Consortium for Educational Research and Evaluation– North Carolina

# STEM Affinity Networks

## Year 1 Report

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# STEM AFFINITY NETWORK: FIRST YEAR EVALUATION

## Executive Summary

### *Introduction and Evaluation Goals*

North Carolina's four-year Race to the Top (RttT) grant provides an unprecedented opportunity to further the state's vision for science, technology, engineering, and mathematics (STEM) education and to develop its understanding of what constitutes a successful STEM school. The RttT STEM schools initiative will support two major activities in North Carolina:

- Establishment of four STEM anchor schools (STEM-focused high schools that will serve as regional leaders in STEM education), each of which will be focused on a major area relevant to North Carolina economic development (health and life sciences, biotechnology and agriscience, energy and sustainability, and aerospace); and
- Support for and growth of a broad network of STEM schools across the state, with the anchor schools serving as centers for professional development for principals and teachers in these networked schools.

This report on the first year of the RttT STEM implementation activities provides a descriptive study and documentation of the implementation of the RttT STEM initiative in participating schools. Additionally, it provides formative feedback on the initiative's long-term goals of building articulated and cohesive models of a STEM school and of a network of STEM schools.

The evaluation is guided by the following research question:

> *To what extent have the following elements of the network of STEM anchor and affinity schools been implemented as intended?*
>
> - *A structure for the network of STEM anchor and affinity schools;*
> - *Professional development for STEM school teachers and principals;*
> - *Curriculum of the STEM schools; and*
> - *Partnerships between STEM schools and IHEs, community, and businesses.*

In addition to documenting project activities to date, this report considers whether these activities as implemented are adequate to ensure the intended short-term outcomes.

### *Data and Methods*

The evaluation is being conducted via a mixed methods approach, with an emphasis on qualitative data and analyses and survey data and analyses; secondary data and analyses play a larger role in the baseline report (submitted December 2011) and in the final phase of the evaluation (2014). Qualitative data for this report consist of various project documents collected by the North Carolina New Schools Project (NCNSP), as well as observational and interview data collected by the RttT STEM evaluation team.

***Findings and Recommendations***

Findings and recommendations are organized in the following sections:

*Creating an Articulated and Cohesive Model of a Network of STEM Schools*

*STEM School and Network Model Implementation*

*I. Structure of the Network*

*II. Professional Development*

*III. Development of Integrated Curriculum with Project Units*

*IV. Partnerships*

*Creating an Articulated and Cohesive Model of a Network of STEM Schools*

NCNSP is developing new STEM school and school network models. Creating new models is a complex undertaking that necessarily includes trial and error and refinement of strategies to achieve desired outcomes. The process of refining these models will take a few years.

These new models build on NCNSP's previous success with implementing early college and redesigned school models using NCNSP's Design Principles, and it adds a STEM vision that includes (1) incorporating a STEM theme across all subjects in the school; (2) improving math and science teachers' content knowledge and teaching strategies via extensive professional development; (3) designing and implementing a new project-based STEM curriculum; and (4) becoming a member of a theme-based network of schools, business, and IHE partners. The Design Principles and STEM vision currently are not integrated with each other.

*Recommendation:*

To address the challenges that schools in the network face in terms of learning about and implementing multiple components of the model, the North Carolina New Schools Project should integrate the six Design Principles with the various components of the STEM vision.

*STEM School and Network Model Implementation*

Structures for networking, professional development, curriculum development, and partnerships are somewhat on track; however, as with any plan or proposal, implementation requires a substantial amount of real-time development. In particular, the North Carolina Department of Public Instruction (NCDPI) and NCNSP interpreted two elements of the proposal differently: (1) the criteria for identifying network schools, and (2) deliverables for the integrated curriculum with inquiry-based project unit(s). Delays in identifying participating schools and in reaching a shared understanding regarding deliverables for the curriculum development work subsequently have delayed overall implementation.

*I. Structure of the Network*

*School enrollment.*

- Three anchor schools had students enrolled in the 2010–11 school year, and the fourth will be opened in 2012–13 school year, as planned.
- There were significant delays in establishing the network of affinity schools due to discrepancies in understandings about school eligibility and criteria for selecting schools to participate. The list of

network schools was not finalized until November 2011. These delays affected the effectiveness of the first-year activities and are likely to affect short-term outcomes.

- One of the four anchor schools opened for the 2011-2012 school year, and one will not open until 2012-2013. Therefore, these schools may not be ready to serve as model schools for the first few years of project implementation.

*Face-to-face and online networking among schools.*

- NCNSP provides many face-to-face networking opportunities for participating schools.
- The online community has four types of networks with varying numbers of participants and intensity of communication: (1) main STEM Affinity Network; (2) theme networks; (3) content networks; and (4) school networks.
- The online networks are used mainly for sharing resources and general information and for announcements. The level of interaction online has been relatively low so far, despite moderators' efforts.
- Participants appreciate networking opportunities and express willingness to collaborate across schools.

*Recommendations:*

- To reduce potential negative impacts, initiative leads should develop a plan for getting those schools that joined the network late rapidly up-to-speed with respect to implementation of all model components.
- To increase collaboration among schools, NCNSP should consider assigning groups of schools to complete common tasks or projects together.
- Two of the four anchor schools are brand-new schools; NCNSP may want to rethink the role of these anchor schools as role models for other network schools.
- To address the challenges of designing a new, complex model with a number of schools that are either brand-new or new to the network (including two of the four anchor schools), initiative leads may want to consider continued use of the four NC Learning Lab Schools as sites for study visits by teams from network schools until anchor schools demonstrate excellence in implementing the STEM vision.

*II. Professional Development*

- NCNSP offered 10 formal face-to-face professional development sessions, supplemented by on-site leadership and instructional coaching. The majority of the professional development activities focused on implementing the Design Principles, with an emphasis on using inquiry- and project-based learning to teach math and science content.
- External observers rated the majority of the sessions as accomplishing their goals and as effective or exemplary professional development. An area for improvement that observers identified was the need for additional time and opportunities for participants to reflect on what they had learned and to consider its application in the classroom.
- Participants identified the most significant barriers for implementation as those related to: (1) obtaining buy-in for the work from the different constituencies; and (2) having time for planning and implementation.

- The potential impact of the professional development was reduced by the changes in the list of schools participating in the RttT STEM network.

*Recommendations:*

- Provide opportunities for schools that joined the network late to catch up via provision of the professional development they will need for successful implementation of the STEM model.
- Provide participants with additional time and opportunities during the professional development sessions to debrief on the activities and discuss how the activities can be implemented in the classroom. It would be particularly useful to help participants explicitly understand the nature of student learning occurring in the activities and how those activities might address (or potentially reinforce if not done well) students' misconceptions about the content.
- Explicitly address concerns about lack of time by providing models of schedules that provide adequate time for collaboration and planning. Additionally, this year, the STEM initiative provided funding for additional planning days in the summer; it might be worthwhile to find additional resources to continue and expand this option.
- To increase buy-in among staff, consider explicit training for leadership teams on creating a common STEM vision for their staff. Part of this involves creating and communicating a well-defined STEM framework with a compelling rationale for its adoption.
- Add STEM themes and new project-based curriculum areas to the coaching report template to help the coaches explicitly focus their work on the STEM vision components.
- To improve the NCNSP's data collection methods, both participant evaluations and event sign-up should be completed online, with all evaluations following a standardized form, designed in conjunction with the evaluation team.

