Online Science Methods for Lateral Entry Science Teachers

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Abstract

The purpose of this presentation and paper is to disseminate information about a lateral entry science teacher education in North Carolina through North Carolina Teacher of Excellence for All Children (NC TEACH). The origins and history of NC TEACH will be discussed, followed by a review of the curriculum development for the face-to-face and online courses. Next, some research findings will be discussed as a result several studies done with this program. Finally, recommendations are offered for future research and suggestions given for policy makers. The presentation will be made by the course developer and teacher and university science educator, the Executive director of NC TEACH, and a former NC TEACH graduate who now teaches the science methods course and mentors new lateral entry science teachers.

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Online Science Methods for Lateral Entry Science Teachers

The current state of science education in the United States is tenuous at best, and a recent report lists the improvement of K-12 science and mathematics as the number one action item in the list of recommendations for developing future innovations and competing globally (National Academy of Science, 2005). Reports dating back to the Sputnik era and leading up to the ongoing International Math and Science Studies have lamented on the lack of qualified teachers in science to adequately prepare the nation's students in science (). Many states and universities have unilaterally developed programs for attracting people into the science teaching profession. These programs have ranged from the traditional program of two years or a fifth year to emergency certification. The later type of program has evolved to encompass what researchers and state policy makers call lateral entry or alternative licensure programs. It is the belief that people with degrees in science will be attracted to teaching through an alternative route of licensure without repeating their university experience. The establishment of such programs comes as a response to several reports indicating the large teacher turnover in education (North Carolina Department of Public Instruction, 2001); especially in science (Ingersoll, 2003). In 1999-2000 there were approximately 35% more teachers leaving the workforce than entering (Ingersoll, 2000). Of the teachers that left the teaching profession in North Carolina, 10% left because they did not obtain or maintain their license, their contract was not renewed, and their interim contract was ended. The purpose of this paper is to present information, curriculum, effectiveness, and online generation of a lateral entry science teacher preparation program in North Carolina. It is hoped that the development of an online lateral entry program, rather than face-to-face, would facilitate the increased recruitment and sustainability of science teachers. The history and rationale for North Carolina Teachers of Excellence for All Children (NC TEACH) and the progression of the curriculum from face-to-face to online will be presented, followed by current research on NC TEACH and a personal reflection of one NC TEACH graduate who teaches a hybrid science methods course for NC TEACH. The paper will end will suggestions for future research questions.

NC TEACH

The NC TEACH program is a statewide teacher licensure initiative for mid-career professionals, developed jointly by the North Carolina State Board of Education and the Board of Governors of the University of North Carolina. The initiative was initially funded from Title II of the Higher Education Act, and it is administered by University of North Carolina General Administration in collaboration with the Department of Public Instruction. It is a comprehensive program designed to recruit, train, support, and retain highly skilled mid-career professionals who seek to enter the teaching profession. The program utilizes a graduate level problem-based approach focused on what teachers must know and be able to do to teach students using high standards in the context of real classrooms.

NC TEACH was developed as a response to the low number of qualified teachers in North Carolina in middle grades and secondary science, math, foreign language, and special education. In subsequent years, NC TEACH has replied to the recently mandated federal guidelines imposed by No Child Left Behind (NCLB) legislation. The NCLB Highly Qualified Rules apply to newly hired teachers at Title I schools teaching core academic subjects and will apply to all teachers teaching core academic subjects by June 30, 2006. If a teacher is hired to teach a course at a Title I school, the teacher must be fully licensed and highly-qualified to teach that course. The teacher cannot teach out-of-field and be considered highly-qualified. The NCLB legislation changes the time limit to qualify for full licensure from 5 years to 3 years. It requires the teacher to have received high-quality professional development that is sustained, intensive and classroom focused before teaching. The teacher must have met the qualifying criteria to be highly-qualified before teaching (e.g. academic major, or PRAXIS II test(s), etc.). The response to developing a face-to-face and online teacher preparation programs supports the data reflected by Ingersoll (2001) in that teacher preparation reduces first year teacher attrition. The full year support and induction program of NC TEACH provides sustained education, training, and mentoring (Smith, 2005).

