PROJECT REPORT

Pre-Service Teachers' Acquisition of Content Knowledge, Pedagogical Skills, and Professional Dispositions through Service Learning

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Abstract

Teacher candidates seeking a K-6 license took a science methods course during which they participated in focused service learning. Candidates were provided the necessary science content instruction to enable them to write the actual event activities and serve as Event Leaders for the regional Science Olympiad competition. Data related to candidate acquisition of content knowledge, pedagogical skills, and professional dispositions were gathered from candidates' responses to written reflections and standardized surveys. It was concluded that through their practical and engaged work participants learned science content and gained pedagogical skills necessary for teaching science. Further, candidates gained desirable professional dispositions related to such civic engagement elements as developing sustainable partnerships, engaging in mutually beneficial work, and serving a diversity of students.

Introduction

The University of North Carolina Asheville

The University of North Carolina Asheville (UNC Asheville) opened in 1927 as Buncombe County Junior College. The school underwent several name changes, mergers with local governments and school systems, and moves before relocating in 1961 to the present campus.

Asheville-Biltmore College joined the UNC system in 1969 as UNC Asheville, with the distinct mission to offer an excellent undergraduate liberal arts education.

UNC Asheville is the only designated undergraduate liberal arts university in the 17-campus UNC system. UNC Asheville is a public State Institution of Higher Education and is classified as a Baccalaureate College of Arts and Sciences by the Carnegie Classification system. UNC Asheville is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools. The university has received national recognition for its Humanities and Undergraduate Research programs. *U.S. News & World Report* ranks UNC Asheville as one of the top five public liberal arts colleges in its America's Best Colleges edition and lists the Undergraduate Research Program among "Programs to Look For" along with some of the top research universities in the country. UNC Asheville is consistently rated a "Best Buy" in the Fiske Guide to Colleges. UNC Asheville founded the National Conference on Undergraduate Research more than 25 years ago, and the university emphasizes student participation in faculty-mentored research projects. Additionally, most UNC Asheville students undertake career-related internships, and are supervised by university faculty during their time working in the field. Seventeen percent of UNC Asheville students take advantage of study abroad and study away programs. Finally, many courses and on-campus programs engage students in service projects aimed at improving the quality of life at home and around the world, which is a major focus of the university.

Teacher Licensure at UNC Asheville

The mission of UNC Asheville's Department of Education is to prepare candidates for a North Carolina Standard Professional I Teaching license with a liberal arts foundation. The Department of Education engages with all departments across campus in the preparation of professional educators; undergraduate candidates major in an academic area specific to their intended licensure area, along with taking additional courses necessary to earn their North Carolina teaching license. Hence, Education is not a major or a minor, but is an area of concentration in addition to the academic major. This structure reflects the liberal arts model. Undergraduate licensure candidates in K–12 and 9–12 areas major directly in their area of specialty (e.g. those seeking K–12 Art licensure major in Art), candidates in 6–9 areas either major directly in their area of specialty or in Psychology, and candidates in K–6 may choose any major. This model necessitates a strong liaison-based partnership between representatives from each of the academic majors and the Department of Education. Post-baccalaureate candidates who have earned the requisite Bachelor's degree may earn a teaching license by taking the necessary Education courses only, or may take a prescribed set of major courses in addition to their Education courses if they are pursuing licensure in a different area from their undergraduate major. Post-baccalaureate candidates are expected to meet the same program requirements and outcomes as undergraduate candidates. The National Council on Teacher Quality has rated the UNC Asheville Department of Education as a Best Value among North Carolina Colleges of Education, and among the top six teacher preparation programs in the Southeast.

Because UNC Asheville is a liberal arts institution, candidates take Arts and Sciences courses in the departments across campus in which they acquire their content knowledge. Courses taken in the Department of Education are structured to build on this content knowledge in the provision of pedagogical skills. This model is supported by such researchers as Davis and Buttafuso (1994), who provide an historical perspective on the role of small liberal arts colleges and teacher preparation. Their claim is that the type of curricular cooperation that is inherent at liberal arts institutions such as UNC Asheville promotes the development of teachers who are knowledgeable, thoughtful, and reflective.

The schools with which UNC Asheville partners frequently speak to the strength of the liberal arts model. In fact, they claim that the strong content knowledge UNC Asheville teacher licensure graduates possess, coupled with their pedagogical knowledge, puts these graduates at the top of the applicant pool. For all of its strengths and advantages, this liberal arts model does come with limitations. The greatest of these limitations is time in the teacher licensure program. Because Education is not a major at UNC Asheville, and candidates are taking their major and other content courses in other departments, there are precious few hours in each candidate's schedule in which Education courses can fit. All programs have been structured so that undergraduate candidates can graduate with their major

and licensure in four years of full-time attendance, but the course of study is intense for these candidates. And this means that Education courses must be efficient at all costs. Therefore, the focus of Education courses at UNC Asheville is almost strictly on pedagogy. It is vital, then, for instructors of Education courses to find ways to reinforce, and in some cases even facilitate the learning of, content knowledge that candidates need—even though Education courses are technically not "supposed to" focus on this.