*III. Development of Integrated Curriculum with Project Units*

- NCNSP conducted a number of activities to support the development of project units: a three-day Summer Project Development Workshop; two days of in-school project development; and a two-day Common Practices Symposium in October 2011.
- Most of the 13 schools that participated in the summer are actively engaged in project development; however, only four of those are on the final STEM school network list. The rest of the schools in the network started their project-related professional development in October.
- School staff working on project design encountered a number of challenges, such as: lack of time to do very time-consuming project design work in addition to teacher workload; effective integration of projects with the regular curricula and creation of meaningful experiences for students; and insufficient resources needed for successful project implementation.

*Recommendations*:

- Provide more background knowledge to teachers about the STEM themes and the engineering design process prior to their work on projects.
- Conduct theme-related webinars to make learning more accessible for everyone in the school.
- Encourage schools to work collaboratively on fewer projects, so that they can combine their human resources.

- Engage instructional coaches in supporting the project work.
- Reach shared understanding of expectations for the deliverables associated with integrated curricula with inquiry-based project units, to ensure that NCNSP and the network of schools developing these deliverables align resources to meet those expectations.
- Consider more active involvement on the part of IHE and business partners in designing a project-based curricula.
- Explore the possibility of contracting with a few highly skilled teachers to develop model projects for each of the four affinity networks.
- If the goal is to create a curriculum that is to be used by others, do not rely on school staff to do this unless significant resources are made available for this to occur over the summer.

*IV. Partnerships*

- NCNSP established four Industry Innovation Councils (IIC), one for each affinity network.
- Business and IHE partners started to participate in the network face-to-face events and to provide teachers and principals with their expertise about the network themes.
- Teachers found this sharing of information useful for their STEM-related work in the schools.

***Next Steps***

In preparation for the next report (December 2012), the Evaluation Team plans to:

- Analyze data collected through the end of the 2011–12 school;
- Continue to analyze project documents received from NCNSP related to all professional development and partners' activities;
- Continue to monitor online and face-to-face networking;
- Collect and analyze any products generated by the project development work of participating schools;
- Conduct site visits in the anchor schools (site visits to network schools will occur in Years 3 and 4);
- Analyze coaches' reports and interview selected instructional and leadership coaches about their work and about the effects on schools of participating in the STEM network;
- Conduct at least one focus group with teachers at one of the professional development or face-to-face networking events in the Spring;
- Conduct observations of Industry Innovation Council meetings and focus groups with business and IHE partners about supports they provide to the networks;
- Investigate RttT-funded NC STEM Collaborative activities; and
- Conduct a quantitative analysis comparing the background characteristics of schools in the network with those of other STEM and non-STEM schools in North Carolina.

**Introduction**

Student success in the core content areas of science, technology, engineering, and mathematics (STEM) is essential for North Carolina to develop a workforce that can compete in the global economy. In response to this critical need, over the past decade, North Carolina has developed several K–12 initiatives that are designed to inspire and prepare the next generation of scientists, mathematicians, and engineers, including: STEM-focused high schools; schools that provide one-to-one computer learning environments; and extensive partnerships between high schools, colleges, and universities. These initiatives and others were developed with the expectation that they would result in: more engagement of groups that historically have been underrepresented in STEM areas (e.g., females, minorities, students from low-income families); an increase in access to teachers who are highly qualified to teach STEM content and supportive school settings statewide; provision of and increased enrollment in advanced STEM courses; increased student achievement in math and science courses; increased graduation rates; and an increase in the number of students who are well-prepared for post-secondary STEM opportunities.

North Carolina's receipt of a four-year Race to the Top (RttT) grant from the United States Department of Education in 2010 provides an unprecedented opportunity to further the state's vision for STEM education and to develop its understanding of what constitutes a successful STEM school. The state's RttT proposal recognizes the ongoing need for increased student enrollment in STEM subjects, as well as for additional resources for strengthening STEM instruction statewide. The RttT STEM schools initiative will support two major activities in North Carolina:

- Establishment of four STEM anchor schools (STEM-focused high schools that will serve as regional leaders in STEM education), each of which will be focused on a major area relevant to North Carolina economic development (health and life sciences, biotechnology and agriscience, energy and sustainability, and aerospace); and
- Support for and growth of a broad network of STEM schools across the state, with the anchor schools serving as centers for professional development for principals and teachers in these networked schools. The anchor schools will support the network by providing instructional coaches, residencies for principals and teachers, peer school reviews, project-based learning curriculum development based on the Grand Challenges of Engineering curriculum, and models for innovative technology use and for collaboration and partnership with business and other STEM partners.

North Carolina's RttT proposal also includes a commitment to evaluate the initiatives outlined in the proposal. This evaluation will take place over the full term of the grant (2010–2014) and is designed to determine the impact of each initiative on STEM-specific goals (outlined in the Background section) as well as on more general student outcome goals set by the state in its application. This report is the second of two first-year reports on RttT-funded STEM activities. The first report (finalized in December 2011) provided a baseline overview of pre-RttT STEM schools across the state. This second report focuses on initial progress toward meeting the STEM-related goals of the grant.

The evaluation is being conducted by the Consortium for Educational Research and Evaluation–North Carolina (CERE–NC), a partnership of the SERVE Center at the University of North Carolina at Greensboro, the Carolina Institute for Public Policy at the University of North Carolina at Chapel Hill, and the Friday Institute for Educational Innovation at North Carolina State University.

## Background: Context for the Initiative

The RttT STEM Initiative builds on the state's extensive work in high school redesign and in STEM education. In particular, it builds on the high school redesign work led by the North Carolina New Schools Project and is part of a larger statewide vision for STEM. In this section, we provide a brief overview of each aspect.

### *High School Redesign (North Carolina New Schools Project)*

The North Carolina Department of Public Instruction (NCDPI) contracted the major part of the implementation of the RttT STEM initiative to the North Carolina New Schools Project (NCNSP). Activities implemented for this initiative by NCNSP build on its seven previous years of experience developing innovative high schools, the total number of which has grown to over 100 (North Carolina New Schools Project, n.d.).

NCNSP's RttT-funded work builds on its experience in transforming existing schools and establishing new schools of two types: (1) Early College High Schools, and (2) redesigned small schools, many of which had a STEM focus.

Early colleges are typically located on the campuses of two- and four-year colleges and universities, and allow their students to graduate with both a high school diploma and two years of transferable college credit or an associate's degree. A typical early college's target population consists of students who often are under-represented in college: minorities, students from low-income families, and those whose parents never attended college. There are currently 74 early colleges supported by NCNSP in North Carolina that provide services for students in all 100 North Carolina counties.

Redesigned small schools are theme-based high schools that were originally part of comprehensive high schools. The first group of these redesigned schools opened in Fall 2005 and was centered on the theme of health and life sciences. Later schools were centered on different themes, some of which were related to STEM topics.

A specific subset of the redesigned high schools included 14 STEM schools that were part of an effort to turn around low-performing high schools. The first 10 of these high schools graduated their first students in 2011. These schools received targeted STEM professional development and were designed to change students' achievement in and engagement with STEM disciplines, as well as their perceived abilities and interest in science and mathematics.