The NC TEACH standard alternative route program consists of the delivery of 15-18 semester hours of graduate-level instruction in a classroom delivery model. After a two-day orientation, participants enter into an intensive five-week summer institute followed by fall and spring seminar-type classes during the academic year in which they are teaching full schedules as lateral entry teachers in NC public schools. The program is cohort based, and includes mentoring, on-line support, team building and problem-solving skills, and authentic assessment of the participants' performance. The curriculum is separated among 6 modules; introduction to teaching, effective teaching strategies, classroom organization and management, content pedagogy, technology, and diversity. The science methods component consisted of five seven-hour days in the summer and 10 three-hour classes during the academic year.

Table 1 provides some general statistics of the participants in NC TEACH for the period of the program, 2000-2004. Many of the participants had strong content backgrounds, worked in industry or business, and were content oriented. These mid-career professionals came to the program wanting to teach science. This was reflected in the average age, GRE, and Undergraduate GPA of the participants. Of particular note is the number and percentage of participants who enrolled for the middle grades and secondary science programs. This number has increased steadily making NC TEACH the largest producer of middle grades and secondary science teachers in North Carolina. Although there are 47 approved Institutes of Higher Education (IHE) that can license secondary teachers, only 40 to 60 secondary science teachers are licensed per year through these IHEs. There are 47 IHEs, however, each only offers a certain number of teacher certification programs. Hence, most secondary science teachers come through the lateral entry program.

Face-to-Face Science Curriculum Development

The process pf curriculum development is usually left to the individual professors at universities. In the case of NC TEACH, secondary science methods instructors and nationally board certified science teachers convened to develop a curriculum that could be used in a limited time frame, yet cover the most important aspects of being a science teacher. This section of the paper will describe the background for developing the science methods curriculum for the face-to-face course. The online curriculum development flowed naturally from the face-to-face curriculum, but was modified for an online environment, which will be discussed later. The committee determined that a pedagogical content knowledge model was necessary to drive the decision curriculum development (Veal & MaKinster, 1999). Some of the decisions that were made contradict those of the National Science Teacher Association's (NSTA, 1992) and the Association for the Education of Teachers in Science (AETS, 1997 & 1998; AETS is now called the Association of Science Teacher Educators, ASTE) position papers on science teacher preparation. It was determined that the adjustments had to be made due to the time constraints imposed on lateral entry training.

Professional Standards

The AETS standards describe the professional knowledge standards for science teacher education, but shed light on what is necessary for classroom teachers. The position statement describes how critical it is that science teacher educators have been "virtually ignored in discussions about the implementation of reform efforts" (p. 1). The six standards developed by AETS define a "framework for the knowledge, skills, experiences, attitudes, and habits of mind essential for the successful science teacher educator" (p. 1). These standards apply to university faculty, but also to school-based mentor teachers, professional development science educators, and agency personnel who have been contracted to lead professional development sessions. In essence, the standards assume that secondary science teachers understand theoretical and practical science content, the nature of science, science process skills, science pedagogy, curriculum, instructional materials, assessment, and learning theories.

The position statement from NSTA describes standards for pre-service science teachers. These standards include core standards for all science teachers and specific standards for high school science teacher preparation. The core standards include knowledge of science interconnections, science and technology relationships, curriculum, and assessment. Teachers are also required to engender positive attitudes about science, motivate students to be life-long learners, encourage students to become reflective learners, and engage students with multicultural differences. The standards for high school call for high school science teachers to provide understanding in interdisciplinary science, understand safety issues, work with diverse students, relate science to students' daily lives, use a variety of instructional strategies, curriculum, and community resources, design interactive laboratory and field experiences, promote decision making and value-analysis, implement technology, instruct and plan based on students' prior knowledge, and apply current research. In addition to these standards, there are five sub-standards that are common among the discipline/area preparation. These include content knowledge (e.g., biology), understanding of interconnectedness of the sciences, applying mathematics, relating science through science/technology/society, and conducting inquiry-based investigations.