Background

North Carolina Requirements for Teacher Licensure Programs

In 2009, all licensure programs in North Carolina were revised to meet North Carolina Department of Public Instruction (NCDPI) requirements. As part of these requirements, all licensure programs were to develop Evidences to be completed by each teacher licensure candidate and submitted to NCDPI to show candidate attainment and demonstration of competencies that meet six statewide Standards for 21st Century Teaching and Learning. These standards include candidate attainment of content knowledge, pedagogical skills, and professional dispositions with which the Department of Education at UNC Asheville's Conceptual Framework tenets of Content, Pedagogy, and Professionalism directly align. Following is a summary of the six state-required standards, and the approved Evidences the UNC Asheville Department of Education developed to meet the standards (note that for standards 1 and 4 NCDPI defined a required Evidence for every licensure program in the state)

1. Breadth of Content Knowledge – All candidates completed at least twenty-four semester hours of coursework relevant to the specialty area from a regionally accredited college or university with a grade of C or better in each of the twenty-four hours in order to be licensed. Additionally, all K–6 and Special Education candidates must have received satisfactory scores on the Praxis II exam in order to be licensed.
2. Depth of Content Knowledge – Candidates completed a Content Exploration Project. Data from assessment of this project showed candidates' depth of understanding and application of content knowledge per professional and state standards for the specialty area, and the ability to relate global awareness to the subject.
3. Pedagogical and Professional Knowledge Skills and Dispositions – Candidates created a three- to five-day integrated thematic teaching Unit Plan. Data from assessment of the unit showed candidates' ability to design effective classroom instruction based on P–12 professional and state standards, and use of effective pedagogy and research-verified practice.
4. Pedagogical and Professional Knowledge Skills and Dispositions – All student teachers are evaluated by their supervisor, in consultation with the P–12 clinical faculty member, using the state-required Certification of Teaching Capacity Instrument. All candidates must receive a rating of "Met" on each facet of the instrument on the final evaluation.
5. Positive Impact on Student Learning – Candidates completed an Impact on Student Learning Project. Data from assessment of this project showed candidates' impact on P–12 student learning given state P-12 standards.
6. Leadership and Collaboration – Candidates completed the Professional Development Project: Self, Learner, Community. Data from assessment of this project showed candidates' ability to demonstrate leadership, collaboration, and professional dispositions per professional and state standards for teacher candidates.

Unit faculty applied common rubrics, also approved by NCDPI, to evaluate candidate products related to Evidences 2, 3, 5, and 6, and all candidates had to score a level 3 or higher on each facet of the assignment rubric.

In 2014, the North Carolina State Board of Education (SBE) adopted a policy requiring that all licensure candidates in every licensure area pass the SBE-approved licensure exam(s) for each initial licensure area. For all licensure areas except K–6 and Special Education, these approved exams were the Praxis II. For K–6 and Special Education, the SBE adopted a new Pearson Foundations of Reading and General Curriculum Test. The Pearson Test is comprised of a Foundations of Reading

subtest; a General Curriculum Mathematics subtest; and a General Curriculum Multi-Subjects subtest consisting of questions pertaining to Language Arts, History and Social Science, and Science and Technology/Engineering. These subtests are all comprised of multiple choice items testing content knowledge in each area. An Integration of Knowledge and Understanding section is also completed by test takers, which includes a few constructed response items to test pedagogical knowledge. For K–6 and Special Education candidates and licensure programs, the new Pearson Test signified a significant change from the previously required Praxis II exam, which almost exclusively tests pedagogical knowledge. The SBE-adopted policy also included the provision that the Evidences required for standards 2 and 3 would be replaced by candidate scores on the SBE-approved licensure exams. Candidates take their licensure exam(s) as one of the final steps to completing their licensure process, after finishing their licensure program.

Purpose for the Study

The aforementioned liberal arts model and changes to licensure exam requirements posed a new challenge regarding the K–6 licensure program at UNC Asheville. Because of the number of areas in which a candidate must be prepared to teach at the K–6 level (Reading, Language Arts, Mathematics, Science, Social Studies, and Health being among the major ones), the K–6 licensure program at UNC Asheville is by far the largest in terms of the number of Education courses required. UNC Asheville K–6 candidates had enjoyed a 100 percent pass rate on the Praxis II for a number of years before the Pearson test was adopted. However, it is important to remember that the Praxis II centered almost solely on pedagogy. The new Pearson test focuses almost solely on content, whereas K–6 courses focused almost solely on pedagogy in direct alignment with former licensure exam requirements and the liberal arts model. To meet the new requirements, faculty in the K–6 program at UNC Asheville began work to structure courses and experiences to ensure that candidates were provided the knowledge necessary to make them successful in their quest for a license and with regard to the competencies required to be effective teachers, while continuing to serve the needs of the public schools and community. This researcher serves as the instructor for the Elementary Science Methods course and worked to structure the course and provide candidates with science-related learning experiences for these reasons. This project grew as a result of this structuring and the desire to determine its impact.