Two early colleges and two redesigned small high schools (both STEM-themed) were identified as Learning Laboratory Schools, which were intended to "serve as showcases of teaching and learning that ensure all students graduate ready for college, careers and life. Through rigorous application of the NCNSP Design Principles, these schools have demonstrated success in improving student achievement, eliminating dropouts and increasing the job satisfaction of teachers" (North Carolina New Schools Project, n.d.). These schools received additional support and essentially function as model schools, hosting teams from other schools or even states for a two-day residency experience.

All schools supported by NCNSP are guided by six Design Principles (North Carolina New Schools Project, n.d.; see also Appendix C), which challenge schools to:

- Believe in a common set of high standards and expectations that ensure every student graduates **ready for college**—schools maintain a common set of standards for all in order to eliminate the harmful consequences of tracking and sorting students.
- Uphold common standards for high-quality, rigorous instruction that **promote powerful teaching and learning.**
- Demonstrate **personalization**—educators must know students well to help them achieve academically.
- **Redefine professionalism**, creating a shared vision so that all school staff take responsibility for the success of every student.
- Work from a **purposeful design** where the use of time, space, and resources ensures that best practices become common practice.
- Empower **shared leadership** embedded in a culture of high expectations and a collaborative work environment to ensure the success of each student.

While innovative high schools supported by NCNSP have been in existence for only a few years, many of them have shown impressive successes in raising student outcomes. More students in redesigned schools and early colleges stay in school and graduate, and fewer students are suspended, compared to the state average. Achievement results have been more mixed, with early college students showing better results on the state tests than redesigned school students (North Carolina New Schools Project, n.d.).[1]

An ongoing experimental study reports that early colleges have a significant impact on student academic and behavioral outcomes (Edmunds et al., 2010; Edmunds, Bernstein, Unlu, Glennie, Smith, & Arshavsky, 2011; Edmunds, Bernstein, Unlu, Glennie, Arshavsky, & Smith, 2011). The study investigates early college schools that used a lottery for student enrollment; therefore, students in the study were randomly assigned into early college and control groups (i.e., those who randomly did not get in and studied elsewhere). The results show that in the 9$^{th}$ and 10$^{th}$ grades, more early college students than control students successfully completed college preparatory math and science courses, and more early college students than control students enrolled in college preparatory courses in other core subjects. Early college students have: significantly fewer absences and lower suspension rates; higher continuous enrollment in school through the 10$^{th}$ grade; higher aspirations to attend four-year college; higher levels of engagement; and more challenging work than students in the comparison group (Edmunds et al., 2010; Edmunds, Bernstein, Unlu, Glennie, Smith, & Arshavsky, 2011). Early college students also reported higher levels of implementation of specific policies than did comparison students, including better relationships with staff, more rigorous and relevant instruction, higher academic expectations, and more academic and social support (Edmunds, Bernstein, Unlu, Glennie, Arshavsky, & Smith, 2011).

These results are consistent with the results of a quasi-experimental study using an interrupted time series design that indicates that early colleges had a significant positive impact on students' course taking and progression through the mathematics college preparatory sequence. The study also suggests that early colleges narrow differences in on-track progression rates across race/ethnicity, parental education, and prior (8$^{th}$ grade) mathematics test scores (Miller & Corritore, 2011).

[1] These results differ somewhat from results reported in CERE–NC's previous STEM report, *North Carolina's STEM High Schools: An Overview of Current Data* (Corn et al., 2011) because the set of schools analyzed in that report included STEM schools only and also included schools outside of the NCNSP network.

***Statewide STEM Work in North Carolina***

The RttT-funded work of NCNSP is a part of a larger statewide STEM initiative. Over the past year, state education leaders, including the Governor's Education Cabinet, leadership at NCDPI, community colleges, state universities, the Joint Legislative Joining Our Business & Schools (JOBS) Commission, and the NC STEM Advisory Panel, have met regularly to develop a coordinated, statewide STEM Education Strategy focused on:

- Identifying, incentivizing and aligning the Attributes of Effective STEM Schools that advance our state's goals (Appendix G);
- Increasing North Carolina's student, teacher, and institutional K-12 STEM Achievement;
- Gaining and sustaining broader Community Understanding and Support for the needs of a knowledge-based economy; and
- Connecting, leveraging, and increasing STEM Resources across public and private sectors to improve North Carolina's citizens and their economic future.

According to the RttT proposal, "While RttT funding will be used to advance the development of the initial four STEM-anchor schools and their associated "cluster" networks of affinity schools, state, local, and other funding will support further development of other schools and networks (e.g., Project Lead the Way, Health Sciences, Schools-within-Schools) across the larger STEM network" (North Carolina Office of the Governor, 2010, p. 222).

As part of the RttT initiative, NCDPI awarded a RttT-funded contract to the NC STEM Collaborative, which was charged with scaling effective practices across North Carolina school districts. In addition to the networks developed by NCNSP, the NC STEM Collaborative will create networks of STEM schools in the state, which will develop STEM attributes defined by the state. Additionally, the NC STEM Collaborative will create a web-based communication platform and provide technical assistance and resources for network members. These networks of additional STEM schools and the web-based communication platform will provide opportunities for utilizing curriculum, resources, and best practices developed by the schools in the NCNSP networks. During the first three months of the contract, the NC STEM Collaborative helped to develop a state STEM Education Strategic Plan, which was approved by NCDPI and the State Board of Education in November 2011. It is in the development stage for some of the STEM resources, and in the planning stage for the STEM Web Portal and Network infrastructure. A more detailed report about RttT-funded NC STEM Collaborative activities will be provided in the Year 2 evaluation report.

## Overview of the RttT STEM Initiative Activities

### *Initiative Objectives and Intended Outcomes*

According to its vision for STEM education in the state, NCDPI defines the following long-term goals (NCDPI 2010, 2011; North Carolina Office of the Governor, 2010):

1. Prepare all students to graduate ready for college and careers;
2. Increase students' achievement and engagement in school;
3. Increase STEM achievement of K-12 students;
4. Increase graduation rates and college enrollment;
5. Align school innovation with economic and workforce development;
6. Build the infrastructure for a core of STEM learning networks and systems across the state; and
7. Develop an articulated and coherent model for a STEM school and a STEM network of schools that can serve as a model for scaling up.

One of the long-term outcomes of the RttT STEM initiative will be a more fully developed model for a STEM school and a STEM network of schools. Currently, this model is not fully articulated. Instead, components of the model are described in different documents. The short-term outcomes, presented in Figure 1 below, summarize the current vision for the STEM school and network models, as related to students, teachers, and principals in the STEM schools, as well as for the schools themselves and the network overall. The descriptions of short-term outcomes are based on interviews with the NCNSP staff implementing RttT STEM initiative and on NCNSP guiding documents that present NCNSP's current vision for the STEM schools (Appendix C). One goal of this report is to analyze the RttT STEM initiative's progress toward the development of a fully articulated and coherent curriculum, instruction, assessment, and professional development model consistent with the NC vision for STEM education.

Figure 1 (following page) presents the implementation strategies for the STEM school and network models, as described in the NC Race to the Top Detailed Scope of Work (NCDPI, 2010).

*Figure 1. RttT STEM Logic Model*

**Implementation Strategies**

*1. Structure*

a. STEM High Schools: Develop/establish 4 anchor schools and recruit, interview and select 16 network schools.
b. Create infrastructure for the face-to-face and online collaboration.
c. Support technology purchases to outfit classrooms to support STEM education in the anchor schools.