Session Sequencing

The committee agreed upon the topics to be included in the module, and the sequencing of classes was carefully determined for the year-long program. It was decided that the summer sessions (ten for the science module) should provide the teachers with the basic foundations for teaching science, while the fall and spring sessions would involve enhancing and refining issues. For example, during the summer sessions, preservice teachers became familiar with the nature of science and inquiry, instruction and assessment in a variety of science content areas, curriculum, resources, instructional technology, and safety. The fall and spring sessions expanded upon science teaching by looking at EOC testing, special education, equity, and professional responsibilities. The topics included in the fall and spring sessions were deliberately scheduled after the preservice teachers acquired classroom experience and would have a context or framework in which to make sense of the ideas.

After the framework of the curriculum was designed, the committee determined how each session would look. There was a strong consensus by the committee members that the lessons be hands-on and that the professor/master teachers would model the pedagogy presented. Each session covered specific pedagogical objectives as well as content objectives. The content objectives reinforced science concepts in the four content areas to serve as one method of review for the Praxis II content exams and to model how lessons should be derived from the state competencies. After the pedagogy was modeled or practiced, the professor/master teacher facilitated a discussion reflecting on the pedagogy and possible related extensions or applications. In addition to practicing the pedagogy, the sessions were to include as many teaching situations as possible for the preservice teachers.

The design of the modules addressed knowledge of the secondary science curriculum at the national and state levels, field and laboratory experiences, pedagogy, equity issues, technology uses, EOCs, safety, and the Praxis exam. For example, during the summer session pre-service teachers were presented with various content area topics (biology, chemistry, physics, and earth science). In these modules the teachers experimented with various teaching pedagogies while connecting their hands-on activities to various issues (e.g., equity, special populations, and safety). For instance, in the physics session, electricity and magnetism was investigated using the constructivist viewpoint, while in one of the biology sessions, cells were explored via problem based learning. Another session focused on teaching science as inquiry. In this session pre-service teachers modeled several experiments and revised cookbook type activities into more open-ended inquiry based activities. Teachers also conducted a mock field trip to collect samples from outdoors. This simulation was important for teachers to realize their ability to create and manage field experiences.

Lastly, after the individual sessions were designed, the committee determined the types of assignments and assessments for each of the lessons. Assignments were intended to be practical either preparing the student for the classroom setting, or in response to the topic of the lesson. The science course assessment took the form of a portfolio and required the preservice teachers to recognize and reflect on the pedagogical objectives presented throughout the science module.

Transition to Online Course

During the second year of implementation of the face-to-face NC TEACH curriculum, the science cohort experimented with online transmission of assignments and group discussions. In 2002-2003, a formal part of the science methods module was instituted during the academic year. The summer institute and face-to-face instruction in science methods still remained, but the follow-up science methods course offered during the school year was converted to reflect an 80% online component. Preservice teachers met face-to-face twice during the academic year. All other instruction was done online (Veal, 2002). The initial intent of the online sessions was to decrease the travel time for students attending the face-to-face classes while teaching fulltime. The easiest areas of the curriculum to modify for the online environment included those topics surrounding classroom management, diversity, science controversies, and lesson planning. In essence, the hands-on component was lost to online discussion, initially.

After a swelling of support for these online sessions, the science educator began to convert some other activities and assignments to be online. For example, the students presented their best activities, demonstrations, resources, and discrepant events on index cards to class members. In the online environment, all lesson plans that included these items were submitted electronically as attachments in an ongoing discussion board. Other students could browse and review the items. Subsequent discussion ensued after several of the students tried the pedagogical activities of the other students. The sharing and trying of ideas was facilitated by the anywhere, anytime format of online learning. The asynchronous aspect also facilitated the sharing of ideas since people were not expecting immediate feedback on their idea submissions.

In the winter of 2004, NC TEACH commissioned the development of a complete online teacher certification program that was to be piloted with science, mathematics, and special education. The online program for science has now completed its second year of online teaching. The students who entered the online program had to satisfy certain technical criteria for Internet connectivity and technology skills.