Specific Goals for Candidates, Students, the Community, and University Faculty

The desired outcome of this project was that UNC Asheville K–6 licensure candidates and participating elementary students, as well as the involved UNC Asheville faculty member who is the instructor of EDUC 322, would benefit from this civic engagement project. This would be made possible through the use of effective teaching strategies, including inquiry, discovery learning, questioning strategies, and demonstrations; active reflection on theories of science education and learning, and how they can be utilized in the classroom and beyond; participation in a variety of educational experiences which positively impact the teaching of science; and sharing responsibility within the greater community for and recognizing the value of collaborations on issues of mutual concern, benefit, and accomplishment.

The specific goals related to this project were as follows:

1. UNC Asheville K–6 licensure candidates will acquire content knowledge necessary for teaching science in their future classrooms.
2. UNC Asheville K–6 licensure candidates will acquire pedagogical skills necessary for teaching science in their future classrooms.
3. UNC Asheville K–6 licensure candidates will acquire professional dispositions necessary for being effective teachers in their future classrooms.

Elementary Science Methods Course

All K–6 licensure candidates are required to take EDUC 322 (Inquiry-Based Science Instruction, K–6). Throughout the semester, candidates enrolled in EDUC 322 learn about effective Science, Technology, Engineering, and Mathematics (STEM) teaching methodology, and how these methodologies translate to their teaching of future elementary students about science and the scientific method. The course has a focus on teaching using the 5E Learning Cycle.

Great emphasis is placed on inquiry and discovery learning, as candidates in the course are afforded traditional classroom learning in addition to participation in hands-on labs aligned with science strands. Candidates also engage in an inquiry-based micro-teaching experience into which the use of Common Core text exemplars are integrated. Given the liberal arts model, the primary goal of the course is to teach effective methodologies for science education, as science content is taught within the other departments in the university outside of the Department of Education. However, science content knowledge is drawn upon throughout the EDUC 322 course within the context of exploring teaching methodologies.

As part of this instruction and practice, licensure candidates in EDUC 322 participate in field experiences during which they gain additional hands-on experience working with elementary students on the teaching of science. Candidates spend six sessions in an elementary classroom observing and/or assisting the classroom teacher, and in addition, each candidate teaches an inquiry-based lesson on their own. Candidates complete a comprehensive Science Notebook as a reflection on the field experience.

Elementary Science Methods and Service Learning

Perhaps the most significant aspect of the EDUC 322 course is candidates' focused participation in service learning. Candidates participated in the Asheville City Schools (ACS) Kids Inquiry Conference (KIC) in the Spring 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013, and Spring 2014 semesters. Unfortunately, the event had to be cancelled due to ACS's focus on Read to Achieve mandates. Candidates participated in the Elementary Science Olympiad in the Spring 2013, Spring 2014, Spring 2015, Spring 2016, and Spring 2017 semesters.

The KIC was an event unique to Asheville City Schools, and was conceived as an alternative to the traditional Science Fair activity. The instructor of EDUC 322 partnered with the ACS Science Coach to plan and facilitate the KIC. Throughout each semester in which KIC was held, EDUC 322 candidates completed their field experiences in the classrooms of third, fourth, and fifth grade teachers and students who would be participating in KIC. This provided the EDUC 322 candidates with the opportunity to assist students with their projects and guide students as they engaged in the inquiry and discovery learning necessary to complete their projects. To complete their projects, students, usually working in pairs or groups of three, engaged in scientific inquiry focused on student-generated questions that came from their curiosities about the natural world. The teachers and EDUC 322 candidates guided students in generating these questions and led students through the process of making predictions, collecting data, analyzing the data, and drawing conclusions related to these questions. Students then created a visual presentation of their investigation and results, and prepared to discuss these with peers.

After a semester of work, the students were prepared for the KIC. During the KIC, UNC Asheville hosted the students and their teachers in a conference on the UNC Asheville campus. During the conference, the students presented visual representations of their work, and asked and answered questions from their peers. The EDUC 322 candidates who worked with the participating students and teachers served as conference facilitators. Candidates' roles as facilitators consisted of keeping time during each presentation, aiding with the discussion by asking questions and offering topics for discussion, and assisting students as they rotated to different tables so they could experience a variety of presentations. The instructor of EDUC 322 supervised and guided the candidates as they completed their work during the semester, and instructed candidates regarding safe and ethical practices for working with students. The instructor of EDUC 322 also served as the conference host and facilitator by coordinating all of the logistics for the conference including room reservations, scheduling, bus parking, and arranging for a campus tour for students. Each conference typically involved approximately 200 elementary students and ten elementary teachers.

Science Olympiad is a national program which engages elementary, middle, and high school students in competitions based on national and state STEM standards. Most competitions are team-based, and all require students to engage in hands-on inquiry science activities. Students choose their preferred event(s) from a list of approximately eighteen, and spend the better part of a school year working on their chosen event(s) with their

school's sponsor teacher and their peers on the Science Olympiad team in order to prepare for the competition.