*2. Professional Development*

a. Principals: Provide on-site leadership coaching for principals in the STEM network schools for approximately 12 days per year to support their development as effective leaders. Provide Leadership Institute for principals. Also, take each principal on one study visit to a national model school.
b. Teachers: Teams of teachers from anchor and network schools participate in professional development focused on content and instruction in math and science. Teachers will have access to "Critical Friends Group" and facilitated Peer School Reviews, as well as other programs.
c. Instructional Coaching: Provide instructional coaches to work on-site with classroom teachers at the STEM network schools for approximately 60 days per school per year to improve teaching practices.
d. Residencies in Model Schools: One-week residencies in national-model schools for staff from each STEM network schools.
e. Peer school reviews

*3. Project-Based Learning Curriculum:*

Develop a $9^{th}$-$12^{th}$ grade integrated curriculum with at least three inquiry-based project unit(s) within the health and life sciences, biotechnology and agriscience, energy and sustainability, and aerospace and security themes.

*4. Partnerships:*

Work with Industry and other STEM partners to design, evaluate, and disseminate all digital project resources to a broader range of NC schools.

**Short-Term Outcomes**

*Students:*

a. Confidence and perseverance when faced with a challenge
b. Ability to gather and analyze relevant information and synthesize knowledge and skills to solve authentic problems; exhibit engineering thinking and decision making
c. Excitement about coming to school and enthusiasm for learning
d. Awareness of and interest in STEM disciplines
e. Increased perceived and achieved abilities in STEM disciplines

*Teachers:*

a. Greater skills at instructional strategies and project-based learning
b. Teaching strategies that engage students in:
   - learning through active solving of real problems; communication and collaboration skills
   - in deep discourse, marked by discipline-based justifications
   - creativity building

*Principals:*

a. Leadership skills described in the Leadership Design Principle
b. Vision for STEM learning

*Schools:*

a. Fidelity to the six New Schools Project design principles
b. Culture of collaborative inquiry among faculty and students
c. Meaningful integration of technology
d. Implementation of integrated curriculum that incorporates theme-based project units and focuses on high-leverage Common Core Standards in math and Essential Standards in Science

*Partnerships:*

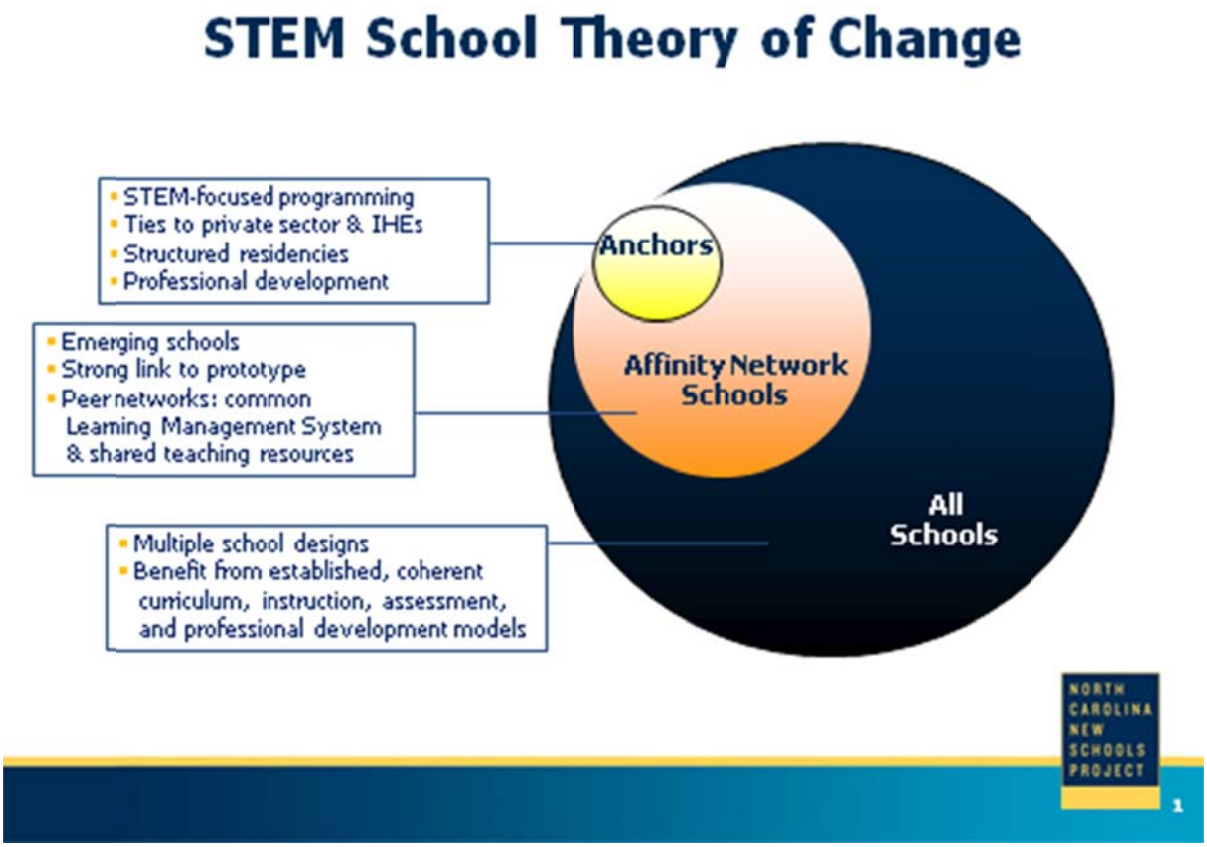
a. Strong partnerships with IHE and business organizations to design, evaluate, and disseminate digital project resources
b. Online and face-to-face collaboration among teachers, students, and administrators in each network around curriculum, instruction, projects, and leadership
c. Adequate technological infrastructures to support such collaboration
d. Increased number of students traditionally underrepresented in STEM disciplines enrolled in network schools

***RttT-Funded NCNSP Initiative Strategies***

As stated in NCDPI's detailed scope of work, the objectives of the NCNSP component of the RttT STEM initiative are (1) to work with partners to support the development of a small set of anchor/model STEM high schools that will serve as laboratory schools and sites for professional development around project-based learning; and (2) to develop a set of STEM "cluster" high school networks. "As the hub of each cluster, the anchor school will accelerate the development of a fully articulated and coherent curriculum, instruction, assessment, and professional development model consistent with the NC vision for STEM education" (NCDPI, 2010). Thus, RttT funding is applied to the development of the STEM school model consistent with the state's vision for STEM education, the North Carolina STEM Education Strategic Plan, and Attributes of STEM Schools and Programs (NCDPI, 2011). This model is to be scaled up from anchor schools to the "cluster" or affinity schools, and then to other schools in the state.

NCNSP created the following figure to represent its theory of change for this initiative.

*Figure 2. NCNSP Theory of Change*




In order to achieve the initiative's objectives and intended outcomes, NCDPI in partnership with NCNSP developed the implementation plan outlined in the RttT STEM Logic Model in Figure 1 above.