Online Course Curriculum Design

The online curriculum followed closely the philosophical values inherent in the face-to-face curriculum (i.e., hands-on, topics, science pedagogy, and issues). The aspect that differed was altering the content to match an online format. Research indicates that online teaching and learning cannot function as a direct transfer of knowledge from text to online (e.g., Ko & Rossen, 2001; Simonson, Smaldino, Albright, & Zvacek, 2006). The online curriculum contained some of the same activities, but the students had to recreate the activities themselves with more detailed directions and guidance, in the form of videos and pictures, provided. The content specific hands-on activities and labs done in the face-to-face classes were either eliminated or altered so that the students could complete them in their own classrooms or done easily with minimal equipment required. Rather than sending students a package with activity resources, it was assumed that the students would have access to supplies at their schools. Some of the more content specific classes that required certain tools or technology were eliminated from the online course. For example, one class had students complete a laboratory exercise on kingdoms by looking at slides under a microscope resulting in a laboratory practicum. This lab was eliminated from the online curriculum due to the heavy emphasis on equipment and hands-on pedagogy. On the other hand, a biology problem-based lab entitled “Lost without a cell phone” was easily transferred to the online environment by having students work in discussion groups to solve the problem. Once each group had a solution, it was placed in a class discussion board so that all students could compare and discuss results.

About 25% of the online classes were newly created for the online environment. The Internet was used for its resources and interactivity for some classes. For example, one class used the idea of a scavenger hunt to find online science education resources and lesson plans. Another class emphasized the use of discrepant events and demonstrations by linking students to science websites with videos. An Earth science theme was used to highlight java applets and sliders. The online environment was effective at presenting science content using interactive modes. For example, a website devoted to atmosphere contained sliders which allowed the user to see how the change in altitude affected temperature of the air.

The online course was divided into a 15 week, 3-4 credit course. Each week was designed to include an introduction, an activity, online discussion, and an assignment. Folders were used to organize the content into this weekly structure (Cooper, 1999). Each weekly Session included an introduction with appropriate professional standards, an advanced organizer in tabular form displaying the components and due dates for activities, and discreet sub-folders for each activity, discussion, and assignment.

Design Considerations

The online course was designed not only to allow for National Science Standards for teacher preparation to be used, but it was also designed with online and web-based design strategies based upon research. The online course management software was Blackboard. This allowed for multiple ways to communicate and organize data. This part of the paper will discuss how and why the online course for lateral entry, preservice science teachers was developed. Young and Keefe (2003) determined that a high degree of interactivity and student participation were critical to online instruction. In this course, weekly discussion forums (including discussion about assignments, vignettes as discussion starters, a coffee house for ongoing general discussions, and ongoing discussions on various issues) were developed to promote student participation and interactivity. Christopher, Thomas, and Tallent-Runnels (2004) determined that instructor guidance in the online discussions was needed to influence higher levels of thinking as defined by Bloom’s taxonomy. The instructor did actively work to participate and steer the multiple online discussions and was a constant presence as a communicator, question poser, and idea initiator. In addition, the instructor tried to provide an atmosphere of respect and safety for all students that promoted informed debate and collaborative problem solving rather than just a text dump (Hansen & Gladfelter, 1996). The rest of this section will describe the research base for the design features used in the online course based upon three themes; classroom culture, structural assistance, and success factors.

Classroom Culture

Classroom culture includes how students interacted in the online environment. Ahern and El Hindi (2000) determined that asynchronous discourse mimicked the dynamics of real-time, multivoiced discussions. The online science methods course incorporated continuous online discussion forums to discuss technology, social, and content related issues. The course management software allowed for synchronous and asynchronous discussions, but the course only instituted asynchronous discussions to increase the quality and depth of interactions. Davidson-Shivers, Tanner, and Muilenburg (2000) determined that asynchronous discussions were more focused and purposeful. The online science methods course developed vignettes, which used theory and applied it to practical situations, to stimulate 3-week long discussions. Three weeks were used to ensure that students had time to discuss, think, and respond to issues and each other.

Knupfer, Gram, and Larsen (1997) determined that study groups and communication modeling and reinforcement were needed to foster communication among the students. This conclusion was played out in the online science methods course with the use of weekly assignment discussions. The science methods course asked students to discuss their weekly assignments with each other. For example, the students had to design an experiment to support their understanding of the Nature of Science and the ability to develop and control experimental variables. The students not only shared their PowerPoint presentations of their experiments, but they also discussed the practical results of the findings. Knupfer, Gram, and Larsen (1997) also determined that the course design should be learner-focused. For example, once students completed hands-on and online battery and bulb activities, they had to develop a science analogy following the Teaching With Analogies process (). The sharing of their analogies from their own content areas promoted the free exchange of experiences and ideas.