The instructor of EDUC 322 has partnered with the Regional Director of the Elementary Science Olympiad, who is also a high school science teacher in an area school. At the beginning of each EDUC 322 semester, the Regional Director visits the EDUC 322 class and together she and the EDUC 322 instructor provide a description of and orientation to Science Olympiad. During this orientation, EDUC 322 candidates are provided information about their role related to their participation as event leaders and event writers for the Science Olympiad competition. This information is on topics such as the event code of ethics, event rules, event writing guidelines, event scoring guidelines, and safe and ethical practices regarding working with students. Throughout the EDUC 322 semesters, candidates work to write their events according to competition standards and under the supervision and guidance of the EDUC 322 instructor. This supervision and guidance involves advising candidates as to the content of their events, providing them with resources to obtain the information necessary to write their events, reviewing and editing their work, assisting them with gaining access to hands-on materials they require to carry out their event, and making copies of student answer sheets and any other written materials needed for events.

EDUC 322 candidates put their knowledge into further practice as they serve as event leaders for the actual Science Olympiad competitions. Event leadership consists of supervising competing students, setting up event materials, and scoring competitors' products. Candidates are supervised by the EDUC 322 course instructor and the Regional Director at each Science Olympiad event.

Methods

Candidate Written Reflections – KIC

Participating EDUC 322 candidates were required to produce written reflections of their experience working on the KIC project. These reflections were graded as part of the course grade for EDUC 322, and evaluated using a standardized rubric. The prompts provided for reflection were as follows:

1. Situational Context – List the date(s) during which you served as a facilitator, how many students were at your table during each session, and how many presentations you saw during each session.
2. Describe – Briefly describe the student presentations for which you served as a facilitator.
3. Analyze – Discuss the presentations you saw in terms of the relevance of the topics of the investigations carried out, the effectiveness of the presentations, and the quality of the questions asked by peers.
4. Appraise – Evaluate what you observed as a facilitator. Discuss any problems that occurred and why they occurred, what questions you have about the KIC process, and other topics you find relevant.
5. Transform – Discuss your involvement in KIC as it relates to your future teaching practice in science. Be sure to answer these questions: What might you do with the knowledge you gained to inform your teaching? How did what you learned by participating in KIC connect with the topics you learned in our course?

Candidate Written Reflections— Science Olympiad

Participating EDUC 322 candidates were required to produce written reflections of their experience working on the Science Olympiad project. These reflections were graded as part of the course grade for EDUC 322, and evaluated using a standardized rubric. The prompts provided for reflection were as follows:

1. Situational Context – Name the event you led and the event with which you assisted. Give a two sentence description of each event.
2. Describe – Describe what you did to prepare the event you led.
3. Analyze – What was student performance like in the event you led? What was the range of student performance? What surprised you?
4. Appraise – Evaluate what you observed as an event leader. Discuss what problems occurred and why they occurred, and what suggestions you have for improving the event you led and the tournament as a whole.

5. Transform – Discuss your involvement in Science Olympiad as it relates to your future teaching practice in science. Be sure to answer these questions: What might you do with the knowledge you gained to inform your teaching? How could you implement your own Science Olympiad experience for your students, even if it wasn't supported in your school or district?

Standardized Science Olympiad Surveys

The standardized surveys used by Science Olympiad as an organization were given to all participating UNC Asheville candidates to gain feedback from them after they served as event leaders, and the results were analyzed. Questions on the survey included the following and were rated by candidates on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree):

1. I was fully prepared to lead this event.
2. Tournament director(s) were well organized.
3. The event rules were clear.
4. The event site for this event was satisfactory.
5. I was provided with the materials and resources I requested.
6. Orientation opportunities were provided to prepare me.
7. Students were prepared for the event.
8. The event was inquiry in nature.

Service Learning Survey

A Service Learning Survey was administered to EDUC 322 candidates as both a pre- and post-assessment of the impact of their participation in service learning. Appropriate IRB guidelines for a classroom-based project were followed. Questions included on the survey were as follows and were rated by candidates on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree):

As a result of participation in service learning I am likely to

1. examine my own cultural experiences
2. educate myself on multiple perspectives
3. use reflection to evaluate my current teaching activities
4. develop lessons that include contributions of all cultures
5. build on learners' strengths
6. teach global awareness
7. incorporate different points of view in my teaching
8. create lessons that require student collaborations
9. incorporate student reflection into lessons
10. encourage students to change things at school they disagree with
11. encourage students to change things in the community they disagree with
12. teach students that they can make a difference
13. teach students to work for equality for people of different races, cultures, or genders
14. make students aware of their political or civil rights
15. teach students that the world outside of school is a good source of curriculum
16. work to improve collaboration between school and community
17. seek a leadership role in curriculum development at my school
18. participate in decision making structures (e.g., school improvement team, district planning team, school board)
19. seek information (e.g., local, state, or national data) when developing school improvement goals
20. have an interest in education policy
21. work to understand community problems
22. work with someone else to solve a community problem
23. become regular volunteer for an electoral organization
24. become a regular volunteer for a non-electoral organization
25. be an active member in a group or organization
26. regularly vote
27. persuade others to vote
28. contact elected officials
29. regularly seek "news" (newspaper, radio, news magazine, internet, TV)