**Evaluation of the RttT STEM Affinity Network**

***Overview of the Evaluation***

The four-year evaluation of the RttT STEM initiative has the following goals:

- Provide formative evaluation for all RttT activities performed to develop anchor schools and STEM schools networks during the RttT period;
- Provide a descriptive study and documentation of the implementation of the RttT STEM initiative in participating schools;
- Evaluate the initiative's short-term outcomes for students, teachers, schools, and the school network; and
- Evaluate the sustainability and scalability of the initiative and provide recommendations about the continuation and expansion of this initiative to other schools and districts.

This report focuses primarily on the second goal of providing a descriptive study and documentation of the implementation of the RttT STEM initiative in participating schools. Additionally, it provides formative feedback (Evaluation Goal 1) on the initiative's long-term goal of building an articulated and cohesive model of a STEM school and of a network of STEM schools that can serve as a model for scaling up. The evaluation is guided by the following research question and sub-questions:

*Research Question*: To what extent has the network of STEM anchor and affinity schools been implemented as intended?

1. To what extent has the structure of the network of STEM anchor and affinity schools been implemented as intended? Specifically:
    a. How many anchor and cluster schools were developed, and on what timeline?
    b. What infrastructure was developed for the virtual community/network of schools? How was this virtual network used to support teacher and student learning?
    c. To what extent is there online and face-to-face collaboration among principals, teachers, and students around curriculum, projects, instruction, and leadership?
    d. To what extent do schools and their partners in business and in institutions of higher education (IHEs) share resources via the network?

2. To what extent has the professional development for STEM school teachers and principals been implemented as intended? Specifically, describe the implementation of a Leadership Institute for principals; summer content professional development and collaborative project design for math and science teachers; one-week residencies in national and NC model schools; leadership, content, and instructional coaching for principals and teachers; peer school reviews; and other professional development (PD).

3. To what extent has the curriculum of STEM schools been implemented as intended? Specifically:
    a. Do schools use an integrated curriculum that incorporates project units that address the four STEM themes?
    b. How was extended teacher employment used?

4. To what extent have the partnerships between STEM schools and IHEs, community, and businesses been developed? Specifically, who are the partners for anchor schools, and in which ways do they support the STEM schools network?

In addition to documenting project activities to date, this report considers whether these activities as implemented are adequate (based on reasoned and evidence-based judgment) to ensure the intended short-term outcomes as well as the long-term outcome of building an articulated and cohesive model of a STEM school and a network of STEM schools that can serve as a model for scaling up.

***Method***

The evaluation is being conducted via a mixed methods approach, with an emphasis on qualitative data and analyses and survey data and analyses; secondary data and analyses play a larger role in the baseline report (submitted December 2011) and in the last phase of evaluation (2014). Qualitative data consists of various project documents collected by NCNSP, as well as data collected by both NCNSP and the RttT STEM evaluation team. Quantitative data will consist of student and school staff surveys and administrative data collected by NCDPI.

Appendix A provides a summary of methods and data sources that are or will be used in this evaluation.

*Sample*

The participant sample for the current report consists of teachers and principals from schools that were considered to be a part of the STEM network at the time of the implementation of activities being evaluated. Additionally, the evaluation team collected data from the implementation providers.

*Data Sources*

The current report incorporates a variety of data sources collected by both NCNSP and the RttT STEM evaluation team.

NCNSP collected and shared with the evaluation team the following sets of information:

- Agendas for all professional development workshops;
- Registration and sign-in lists for all professional development workshops;
- Participants' evaluations for all professional development workshops conducted by the end of September 2011;
- Leadership and instructional coaches' reports of their activities in the schools;
- Agendas and minutes from Industry Innovation Council meetings; and
- Materials submitted to NCNSP by schools about their planning and work on projects.

The evaluation team collected the following types of original data:

- Observations of professional development;
- Interviews with NCNSP staff;
- Focus group with teachers; and

- Systematic review of posts and interactions on the online networking site, Edmodo.

*Measures*

The evaluation team developed three original protocols to collect data for this report: a Professional Development Observation Protocol, an Interview Protocol for the Teacher Focus Group, and a Protocol for Monitoring the Online Networking Site. The full protocols are provided in Appendix B, and a brief description of these tools follows.

The Professional Development Observation Protocol was adapted from a protocol developed for the National Science Foundation by Horizon Research, Inc. (Horizon Research, n.d.). The original protocol was revised to remove sections and questions not relevant to this projects, and to add sections and questions describing the goals and intent of RttT STEM professional development.

The other two instruments—Interview Protocol for the Teacher Focus Group and Protocol for Monitoring the Online Networking Site—were designed specifically for this evaluation. The Interview Protocol for the Teacher Focus Group was designed to gather teachers' vision for the STEM programming in their schools, their understanding of the role of the STEM Affinity Network, and changes occurring in their schools due to the STEM initiative. The Protocol for Monitoring the Online Networking Site was designed to evaluate the quantity and quality of online interactions among network participants, as well as the nature and topics of these interactions.

*Procedure and Analyses*

Because the RttT STEM initiative is in its beginning phases, the initial emphasis for the evaluation is on describing implementation. As a result, all data sources were analyzed descriptively with an emphasis on understanding the nature of the work that has been completed so far.

The agendas for all meetings were examined to describe the content and intended outcomes of the specific activities. The registration and sign-in lists were summarized to describe school participation levels in the different activities.

Interviews and focus groups with NCNSP staff were used to gather providers' perspectives on the initiative's activities—both those that have been completed and those being planned. A focus group with teachers at one of the workshops was used to gather teachers' perspectives on their schools' participation in the network and the extent of implementation happening in the schools. Focus groups with the NCNSP staff and teachers were audio-recorded and transcribed. These transcriptions were then analyzed for relevant information.

PD observations and participant evaluations were used to describe the quality of professional development and participants' perceptions of the utility of professional development provided to teachers and principals in participating schools, as well as face-to-face networking opportunities. These observations and evaluations were analyzed quantitatively and qualitatively. Participants' evaluations were designed and administered by NCNSP. These forms were not standardized across different professional development offerings, which made comparisons difficult.

Leadership and instructional coaches submitted brief reports after each visit. In these reports, the coaches were asked to provide an update on the implementation of the Action Plan; comment as appropriate on actions taken relative to each of the six NCNSP Design Principles; and identify strengths, areas of concern, and next steps. These reports were analyzed with particular attention to the number and focus of visits to different schools.

The Professional Development Observation Protocol contains both ratings of and open-ended responses about the activities of interest. The ratings were analyzed descriptively to provide the mean ratings and the proportion of certain types of responses (e.g., proportion agreeing). Open-ended responses were coded to identify themes that cut across responses.

The professional development evaluation surveys were developed by NCNSP staff, who then administered them to professional development participants. The results from the scaled survey items and open-ended items were entered into data management files from hard copies of each survey. Scaled responses were analyzed for descriptive statistics, and open-ended responses were coded by theme, topic, and key word.

Analyses of the interactions among the moderators and participants collected from the networking website Edmodo were used to describe the amount and nature of collaboration among the network members. The number and types of posts in various groups in the network were collected for the period from the launch of the site (mid-July 2011) to the date of the collection (early November 2011). The data were analyzed for the average number of posts by moderators and participants and for the average number of responses to these posts.

NCNSP staff asked schools to submit copies of their project plans and provide an update as to activities taken so far to implement projects consistent with the STEM Affinity Network theme. Project documents received from NCNSP and collected from the networking website were used to describe the implementation of activities such as professional development workshops and coaching; the collaborative work on designing the project-based curriculum; and the development of partnerships with IHEs, community, and businesses.