Structural Assistance

Structural assistance includes how the course was organized and how the course proceeded through the content. Christel (1994) determined that motion-video-interface enhanced the recall of content and ideas. In the science methods course, Sessions 2 and 3 used video demonstrations by the instructor to demonstrate procedures and instructions for hands-on assignments. This was done to ensure that difficult content related to the Nature of Science and inquiry was modeled. For example, an inquiry activity involving candles, water, and a jar was filmed and placed on the course site to ensure proper procedure, technique, and order of steps. Since inquiry has been determined to be a difficult process and theory to learn as a lateral entry science teacher (Veal, 2002), the video demonstration provided scaffolding to increase the ability of these students to learn about inquiry.

Even though the video demonstrations were non-interactive, the online science methods course contained multiple outlets for interactivity. Meyer and Chandler (2001) determined that a modest amount of interactivity promoted deeper cognitive learning based upon cognitive load theory. This course combined online discussion with individual and group assignments that include hands-on activities, readings, PowerPoint presentations, and homework.

Greene and Land (2000) determined that guided questions help students focus and develop ideas. The online science course used PowerPoint presentations to introduce content. The slides included specific questions that guided the students through the content and asked them to stop and think about the content previously discussed or to predict what might be on the next slide. Specific directions were given to the students to write down answers to the questions before continuing to the next slide. This type of presentation allowed for guided instruction to occur in an online format. Greene and Land (2000) also found that student-student interactions over shared experiences influenced students' ideas and encouraged them to expand, formalize, and refine their reasoning. Several online discussions for the science methods course promoted their shared experiences in the classroom since all of the students were teaching in a K-12 classroom during this course. Vignettes (Veal, 2003) based upon theory and related to potential, practical, classroom-based experiences were used to drive 3-week long discussions. Students were encouraged to include their own practical experiences in the discussion. They were also encouraged to share their best practices and lesson plans with each other.

Success Factors

Success factors include those course design elements that encourage students to succeed in the course. Along similar lines as the discussions for the structural assistance, the use of online discussions fostered the success of students understanding the content and sharing of ideas. Daroszewski (2004) showed that sharing clinical experiences in the online environment enhanced nursing students' learning and promoted their mentoring, critical thinking, and socialization. The theoretical and practical vignettes were designed to support this idea for the preservice science teachers. These vignettes were used to establish social interaction so that social construction of knowledge, based upon individual and common experiences in the classroom, would flourish. Vygotsky (1978) stated that discussion should challenge students to reform old and synthesize new knowledge through interaction with others. For example, one set of vignettes allowed the preservice science teachers to discuss science controversies such as the teaching of evolution, dissection, and the care of animals in the classrooms. The intent was to allow the preservice teachers to understand the content and issues and then formulate some practical advice and guidelines for when they experienced these issues in their own classroom.

One way to promote success in face-to-face and online learning environments is to use problem-based and discovery learning. Trinidad and Pearson (2004) used the Online Learning Environment Survey (Fraser, Fisher, & McRobbie; 2003) to conclude that the use of problem-based learning in an online course was effective and practical. In the online science methods course several interactive activities were developed to foster problem-based learning. For example, a Session asked students to develop a method for getting their nano-transported out of the nucleus of different cells within the body. The students had to collaborate on solving the problem and determine the best process for getting out of the nucleus of a cell, through the cell wall, out of a specific organ, and out of the body. Another method to promote online success is to use discovery learning. Hickey (1997) and White and Frederiksen (1998) suggested the use of discovery leaning, when properly planned and structured, to promote students' solving problems and interpret and process information at high levels. The online science methods course used a safety scavenger hunt that allowed students to use a checklist to discover the extent of safety violations in their classroom, laboratory, and storeroom. Once the preservice science teachers discovered what the potential safety problems were, they had to develop a letter to their principal outlining the problems and how best to fix them with minimal cost.

Course Design Conclusions

Research has shown that there are specific design principles that should be used to construct and organize an online course. The science methods course should be no different in how and why they use good teaching techniques. The intent of a well designed online course is to make the interface as transparent as possible. The online discussions are needed and should be designed to reflect the theoretical ideas in science education while also providing an opportunity to apply those ideas in the practical science classrooms of the students. Classroom culture is enhanced with the type of activities and the depth of the discussions. This can be aided by the structural design of the course to include guided questions, video, and interactivity with the content and colleagues. The use of problem-based and discovery learning will also help students become engaged in the course and providing a forum for higher order thinking.

