	
Science Theme for Center:	Balloon: Inflate a balloon using a neutralization reaction
Standards(s):	Students conduct experiments to find the optimal mixture ratio of baking soda and vinegar, to inflate the balloon to the fullest without popping. Students will explain their experiment process to justify their choice.
Procedures: Number steps used to facilitate activity. Include list of questions. Make instruction generic to all age groups can participate	1. Wear safety precaution - o Goggles - o Lab coat/apron 2. Start experiment by putting measured amount of vinegar into test tubes - o Record the amount of vinegar you used for each trial 3. Transfer specific amount of baking soda into the balloon - o Record the amount of baking soda used for each trial 4. Wrap the mouth of the balloon to the mouth of the test tube - o Pin the mouth of the balloon to seal tight 5. Lift the bottom of the balloon, so the baking soda drop into the test tube - o Pin the mouth of the balloon to seal tight 6. Once the size of balloon remains constant, record the size of the balloon 7. Repeat the experiment with different amount of vinegar and baking soda - o Document the ratio of vinegar and baking soda for each trial and size of the balloon 8. Record the most efficient ratio of vinegar and baking soda that gave the balloon the biggest size - o Which trial gave the biggest balloon but used less baking soda and vinegar? 9. Justify your answer with data collected from this experiment - o If you have knowledge of stoichiometry and limiting reagent, show calculation

Science Day Lesson Plan Template		
Considerations for Diversity: Address how you are providing appropriate considerations for the following areas of diversity within your session:		
Gender:	Color of the balloon varies, students can choose their preferred color(s) for this experiment.	
English / language Proficiency:	Visual demonstration is performed to guide students through this experiment.	
Socioeconomic Status:	All materials are provided for this activity.	
Accommodations/Modifications (e.g. Visual requirements, Hearing requirements, Learning Disabilities, etc.):	- Visual impairments: instructors verbalize the procedure and introduce the equipment and materials using auditory or tactile stimulus. visually impaired (students) is tactile and visual - Hearing impairments: instructor helps students visualize the procedure and equipment and visual responses - Learning disabilities: instructor use diagram guide students through this experiment and for step - Other impairments: use test tubes of different sizes, large funnels for mixing, test tube racks for stability - Glasses provided for students with sensory processing differences	
Learning modalities:	This experiment uses visual demonstration, verbalization of the procedure, immediate movement in each station, and uses tactile senses to evaluate the procedure and data collected from this experiment.	
Materials:	Listed below	
Technology (Use, not right):	No technology is implemented in this lab.	
Materials and Budget		
Materials Needed	Source	Cost
25 test tubes (100 volumes)	Amazon	\$0.40
4 pairs of goggles	Amazon	\$15.00
1 test tube rack	Amazon	\$0.40
100 mL gloves	Amazon	\$0.70
1 gallon vinegar	Amazon	\$0.70
2 pack baking soda	Amazon	\$3.00
100 balloons (different colors)	Amazon	\$3.00
3 aprons	Home provide	Free
Total Cost: \$45.70 (from Amazon)		

In addition to identifying activities that engaged different senses, our students thought about how to meet a variety of learners' needs. For example, magnifiers and large ink stamp pads would be available at the fingerprint station for all students, while the “Blobs in a Bottle” activity station had alternative “jelly balls” that could be felt by visitors who couldn't see the vegetable oil “blobs.” The kazoo station, which used toilet paper tubes, waxed paper, and rubber bands, allowed visitors who could not hear to feel the movement of the waxed paper when the kazoos were played. The station also had adaptive scissors and pre-cut waxed paper for visitors needing fine motor skill support. The UDL considerations and accommodations provided for each activity are contained in Table 1 below.