Pearson Science and Technology/ Engineering Subtest

The standardized Pearson test, composed of a Foundations of Reading subtest; a General Curriculum Mathematics subtest; a General Curriculum Multi-Subjects

subtest consisting of multiple choice questions pertaining to Language Arts, History and Social Science, and Science and Technology/Engineering; and an Integration of Knowledge and Understanding section which includes a few constructed response items to test pedagogical knowledge as applied to teaching a concept in a content area, has been taken by all K–6 candidates since the 2013–2014 academic year. Each test taker receives an overall Scale Score, a Sub-Area Performance score for each of the three General Curriculum Multi-Subjects subtests, and a score for the Integration of Knowledge and Understanding section. The Sub-Area Performance scores for the multiple choice items are presented on a scale from 1 to 4 to show how many items test takers answered correctly, as follows:

1-Few or none of the items answered correctly
2-Some of the items answered correctly
3-Many of the items answered correctly
4-Most or all of the items answered correctly

The Integration of Knowledge and Understanding scores for the constructed response items are presented on a scale from 1 to 4 to show the quality of the response by the test takers, as follows:

1-Weak, blank, or unscorable
2-Limited
3-Adequate
4-Thorough

For this study, the Sub-Area Performance scores for the Science and Technology/Engineering subtest and the Integration of Knowledge and Understanding scores were analyzed.

Results

Key Findings: Candidate Written Reflections – KIC

Participant responses (N=61) to the written reflection related to their participation in the KIC were evaluated to determine the most common themes that emerged in reference to content and pedagogy. An overwhelming number of participants (N=56) indicated that involvement with the KIC provided them with more science content knowledge. In their reflections on the experience they stated such things as, "I believe the presentations were very effective, because I even learned things that I didn't know before such as Ingles brand bag holds the least amount of weight compared to Best Buy and Wal-Mart…"

Numerous participants (N=50) also noted that their role in the KIC assisted them with learning how students conduct inquiry. Participants' anecdotal comments, such as the following, demonstrate this learning: "…I feel that the process of going through putting together an experiment, making predictions, implementing the experiment, and then having to present their findings was a good exercise and definitely good practice for further inquiry...."

Finally, a number of participants (N=44) suggested that the KIC process taught them to assist students with communicating in scientific terms and carrying out investigations using technological design. This was exemplified in participant comments such as:

> *Participating in the KIC conference will be helpful to me as a future science teacher. I was able to see that students as young as eight and nine are able to follow the science process and they can work through a problem efficiently. For some reason, the age of these students compared to their work surprised me. I wasn't expecting such good quality work and investigations, and I look forward to trying this out in the classroom.*

and:

> *I found that many of the presentations were relevant to a child's life. Many students asked, "So, why did you do this? How does this affect your life?" The students that tested hair ties said they wanted to know what hair [tie] would be best to wear at the playground. The students who tested the batteries said they wanted to know which one lasted the longest for their camping trip. The topics listed above are far different from the science projects I did in elementary school. The topics are things that really matter to the students. One may say that knowing what frozen pizza has the most cheese is not a relevant topic, but what I saw at conference was that it was sometimes the process more than the content that was effective. The students were really engaging in scientific thinking and solving everyday problems using scientific methods. I have no doubt that the students will be better equipped to solve real life science problems because of the conference.*

Key Findings: Candidate Written Reflections – Science Olympiad

Participant responses (N=44) to the written reflection related to their participation in the Science Olympiad were evaluated to determine the most common themes that emerged in reference to content and pedagogy. Almost all participants (N=36) wrote that they felt confident that they could make a Science Olympiad event for their own class or grade level that could be used as a science teaching experience. In fact, some plans, such as the one provided by the following participant, were very fully developed:

> *I would implement a science Olympiad in my classroom by grouping students into two or three and assign 3 events for each to compete in. Students can have a choice of course. It would take place during the end of the year as an all-day event after EOG's as a fun way to end the school year. I could potentially use a designated spot outside for Newton's Notions and an empty room/space near-by for overflow of activities. Stations would have to be condensed in order to fit inside my one classroom and furniture rearranged or taken out of the room for additional space. The groups will have time to prepare similar to the real Science Olympiad. I would bring in volunteers to help with the stations (preferably student teachers, NOT PARENTS) and supervise each event. There would be eight different events inside my classroom. Each event would consist of 3 activities.*

TABLE 1. Average responses to statements in the preliminary survey and final survey.

Survey Item	N Item Responses					Item
	1	2	3	4	5	
1	0	0	2	7	35	4.8
2	0	2	2	5	35	4.7
3	0	0	4	7	33	4.7
4	0	0	2	2	40	4.9
5	3	1	0	3	37	4.6
6	1	0	4	4	35	4.6
7	1	4	5	9	25	4.2
8	0	0	3	8	33	4.7

Note: Item Response choices were 1 (Strongly Disagree), 2 (Disagree), 3 (No Opinion), 4 (Agree), and 5 (Strongly Agree).