NC TEACH Graduate Success Story

When I made the decision to leave scientific research for teaching, I had no idea how my life would change. I had the desire and the content knowledge to be a science teacher, but I learned quickly that these attributes do not guarantee success in the classroom. In the summer of 2000, I entered NC TEACH also in its first year. The summer program was a crash course including such topics as lesson planning, classroom management, and pedagogy. At first it was difficult to enculturate myself into the educational jargon such as pedagogy, inquiry, and assessment. I had no idea at the time how valuable these classes would be, because I had not yet set foot in a classroom. In the fall of 2000, I began my teaching career with only the NC TEACH Summer Institute, the support structures available at my school, and my ingenuity and perseverance. The rest of this section will focus on my first year teaching, the values I bring from industry to lateral entry teaching, my analysis of NC TEACH as a face-to-face and online teacher, and my accolades for this program.

My first year of teaching was hard and overwhelming, and the support from my NC TEACH cohort and instructors were keys to my survival. Our weekly NC TEACH classes provided a support network, trouble-shooting sessions, and resources that made my first year manageable. Most important to my success was the content area pedagogy and modeling of inquiry teaching that was taught in the science module of NC TEACH. In these courses, I learned how to teach science, and I realized that a thorough knowledge of the content was not the most important attribute of a teacher. Though content knowledge is a wonderful tool, engaging students, managing a classroom and designing meaningful and relevant lessons for my students were equal necessities. NC TEACH helped bridge the gap between desire and practice by providing these tools. The mentoring from fellow teachers, my instructors in NC TEACH, and the consistent support were the most valuable aspects of the program. These kept me in the classroom during my difficult first year.

Many of the skills I used in my scientific research on the symbiotic bacteria in termite hindguts provided a unique skill set that continues to enhance my teaching. In research, I learned to be creative and ingenious in addressing problems and questions, and these skills have served me well as a teacher. In addition, as a researcher I was very comfortable with learning and implementing new technologies, and these aspects of my former career are visible in my classroom where technology is used on a daily basis. As a researcher, I also learned how to successfully develop collaborations, which I have also integrated into my teaching through partnerships with local scientists and other educators at all levels. Research also necessitates careful reflection and analysis which transfer readily to my teaching. NC TEACH helped me hone these skills and make me a truly reflective practitioner in the classroom. My colleagues who entered with me the first year and the subsequent cohorts strive for professional opportunities more than the traditional teachers with whom I work. For example, many of my NC TEACH colleagues have pursued their masters' degrees, National Board certification, district and state teaching awards, professional development opportunities, and other awards.

The increased online presence of NC TEACH adds to the flexibility of the program. During my tenure with NC TEACH, both as a student and currently as an instructor, I have witnessed the change to more online mentoring and instruction. My cohort developed our own online chat room which for several years even after the completion of the program was a sounding board for support, suggestions, and ideas. This idea has been expanded, and online communication serves as an easily accessible, immediately available resource for beginning teachers in the program. In addition, the stress of attending classes during the week or on the weekends is difficult during the already hectic first year of teaching. As a result of its flexibility and convenience, the online model of NC TEACH is effective in providing the pedagogical tools and mentoring first year lateral entry teachers require. As I have developed into a NC TEACH instructor, I have progressively incorporated a hybrid course that utilizes an online component. I have come to realize that the nature of the online environment is vital as long as it is developed appropriately. My students have appreciated the nature of the hybrid course for content, structure, and scheduling. Because teachers in NC TEACH are often self-motivated individuals with a strong desire to be great teachers who actively seek advice and resources, the online forum is an effective tool.

Lateral entry teachers need modeling of good teaching practices. They need support on many levels to help them trouble-shoot and address the diverse issues they face. They need coaching, critical feedback, support and encouragement, and they need help navigating the licensure process. NC TEACH was created and continues to evolve to meet these needs. NC TEACH success stories abound, and I am proud to be one of them. I am confident that as data are collected on past and future cohorts it will show that we are great teachers with high rates of National Board Certification and other accolades. NC TEACH laid the pedagogical groundwork, provided the necessary mentoring tailored to our needs, and made us reflective practitioners. These key attribute of the program coupled with our content knowledge and eagerness to enter the teaching professions make us great teachers who have the skills to effectively transfer our scientific knowledge and experiences to the classroom, thus enriching the education of our students.