Table 1 (Click on image to enlarge)

UDL Considerations and Accommodations for Accessibility on Inclusive Science Day

Activity Name	UDL Considerations and Accommodations for Accessibility
Fingerprint Detectives	Visual and verbal directions, illuminated magnifiers for low vision, readers (blue acetate overlays for visitors with Dyslexia), enlarged pictures of fingerprint types, scaffolded directions, large ink stamp pads and stampers available, Wikki Stix (wax-covered string) for making tactile fingerprints.
Creating a Galaxy in a Jar	Modeling for visitors, hand-over-hand guidance, wide-mouthed jars available, gloves for visitors with sensory processing differences, magnifier.
Chemical Reactions in a Pan (using baking soda and vinegar mixed with food coloring)	Small and large pipettes (turkey baster can be used for large), no-spill ice cube trays used for vinegar food coloring, large shallow pans, pre-poured baking soda, gloves for visitors with sensory processing differences.
Exploring Static Electricity with Balloons	Written, pictorial, and verbal instructions, modeling for visitors, unlabeled time activity, buddy system, "Most Knowledgeable Other" (MKEO), use different learning modalities (e.g., visual, kinesthetic, auditory).
Egg Drop	Written, pictorial, and verbal instructions, use of small group talk, large tape dispensers, adaptive scissors, varying heights of drop, providing materials of varied shapes, sizes, and tactile qualities.
Making and Testing Kazoos	Pre-cut waxed paper available, options for creating holes (e.g., hole puncher, pen cap, pencil), hand-over-hand guidance, use of different sized rubber bands for fastening, different learning modalities (e.g., tactile, visual, auditory, etc.).
Blobs in a Bottle (with vegetable oil and Alka-Seltzer tablets)	Written, pictorial, and verbal instructions, modeling for visitors, magnifiers, use of tactile "jelly balls" for visitors with visual impairments.
Inflate a Balloon Using Chemistry	Test tubes of varied sizes, large funnels for pouring, test tube racks for stability, gloves for visitors with sensory processing differences, results (balloon inflations) are visual and tactile.

The Day of the Event

The Inclusive Science Day was announced by the museum on social media, through our local schools, and through the local newspaper. The museum generously waived their admission fee for the day in order to encourage attendance as well. On the day of the program, students were asked to arrive two hours in advance to set up their stations. We provided lunch to ensure that we had time to speak to the group about the importance of the work they were about to do, and to allow the museum staff to convey any final instructions to the students. When the doors were opened, we were thrilled to see large numbers of families entering the museum space. Over the two hours that our program ran, the museum estimated that we had over 150 visitors, approximately three times their expected attendance. The attendance was so good that some of our student groups needed to send "runners" out to purchase additional materials; our "Galaxy in a Jar" group even began using recycled bottles from our lunch to meet the demands at their table. Safety was a consideration at all times. Goggles were made available at all tables with splash potential, and safety scissors were used at stations with cutting requirements. In addition, our students (and we) wore our clubs' T-shirts so that visitors could easily identify instructors. Each activity table had at least one science education and one special education candidate co-teaching. We supervised the students by assisting in crowd control, helping to ensure that visitors could easily navigate through the rather limited museum space, obtaining written permissions for photos from parents/caregivers, and responding to candidate questions. Some photos from the day are shown in Figures 2-4.

Figure 2 (Click on image to enlarge). "Blobs in a Bottle" activity demonstrating density and polarity of water and oil. Tactile "jelly balls" and magnifiers were available for visitors with visual impairments.



Figure 3 (Click on image to enlarge). “Chemical Reactions in a Pan” activity using baking soda, vinegar, and food coloring. Varied sizes of pipettes and pans were available to address diversity in visitors’ fine motor skills.



Figure 4 (Click on image to enlarge). “Exploring Sound with Kazoos” activity. Visitors were encouraged to use their senses of vision, touch, and hearing to test the instruments.