Most participants (N=32) said that their participation in Science Olympiad gave them the skills needed for building a classroom science community around the concept of students possessing common scientific knowledge on a variety of topics. Participant reflections demonstrating this include the following:

> *I think this experience made a definite impact as far as me feeling like a REAL teacher. This experience really made being a teacher as real as possible. By observing what students are able to do and what they cannot do, it also enhanced by awareness of upper-level elementary developmental/thinking and where they are with that.*

Many participants (N=30) specified that their involvement in Science Olympiad provided them with ideas centering on multiple means for assessing student knowledge. One participant suggested:

I also can envision possibly using the Science Olympiad as an assessment or testing tool. Should the Olympiad be used as a testing tool, the individual grades would be graded, but not shared. The students could be divided into teams of 4 or 5 students before the testing period. Their test scores would be combined to form a team score. My guess is that this would encourage a higher level of preparation and group study before the test.

Key Findings: Standardized Science Olympiad Survey

Given the nature of this survey and because of its standardization to serve the needs of the established Science Olympiad program, the results shown in Table 1 do not reveal much in terms of participant (N=44) acquisition of skills related to content, pedagogy, or professional dispositions. The exception is with regard to the first and last items. Participants had to have the appropriate content knowledge in order to create their event and be fully prepared to lead it, and most participants had to study and learn content information in order to do so. Therefore, the fact that the mean rating for the first item was 4.8 was a good indicator that participants gained content knowledge as a result of their participation as Science Olympiad event leaders. The mean rating of 4.7

TABLE 2. Results of Service Learning Survey

Survey Item	N Item Responses											
	1 Pre	1 Post	2 Pre	2 Post	3 Pre	3 Post	4 Pre	4 Post	5 Pre	5 Post	Mean Pre	Mean Post
1	0	0	0	4	1	0	46	40	31	34	4.4	4.3
2	0	0	0	0	0	0	27	32	51	46	4.7	4.6
3	0	0	0	0	0	0	38	21	40	57	4.5	4.7
4	0	0	0	0	3	2	28	30	47	46	4.6	4.6
5	0	1	2	1	0	2	22	27	54	47	4.6	4.5
6	0	0	3	2	2	4	28	22	45	50	4.5	4.5
7	0	0	2	1	2	3	18	17	56	57	4.6	4.7
8	0	0	3	2	0	4	29	18	46	54	4.5	4.6
9	0	0	1	0	0	9	30	16	47	53	4.6	4.6
10	0	0	1	4	25	24	45	32	7	18	3.7	3.8
11	0	0	2	4	14	21	52	28	10	25	2.8	3.9
12	0	0	0	0	1	3	9	5	68	70	4.8	4.9
13	0	0	0	1	0	9	38	17	40	51	4.4	4.5
14	0	0	1	3	13	5	34	29	30	41	4.2	4.4
15	0	0	0	0	2	4	22	27	54	47	4.5	4.6
16	0	0	0	0	1	3	39	26	38	49	4.5	4.6
17	0	0	0	0	26	28	32	18	20	32	3.9	4.1
18	0	0	0	0	24	30	33	23	21	25	4.0	3.9
19	0	0	0	2	1	5	58	23	19	48	4.2	4.5
20	0	2	1	0	9	11	34	31	34	34	4.3	4.2
21	0	3	0	2	2	0	48	32	28	41	4.3	4.4
22	0	2	0	0	25	13	38	40	15	33	3.9	4.7
23	0	2	28	15	37	38	7	10	6	13	2.9	3.2
24	1	2	14	13	28	26	24	31	11	6	3.4	3.3
25	0	0	1	4	9	4	46	39	22	31	4.1	4.2
26	0	0	0	0	10	10	23	19	45	49	4.5	4.5
27	1	0	5	6	20	21	24	22	28	29	3.9	3.9
28	1	0	4	4	35	33	19	13	19	28	3.7	3.8
29	2	1	3	2	1	3	35	34	37	38	4.3	4.4

Note: Item Response choices were 1 (Strongly Disagree), 2 (Disagree), 3 (No Opinion), 4 (Agree), and 5 (Strongly Agree).

for the last item was also encouraging, as it suggested that participants understood the nature of inquiry as a result of their role in Science Olympiad.

Key Findings: Service Learning Survey

Participant responses (N=78) to the Service Learning Survey were evaluated to determine the items for which participants showed the most growth between their pre- and post-service learning participation in reference to professional dispositions. From the results illustrated in Table 2, four topics emerged: as a result of their participation participants indicated they were more likely to educate themselves on multiple perspectives, use reflections to evaluate their current teaching activities, teach students that the world outside of school is a good source of curriculum, and work to improve collaboration between school and community.