Future Research

Due to the limitations of the numbers of students in the past two years to take the full online version of NC TEACH for science methods, no significant and valid research studies were conceived, implemented, and carried out. Future research will have to include more subjects and the use of experimentally based, randomly assigned participants to study individual components of the online science methods course. Due to the large scale use of online discussion in this course, it will be imperative to use theoretical models to conduct research studies. For example, more studies like the one conducted by Kanuka and Anderson (1998) that used a model of mass communication should be conducted. The model of mass communication contains a five-stage process that describes the level of students' knowledge construction. Thomas (2002) provided another potential theory of communication that can be used to discover the extent and effectiveness of online communication. Thomas' study used a five-level taxonomy of cognitive engagement (Biggs & Collis, 1982) to assess students' online interaction.

Other issues related to the success of NC TEACH also need to be studied. Based upon our experience developing the program and curriculum, teaching face-to-face and online science methods courses, and researching lateral entry science teachers, we have developed a set of core research questions that need to be included for policy makers and funders.

1. How effective can an online program be for developing and mentoring lateral entry science teachers? This question can only be answered when there is a critical mass of lateral entry teachers who can be randomly assigned to two types of instruction thus comparing online with face-to-face. Even though distance education and online instruction have been shown to be as effective, there needs to be solid research for the development of lateral entry science teachers' knowledge and skills. This leads us to our next question.
2. How can scientifically based research methods be used to study how lateral entry teachers learn to translate their content and experiential knowledge? Too many studies are not valid and reliable, and most don't use valid instruments. Research design must be implemented in future studies to analyze the online course design and communication aspects of online teaching. In order to do this the numbers involved in studies needs to drastically increase indicating that multiple universities may have to collaborate and share students.
3. What knowledge is of most worth for the development of lateral entry science teachers? Just as the debate rages for face-to-face instruction, we need to analyze what experiences, content, and skills should be placed online for preservice teachers to learn.
4. What are the most important parameters and knowledge necessary of lateral entry science teachers for entering a classroom and becoming highly qualified?

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Table 1.
NC TEACH Cohort statistics for years 2000-2004

	2000-01	2001-02	2002-03	2003-04
Total Applications	289	419	1427	1075
Enrolled in Program	124	190	458	452
Completed Program	87	161	426	428
Age Range	26-60	22-61	22-62	22-61
Average Age	37	37	36	41
% Female	50	64	68	59
% Male	50	36	32	41
% White	85	82	77	67
% Black	10	16	17	24
% Other	5	3	5	9
Average GRE	1092	1070		
Average U-GPA	3.06	3.18	3.12	3.27
% with Advanced Degrees	29	21	19	20
# and % of Secondary Science	12 (10)	27 (14)	51 (11)	50 (11)
# and % of Middle Grades Science	13 (10)	20 (10)	36 (8)	32 (7)
% Employed	97	96	93	95

Table 2.

NC TEACH Science Curriculum Topics

NC TEACH Suggested	Science Curriculum Session	Titles for Science Module
NC Standard Course of Study	All sessions	Chemistry, Physics, Biology, Earth Science
Techniques and strategies for teaching	Modeled in all sessions	Science Misconceptions and Discrepant Events
Resources and textbooks	Curriculum and Resources	Share-a-Thon
Trends in science	Trends in Science Education	Science Education Reform/ Science Controversies
Lesson planning	All sessions	Chemistry, Physics, Biology, Earth Science
Course planning	Curriculum and Resources	Curriculum and Resources/ Special Populations
Related reading and resources	All sessions	
Professional organizations	Professional Organizations	Professional Organizations
Teaching reading	N/A	N/A
Needs of special students	Special Populations	Special Populations
Praxis content review[a]	Praxis	Grant Writing, Praxis, and End of Course

Testing

a. Teachers obtaining initial certification in the state of North Carolina must take the science content and science pedagogy components of the Praxis exam.