**Findings**

The findings are organized in four sub-sections according to the four specific evaluation questions. They address the extent to which the following proposed strategies have been implemented as intended:

1. Structure of the Network of STEM Anchor and Affinity Schools;
2. Professional Development;
3. Development of Integrated Curriculum with Project Units; and
4. Partnerships.

***Overview of Activities***

Table 1 below provides a comparison of proposed strategies and the actual level of implementation as of November 2011. The details of how these activities were implemented are provided in the sections following this summary.

*Table 1. RttT STEM Initiative Activities through November 1, 2011*

| | Proposed Activities | Implemented Activities |
|---|---|---|
| **Structure of the Network** | STEM high schools: Develop/establish 4 anchor schools and recruit, interview and select 16 network schools. | By November 2011, there were 3 anchor schools and 12 affinity schools enrolled in the network. |
| | Create infrastructure for face-to-face and online collaboration. | NCNSP and participating schools are using the Edmodo platform for online collaboration. They devote time at various professional development events for face-to-face collaboration. |
| **Professional Development** | *Principals*: Provide on-site leadership coaching for principals in the STEM network schools for approximately 12 days per year to support their development as effective leaders. Provide a Leadership Institute for principals. Also, take each principal on one study visit to a national model school. | From the beginning of the 2011–12 school year, six leadership coaches are providing services to network schools. Principals were given the opportunity to participate in the New Principal Institute as well as other professional development workshops. |
| | *Teachers*: Teams of teachers from anchor and network schools participate in professional development focused on content and instruction in math and science. Teachers will have access to a "Critical Friends Group" and facilitated Peer School Reviews, as well as other programs. | Multiple professional development workshops were provided to anchor and network schools in Summer 2011 and the first two months of the 2011–12 school year. Teachers had access to a "Critical Friends Group" workshop and facilitated Peer School Reviews. |
| | *Instructional Coaching*: Provide instructional coaches to work on site with classroom teachers at the STEM network schools for approximately 60 days per school per year to improve teaching practices. | From the beginning of the 2011–2012 school year, 11 instructional coaches, including one math and one science content coach, are providing services to network schools. |

| | Proposed Activities | Implemented Activities |
|---|---|---|
| | *Residencies in Model Schools*: Support one-week residencies in national model schools for staff from each STEM network school. | NCNSP provides opportunities for two-day study visits to four Learning Lab Schools on an ongoing basis. A study visit in Spring 2012 is being planned in an out-of-state school. |
| | *Peer School Reviews*: Teams from peer schools visit an anchor school and each other to provide feedback to support continuous improvement. | Peer School Reviews were scheduled to happen in network schools in October 2011. |
| **Project-Based Learning Curriculum** | Develop a 9th–12th grade integrated curriculum with inquiry-based project unit(s) within each of the four STEM themes. | Professional development participants began developing a school-wide cross curricular unit in the summer of 2011. |
| | Extend teachers' salaries into the summer and provide time throughout the school year, so that they can assist in developing STEM curriculum and align assessment strategies. | School staff used time during a three-day workshop in the summer, during planning days in the fall, and during the Common Practices Symposium in October 2011 to work on project-based curriculum. |
| **Partnerships** | Work with industry and other STEM partners to design, evaluate, and disseminate all digital project resources to a broader range of NC schools. | Three Industry Innovation Councils, consisting of members from businesses and IHEs, were established in August/ September 2011, and one is being established by January 2012 to support the four themed networks. |

### *I. Structure of the Network of STEM Anchor and Affinity Schools*

In this section, we describe NCNSP's efforts to:

1. Develop/establish 4 anchor schools and identify 16 additional network schools; and
2. Create an infrastructure for face-to-face and online collaboration.

*Enrolling Schools into the Network*

Our analyses of the process of school enrollment reveal the following findings:

- Three anchor schools had students enrolled in the 2011–12 school year, and the fourth will be opened in 2012–13 school year, as planned.
- There were significant delays in establishing the network of affinity schools due to discrepancies in understandings about school eligibility and criteria for selecting schools to participate. The list of network schools was not finalized until November 2011. These delays affected the effectiveness of the first-year activities and are likely to affect short-term outcomes.
- One of the four anchor schools opened for the 2011-2012 school year, and one will not open until 2012-2013. Therefore, these schools may not be ready to serve as anchor schools for the first few years of project implementation.

From the beginning of this project in Fall 2010, NCNSP started to invite schools to participate in the STEM Affinity Network and to negotiate with NCDPI about the list of eligible schools. NCNSP conducted informational sessions, had interested schools go through the application and approval process, and had signed Memorandum of Understanding documents with a number of existing STEM schools interested in developing their STEM work by adding engineering project design work and math and science content-specific coaching. This was done in accordance with the RttT proposal, which states that "beginning with the STEM-themed high schools already operating in NC," the plan was to develop 4 anchor and 16 affinity schools in four selected themes (Health and Life Sciences, Energy and Sustainability, Biotechnology and Agriscience, and Aerospace and Security). By the start of the Summer 2011 professional development offerings, there were at least 15 schools in the network clustered around three themes, three of which were anchor schools (one of which opened its door to students in 2011–12 school year).

Throughout the first year of the project, NCNSP and NCDPI worked on reaching a shared understanding about which schools were eligible for enrollment into the network. NCDPI stipulated that, with the exception of the anchor schools, the eligible schools should only include those schools that had not previously received NCNSP services. These terms made many of the schools already enrolled in Spring 2011 ineligible to receive RttT-funded services from NCNSP. The final understanding between NCDPI and NCNSP on the list of eligible schools was reached in November 2011, and the list was shared with the evaluation team on November 14, 2011. The list of schools is provided in Table 2 (following page).

As a result of the length of this process, some of the schools that were enrolled in Spring 2011 and that received professional development services from NCNSP in June through October are no longer part of the RttT-funded STEM network. These schools may, however, still participate in an extended STEM Affinity Network that NCNSP plans to support. Additionally, some of the schools that are on the agreed-upon network list did not start receiving NCNSP services until the end of October. As a result, in this report we describe activities that were received by both groups of schools: those that were initially in the network and those that joined later in the process.

These delays in finalizing which schools will belong to the RttT-funded STEM network have broad implications for effectiveness of implementation activities and for the short-term outcomes of this initiative. These implications will be discussed throughout this report.

*Table 2. Schools Enrolled in the STEM Affinity Network as of November 2011*

| School System | Name of School | STEM Theme | Year Joined Network |
|---|---|---|---|
| Craven County | * Craven EAST Early College | Aerospace and Security | 2011 |
| Durham County | * Durham City of Medicine Academy | Health and Life Sciences | 2011 |
| Wake County | * Wake NCSU STEM Early College High School | Energy and Sustainability | 2011 (new school) |
| Washington County: Beaufort, Martin, Pitt, Tyrell, and Washington | * Northeast Regional School of Biotechnology and Agriscience | Biotechnology and Agriscience | 2012 (new school) |
| Avery County | Avery County High School | Energy and Sustainability | 2011 |
| Bertie County | Bertie High School | | 2011 |
| Columbus County | East Columbus High School | | 2011 |
| Columbus County | South Columbus High School | | 2011 |
| Columbus County | West Columbus High School | | 2011 |
| Davidson County | Yadkin Valley Regional Career and College Academy | Aerospace and Security | 2012 (new school) |
| Davie County | Davie High School | | 2011 |
| Duplin County | East Duplin High School | Biotechnology and Agriscience | 2011 |
| Duplin County | James Kenan High School | Biotechnology and Agriscience | 2011 |
| Duplin County | North Duplin High School | Biotechnology and Agriscience | 2011 |
| Duplin County | Wallace Rose Hill High School | Biotechnology and Agriscience | 2011 |
| Durham County | Southern Durham High School | Energy and Sustainability | 2011 |
| Guilford County | Guilford STEM Early College High School A & T | | 2012 (new school) |
| Guilford County | Middle College at UNC–Greensboro | Health and Life Sciences | 2011 (new school) |
| McDowell County | McDowell STEM Early College High School | | 2012 (new school) |
| Wake County | Leadership Academy | Aerospace and Security | 2012 (new school) |

*Note*: An asterisk (*) designates an anchor school.