TABLE 3. Results of Pearson Test Sections

Candidate Exam Year	Science, Technology/ Engineering Score*	Knowledge, Understanding Score**
'14-'15	2	3
'14-'15	3	1
'14-'15	3	2
'14-'15	3	3
'14-'15	4	1
'14-'15	3	1
'14-'15	3	2
'14-'15	2	2
'14-'15	3	3
'14-'15	2	1
'14-'15	1	1
'14-'15	2	2
'14-'15	3	2
'14-'15	3	2
'15-'16	3	2
'15-'16	3	3
'15-'16	3	4
'15-'16	2	2
'15-'16	3	2
'15-'16	4	3
'15-'16	3	1
'15-'16	3	2
'15-'16	3	3
'15-'16	3	2
'15-'16	3	3
'15-'16	4	4
'16-'17	4	3
'16-'17	3	3
'16-'17	3	3
'16-'17	4	3
'16-'17	2	1
'16-'17	3	3
'16-'17	3	2
'16-'17	4	2

NOTES:

*Scores were 1 (Few or none of the items answered correctly), 2 (Some of the items answered correctly), 3 (Many of the items answered correctly), and 4 (Most or all of the items answered correctly);

**Scores were 1 (Weak, blank or unscorable), 2 (Limited), 3 (Adequate), and 4 (Thorough)

Key Findings: Pearson Science and Technology/ Engineering Subtest and Integration of Knowledge and Understanding Section

The means of participant results on the Pearson Science and Technology/Engineering Subtest were analyzed by year. For 2014–2015 (N=14) the mean was 2.64. For 2015–2016 (N=12) the mean was 3.08. For 2016–2017 (N=8) the mean was 3.25. The means of participant results on the Pearson Integration of Knowledge and Understanding section were also analyzed. For 2014–2015 (N=14) the mean was 1.86. For 2014–2015 (N=12) the mean was 2.58. For 2016–2017 (N=8) the mean was 2.63. In the 2014–2015 testing year, three participants did not pass the General Curriculum Multi-Subjects subtest the first time they took it. For the 2015–2016 and 2016–2017 testing years the same was true for one participant each year. In all of these instances, for purposes of this study, the first testing attempt was used in figuring the means so that the same level of data was used for all participants.

Discussion and Summary

Two of the goals of this project for participating candidates centered on the acquisition of content knowledge and pedagogical skills necessary for teaching science in their future classrooms. The Key Findings show clearly that these goals were achieved, especially when the results from the instruments used to obtain results in this study are considered together. Specifically, in the Key Findings section above it is stated that the results from the Standardized Science Olympiad Survey as shown in Table 1 do not say much on their own about participant acquisition of skills related to content, pedagogy, or professional dispositions, with the exception of the first and last items. The results related to the first item on this survey do, on their own, suggest that participant content knowledge was improved by their participation in the Science Olympiad. The impact of these results is strengthened by participants' anecdotal comments on the Candidate Written Reflections for the Science Olympiad which include, "I really enjoyed creating my event for the Science Olympiad and I learned a lot about rocks and minerals and became more informed on the information…" and, "I feel like this was a great first time getting to work with older students. I've only worked

with kindergarteners so far. I felt confident helping the students because I knew what I was talking about, due to my research on the subject…." The results related to the last item on the Science Olympiad Survey showed that participants understood the nature of inquiry as a result of their role in Science Olympiad.

Participant reflections support this claim. As one participant stated:

> *I definitely want to incorporate my event stations into activities that students could do in my future classroom. Rocks and Minerals can be boring for certain students but having activities to incorporate learning makes it more enjoyable for students. After taking several education classes I have learned through myself that hands-on activities give me a better understanding of information and make learning more enjoyable when you are able to be creative through acting and building things. The students really enjoyed looking at the rocks and minerals I had as samples and the students seemed to be very intrigued.*

The Pearson test components, as a standardized and quantitative measure of participant learning, can also be considered in concert with the Standardized Science Olympiad Survey. As can be seen, the means related to the subtests of of science content and pedagogical knowledge increase each testing year. As described in the Background section, the KIC was terminated by ACS after the Spring 2014 semester. Additionally, the Science Olympiad is held only in Spring semesters. EDUC 322 was offered every semester until Spring 2016 and thereafter was offered only in Spring semesters. Therefore, there were some participants who completed their licensure program and the Pearson test in the 2014–2015 and 2015–2016 testing years without having participated in either one of the EDUC 322 service learning activities. All participants who completed their licensure program and the Pearson test in the 2016–2017 testing year participated in at least the Science Olympiad activity. The increased means on the analyzed Pearson test component strengthen the conclusion that participants' knowledge regarding both content and pedagogy increased, despite the technicality that EDUC 322 is not "supposed to" teach content. It is the assumption of this researcher that this outcome is due to the practical and engaged work in which participants were involved as part of their service learning.