Research Findings/Project Evaluation

Overall, our teacher candidates found this project to be highly meaningful and helpful for their professional learning. Perhaps one of the most important themes that emerged from our evaluative research was that science and special education candidates welcomed the opportunity to collaborate as none of them had reported having opportunities to do so in the past. Some of the student post-activity responses included the following:

“[Inclusive Science Day] allowed me to gain more experience and to really learn what it is like to teach students who have disabilities. I also was able to see how students with different disabilities reacted to the same activity. I found that those students who had a disability found a different way to cope with their disability than we had thought they would.”

“I saw how different general education and special education teacher think. There were many differences to our approaches to creating the lesson.”

“I really liked that I was able to consult with the special education teachers if I was unsure of how to help a student with disabilities.”

“I had a great time sharing my content knowledge of science with those whose specialty is special education. Conversely, I had a great time learning from experts in special education and I really enjoyed seeing them be so in their comfort zone when we did have kids with exceptionalities. I envy their comfort levels and it makes me want to reach that level of comfort.”

“We were well prepared for any differentiation that would have needed to be done. And we all learned from each other.”

“I feel this was an awesome experience. The people I worked with really added something to our experiments that I otherwise may not have thought about.”

Challenges cited by our students included feeling a bit overwhelmed by the number of visitors at each station, not having knowledge about the visitors' backgrounds in advance, and difficulties in maintaining visitors' focus on the science content. We found one student's reflection to be quite sophisticated in its recognition of the need for more training on inclusive science:

"I still feel that I would like more professional development when it comes to leading science activities for students with disabilities. I had an experience with a wonderful young man and I felt very challenged because I don't feel comfortable enough to gauge what I should be allowing him to do on his own and at the same time I didn't want to hinder him from reaching his full potential. So, I feel like further professional development in that area is needed for me."

Qualitative analysis of candidate pre and post responses resulted in themes that included: 1) candidates' assessment of collaboration as a powerful professional development opportunity; 2) identification of different perspectives between science and special education candidates; 3) a common desire to do good work by making accessible for all students; 4) recognition of informal learning spaces as viable teaching venues; and; 4) a strong need for more training and opportunities to teach science to students with disabilities. Our findings support earlier research suggesting that teacher candidates are inclined toward inclusive practices (McGinnis, 2003) and that opportunities for collaboration with special education candidates enhance their comfort level in co-planning and co-teaching (Moorehead & Grillo, 2013). Our teacher candidates' expressions of the depth of impact this professional development experience had on them makes sense when considered in light of Kahn and Lewis' (2014) study which suggested that teachers' experience with *any* students with disabilities increased their feelings of preparedness toward working with *all* students with disabilities. In addition, our findings reinforce studies suggesting that informal learning spaces can provide unique and flexible learning opportunities for teacher candidates, particularly in that they provided multiple opportunities to teach the same lesson repeatedly, thus allowing for reflection and revision (Jung & Tonso, 2006). Perhaps most importantly, this study underscores the desire for and efficacy of increased training and experience in implementing inclusive science practices during teachers' pre-service educations.

Future Plans and Conclusion

Based on the feedback from the teacher candidates and the museum, we are planning to make Inclusive Science Day an annual event. However, we are considering several changes for future projects including:

- Multiple training evenings for teacher candidates
- Pre-registration for Inclusive Science Day so that we can anticipate attendance size and specific needs of visitors

- Creating a “Quiet Zone” area at the museum for visitors who would benefit from a less bustling environment
- Identifying additional sources of funding for consumable materials
- Greater outreach to our early childhood teacher candidates to encourage participation

As students with disabilities are increasingly included in science classrooms, it is incumbent of teacher education programs to ensure that their science teacher candidates acquire the tools and the dispositions for teaching all learners. While more formal approaches, such as dual licensure programs and co-teaching internship placements are on the horizon for many programs, teacher education programs should not overlook the power of extracurricular events, informal learning spaces, and student organizations to provide important professional development opportunities for teacher candidates, pilots for new program development, and occasions to both serve and learn from the community.

Supplemental Files

[Lesson-Plan-Template.docx](#)

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