As is evident from the table, of the four anchor schools, one opened as a brand-new school in August 2011, and the second is scheduled to open as a brand-new school in August 2012. The two remaining anchor schools have been supported by NCNSP for one and four years, respectively. Having two brand-new schools as anchor schools may require NCNSP to rethink the role of anchor schools as role models for other network schools, at least in the first few years. As stated in the proposal, the anchor schools are expected to be "providing support for peer schools within each cluster, including peer school reviews, in which teams from these peer schools visit an anchor school to observe classes, collect data, and provide feedback on teacher-developed questions about student learning and questions about school-wide practices to support continuous improvement; and accelerating the development of a fully articulated and

coherent curriculum, instruction, assessment, and professional development model consistent with the NC vision for STEM education" (North Carolina Office of the Governor, 2010). It will be challenging to expect new schools to operate immediately as models. In fact, during the 2011–2012 year, NCNSP is using its four existing NC Learning Lab Schools (two of them are STEM schools) as the sites for study visits by teams from other schools in the network, instead of the four anchor schools. The NC Learning Lab Schools have been intensively supported since 2007 with the explicit purpose of creating high-functioning schools that can serve as models for other schools.

Seven of twenty schools are brand-new as of 2011 or 2012, and a number of schools are regular comprehensive schools in their counties. Over the duration of this project, these schools aim to accomplish a very ambitious set of goals: (1) learn about and implement NCNSP's six Design Principles, including changing their way of teaching (project- and problem-based learning) and possibly implementing a new curriculum in math and science; (2) become a STEM school with a theme, learn about this theme, and implement it within all subjects; and (3) participate in designing and implementing a new cross-subject project-based curriculum that addresses the Grand Challenges of Engineering, for each of the four high school years. For the brand-new schools, there is an added challenge of the logistics that accompany creating a new school. Each of these goals by itself may require a few years of very intensive and time-consuming work by all school staff in order to achieve success. Implementing them all at the same time creates a very steep challenge for the schools in the RttT STEM network.

*Face-to-Face and Online Networking*

NCNSP believes that a combination of face-to-face and online networking is the best solution for teacher learning and collaboration for innovative work, so both forms of networking are a part of the STEM network design. Face-to-face interactions provide opportunities for people to get to know each other and each other's interests, and online media provide flexibility of time and help to overcome the barrier of distance between network schools.

Our analyses of face-to-face and online networking among schools reveal the following findings:

- NCNSP provides many face-to-face networking opportunities for participating schools.
- The online community has four types of networks with varying numbers of participants and intensity of communication: (1) main STEM Affinity Network; (2) theme networks; (3) content networks; and (4) school networks.
- The online networks are used mainly for sharing resources and general information and for announcements. The level of interaction online has been relatively low so far, despite moderators' efforts.
- Participants appreciate networking opportunities and express willingness to collaborate across schools.

This subsection of the report is organized into two main areas:

1. Networking at face-to-face events; and
2. Online networking

*Networking at Face-to-Face Events*. NCNSP incorporates face-to-face networking in all of its professional development events, with the Common Practices Symposium in October 2011 being the

event in which members from all STEM schools participated. By design, this symposium included time for sharing promising practices and for networking, planning improvements, and collaboration. There were also special sessions scheduled for schools to share the work they have been doing in their schools as part of the STEM network, such as developing cross-curricular projects for one of the four STEM themes.

Additionally, principals are provided with networking opportunities via one of six regional groups in the Leadership Innovation Network, which includes all NCNSP-supported schools. Through these groups, they will meet twice a year to engage in professional development with leadership coaches, NCNSP staff, and their peers, with a focus on Design Principles implementation, building Critical Friends Groups, and other NCNSP priority areas. In the same regional groups, principals and one of their teachers meet twice a year for an Action Planning Session.

There will be more opportunities for schools and student teams to share their work and to learn from and motivate each other at the Student STEM Symposium and the Project-Based Learning Conference in Spring 2012. NCNSP is planning to be more strategic about including students in the networking activities across schools and providing tools for them to connect around themes or projects in which they become interested.

*Online Networking: Edmodo*. NCNSP started an online community (www.edmodo.com) during the Summer Project Development Workshop (July 18–21, 2011) with the expectation that it would be not only a mechanism for NCNSP to share resources, information, and tools with members of the network, but also for schools to share those resources and tools among themselves, have discussions, and solve problems together (according to interviews with NCNSP staff). NCNSP staff indicated that during the last day of the Summer Project Development Workshop, it was made clear to network participants that Edmodo would be the "preferred method" of communication for building the STEM network and for data tracking and evaluation. The Edmodo online community started with the main group—the STEM Affinity Network—which includes members from all STEM schools, and four additional large networks, one for each of the four themes (Aerospace and Security, Biotechnology and Agriscience, Energy and Sustainability, and Health and Life Sciences). Later, by participants' request, additional networks for content subjects and individual schools were added. As of November 2011, there were 21 content subject networks and 14 school networks (Table 3).

*Table 3. Total and Average Number of Participants per STEM Network*

| Edmodo Network Type | Number of Networks | Total Number of Participants | Average Number (Range) of Participants per Network |
|---|---|---|---|
| STEM Affinity Network | 1 | 173 | 173 |
| Theme Networks | 4 | 177 | 43 (4–78) |
| Content Networks | 21 | 225 | 11 (2–77) |
| School Networks | 14 | 300 | 21 (5–97) |

*Note*: All networks include NCNSP staff, district staff, school staff, and evaluators. Some school networks also include students. Each member can participate in multiple networks, so the totals do not represent the number of unique members.

The Aerospace and Security network is an outlier among the theme networks, with only 4 members. This is not surprising, given that there are only three schools in the network, two of which have not yet opened. The number of participants in each of the other three theme networks is greater than 30 participants. Most content networks have fewer than 13 participants. Most school networks have between 7 and 21 participants.

Among the four network types, the school networks had the largest number of participants, with some of them including students. Some schools had been using Edmodo before NCNSP selected it as the tool for the online community. Others hoped that the community would facilitate inter-school collaboration in projects; however, this has not yet happened, according to some teachers' reports during the focus group.

Most activity in the community is being moderated by NCNSP staff, with one NCNSP staff member serving as the main moderator and two other NCNSP staff members also contributing and answering participants' questions. Some of the school networks, particularly those that have student members, have a point person who moderates interaction within the network.