Another project goal centered on the acquisition of professional dispositions candidates will need to be effective teachers in their future classrooms. The definition of professional dispositions has been widely disputed, as there are many dimensions through which the concept can be delineated. The quest to define dispositions dates back to seminal works, such as those completed by Arthur W. Combs in the 1960s, which sought to determine the dispositions that effective teachers must possess (Wasicsko 1977). There is also great deliberation over whether or not dispositions can be taught, or if they are simply acquired (Cummins and Asempapa 2013). Many researchers, such as Combs and Wasicsko, have developed a series of assessment tools related to pre-service teacher professional dispositions. But again, the tools are contested due to their content, purpose, and validity. Given these debates, many teacher education programs such as that at UNC Asheville provide their own definitions of professional dispositions, and seek to combine formal assessment of them through the use of prescribed tools with performance-based assessment as candidates are engaged in authentic experiences. At UNC Asheville, candidates displaying professional dispositions to a satisfactory degree are defined within the following parameters:

- Collaborative teachers who demonstrate awareness of and appreciation for the communities in which they teach and who foster mutually beneficial relationships with the community.
- Responsible teachers who exemplify the skills, behaviors, dispositions, and responsibilities expected of members of the teaching profession.
- Reflective teachers who maintain a commitment to excellence and to the continuous assessment, adaptation, and improvement of the teaching-learning process.
- Humane teachers who value the dignity of every individual and foster a supportive climate of intellectual inquiry, passion for learning, and social justice.

The themes that emerged from the Service Learning Survey results, as described in the Key Findings, show that project participants gained knowledge and skills in the area of acquiring desirable professional dispositions, especially when analyzed in conjunction with participant reflections. For example, one participant noted:

This Science Olympiad experience confirms my compassion and love for children and desire for being a teacher even during some crazy days. It also confirms my desire to help them learn and discover new knowledge while becoming confident in their science skills. This learning experience was really cool to be a part of and I felt like I was doing something truly important to further children's interest in science and education. I am happy and proud to say that I was able to participate in the Science Olympiad and confidently show the work that my fellow peers and I produced for such a well-known competition. I will always reflect on the experience as a future teacher and use it to influence my decisions as a teacher in a positive way.

The supposition of this researcher is that the field work in which participants were engaged, which can actually be defined as service learning, and the specific Service Learning activities in which they participated can set candidates on the path to civic engagement. Specific civic engagement elements that were realized include the fact that sustainable partnerships were developed, the work was mutually beneficial, and candidates learned to serve a diversity of children. Participants were able to realize the potential for forming partnerships to benefit their future classrooms. One participant's reflection showed this clearly, as the participant stated:

If implementation of my own Science Olympiad were not supported in my school or district, I could look to the community and to private industry for support. The concept of the Olympiad is valuable to fostering scientific education and to meeting the current and future needs of the world. Science is life and to neglect it in our children's education and preparation for life is not an option.

In summary, education in Science, Technology, Engineering, and Math (STEM) competencies is a growing area in terms of career and workplace skills. Interest in this area has to be started in elementary schools in order to ensure that students are not only being introduced to science skills but are also actively engaged in scientific processes and engineering design cycles. The KIC and Science Olympiad were designed to support elementary science standards, and to assist teachers in fostering these skills in their students. The involvement of the preservice teachers who served as participants in this study and created quality, age-appropriate science challenges for students, is helping to achieve these long-term goals for students and support STEM education.

ASCD (formerly the Association for Supervision and Curriculum Development) is one of the most prominent professional associations in the field of Education. ASCD provides resources, training, research, and programs that emphasize transformational leadership, global engagement, poverty and equity, redefining student success, and teaching and learning (ASCD 2016). "The ASCD defines citizenship as a concern for the rights, responsibilities, and tasks associated with governing. It identifies citizenship competencies as an important component of civic responsibility. These competencies include acquiring and using information, assessing involvement, making decisions and judgments, communicating, cooperating, promoting interests, assigning meaning, and applying citizenship competencies to new situations" (Constitutional Rights Foundation 2000, 4). The participants in this study were introduced to this information toward the beginning of the EDUC 322 course. Then, throughout the course, discussions were held and activities were completed related to teaching candidates how educating students in STEM areas as well as helping them understand the ethical use of science and scientific data are contributing to candidates' and students' citizenship, civic engagement, and civic responsibility—both through their current engagement with students and schools and in their future teaching careers. All of this discussion and activity completion is grounded in the framework of strategies for effectively teaching a diversity of students in the public school classroom according to STEM education principles. Additionally, the participants in this project were provided with a responsibility to both teach and learn within a service and civically engaging context. As a result, they were able to learn to teach using discovery, while engaging in discovery learning themselves. Given their self-reflections, it is evident that the participants are excited about and prepared for the prospects of related responsibilities in their future teaching. And, given the results of the measure of student learning, each group of participants is entering the classroom more prepared in terms of their content and pedagogical knowledge than the one before it.

About the Author

Kim Brown is an Associate Professor and the Chairperson of the Department of Education at the University of North Carolina Asheville. Kim teaches numerous licensure courses, including Inquiry-Based Science Instruction for candidates seeking elementary licensure. For her curricular and service work in this course, Kim was named a University SENCER Fellow. Kim has been very involved in work related to the University of North Carolina Asheville's liberal arts model, serving as the chairperson of the university's Integrative Liberal Studies Oversight Committee and the university's representative on the state-level General Education Council. Kim was the university's recipient of the 2014 Distinguished Service Award.

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