Data from the protocol for Monitoring the Online Networking Site revealed that online community members have used Edmodo to share questions, announcements, assignments, links to online resources, and documents related to their projects. They have posted questions and polls to decide the topic of the project and discuss their project plan, to elicit discussion about a topic connected to the network's theme, and to ask about next steps in their work. The community moderator and NCNSP staff have posted the most announcements in the community, but other network participants also have posted announcements for their networks (e.g., information about a grant competition, time and date of a meeting). NCNSP staff, as well as other network participants, also have shared links to online articles and videos related to the network's theme, such as articles featured in *The New York Times* Health section and videos on math pedagogy. NCNSP staff and participants also have posted resource documents, including project plan templates, time logs, community service logs, photos documenting network members working on their project plans, lesson plans, and PowerPoint slide shows from professional development events. Table 4 provides a summary of the activities in the online communities from the start of the community (month, year) to the date of the report (November, 2011; a period of about three and one half months).

*Table 4. Average Number of Posts per Network*

| Network Activity | Main Network* | Theme Networks | Subject Networks | School Networks |
|---|---|---|---|---|
| Average number of members | 173 | 43 | 11 | 21 |
| Date of the report | 11/7/2011 | 11/9/2011 | 11/7/2011 | 11/7/2011 |
| Date of the first post | 7/18/2011 | 7/18/2011 | 7/18/2011 | 7/18/2011 |
| *Average number of postings by moderators, by type of posting* | | | | |
| Information | 20 | 5.5 | 0.4 | 1.1 |
| Questions | 4 | 0.8 | 0.0 | 8.0 |
| Assignments | 4 | 1.5 | 0.0 | 3.0 |
| Announcements | 10 | 0.5 | 0.1 | 2.1 |
| *Average number of postings by participants* | | | | |
| Information | 17 | 4.0 | 0.4 | 4.1 |
| Questions | 6 | 1.0 | 2.0 | 1.4 |

**Note:* The Main Network column reflects data from a single network, while the other three columns show the average of all posts of the specific network type for the whole reporting period.

Even though data from some networks indicate a fair amount of interaction throughout the three and one half months that the community has been in existence, communication and collaboration remain low within most networks. Some networks, for instance, communicated only during the three days of the Summer Project Development Workshop in response to an assignment. Other networks continued to communicate for a few days after the Summer Project Development Workshop, but then their online

activity stopped altogether. There are various networks, especially school networks that involve students, that continue to interact. For example, a school network composed of 96 members (2 NCNSP staff, 5 school teachers, and 90 students) has been the most active of all the networks. Most posts in this network belong to students—with a large proportion of them being questions about schedules, assignments, or logistic information related to the project.

The average number of replies per post has been very low across all networks. Posts with replies usually have received between one and three replies; very few have received five or more replies. The majority of posts, including some questions, have not received a single reply. In addition, some of the replies lacked substance or did not contribute to discussions of the network themes. The moderator highlighted this issue in the context of network member responses to NCNSP assignments. The moderator assigned various targeted tasks—shown in the community as assignments with due dates—to which network members were slow to respond. For example, the moderator asked them to write a 100-word reflection and submit any documents supporting their progress on the network, but "slightly less than 50%" submitted them initially. It took "a lot of backend e-mailing" to participants (by NCNSP staff) to get them to submit that information. The moderator believes that even though NCNSP provides templates for documents that participants need to submit, perhaps additional clarification is needed on specific expectations for engaging in online networking, including timelines and emphasis on purpose.

The topics that generated the most posts were either responses to assignments by the moderator or links to resources. School networks featured the largest variety of topics with multiple posts. Documents, agendas, forms, announcements, and presentations pertinent to project planning; information about grants; and online information related to network themes were the focus of many posts in the school network.

Despite the low level of interaction observed in various networks, there is some indication that the online community facilitates the sharing of resources and information as well as collaboration between NCNSP and community members and among community members themselves. The analysis of the content of postings from the first three and one half months of the online community shows that:

- Many participants expressed excitement about being part of the community and were looking forward to working with their networks;
- Moderators and participants posed questions and posted resources pertinent to the network themes;
- Moderators and participants shared documents using the features available on the online community (e.g., Library);
- The moderator and some participants sometimes made an effort to further a discussion by replying to questions or commenting on resources;
- The moderator and participants utilized interactive features of the community (e.g., hyperlinks, RSS [Rich Site Summary] feeds, polls) to enhance communication and access to information; and
- Theme networks, and some school networks that include students, communicated in more depth and more often than did subject networks (although many exchanges were superficial or peripheral to STEM).

Factors such as participants' multiple network affiliations, lack of local network leaders, and unclear expectations may have affected the quantity and quality of online activity in the community. It is also possible that the excitement of encountering a new tool led participants to create networks without a clear goal or purpose for the network. To increase interaction, it may be helpful to have a collaborative project as a goal for the network. As some of the more active networks show, it also may be helpful to have network leaders (in addition to the formal moderator) or student members who take an active role in

guiding the local network. Finally, NCNSP staff pointed out that they might need to clarify their expectations to the network members regarding the community. To address this last issue, NCNSP plans to emphasize the goal and expectations of the online community to participating schools in future meetings.

*Participants' Perceptions of the Value of Face-to-face and Online Networking*

Participants generally appreciated the opportunity to network with others. When asked an open-ended question about the most valuable part of the summer professional development, almost one-third of participants commented on the opportunity to collaborate with other teachers. Below are some quotes about the most valuable aspects of the professional development:

- "Being able to network with other math teachers and discuss some of the things we learned this week."
- "The chance to work with different teachers and have ideas communicated about ways they do things in their class."
- "Working with other schools and hearing their ideas on the project and how they plan to work this into their curriculum."

At the focus group during the Common Practices Symposium in October 2011, teachers commented that they appreciated the opportunity to collaborate with other schools both online and face-to-face and that they wanted more opportunities to do so. Part of the challenge for networking with other schools has been the diversity of the projects on which different schools are working. As one teacher commented during the focus group, she expected that all schools would be working on the same project and collaborating with each other, "But I think logistically and resource-wise, the materials aren't there for us to be able to interact with [other] schools the way that we had thought we would be able to."

Face-to-face and online networking across schools is one of the design features of the STEM network model, and as currently implemented, it is appreciated by participants. Collaborating on common projects and having network leaders facilitating collaboration may help in increasing network interaction. An expectation of the STEM network model is to use Edmodo for learning opportunities and online networking with each other, and as one of the NCNSP staff indicated in the focus group, this expectation may become a part of the Redefined Professionalism Design Principle and corresponding rubrics for the STEM schools. As NCNSP continues to build an articulated and cohesive model of a network of STEM schools, it may consider articulating the networking expectation in both the Redefined Professionalism Design Principle and corresponding rubrics for the STEM schools. This expectation then may become a part of schools' continued conversation and reflection on their progress.

A full discussion of specific recommendations for addressing issues related to improving the anchor and affinity school network structure appear in the Conclusions and Recommendations section.

## *II. Professional Development*

Our analyses of professional development activities reveal the following findings:

- NCNSP offered a total of 10 formal face-to-face professional development sessions, supplemented by on-site leadership and instructional coaching. The majority of the professional development activities focused on implementing the Design Principles, with an emphasis on using inquiry- and project-based learning to teach math and science content.
- External observers rated the majority of the sessions as accomplishing their goals and as effective or exemplary professional development. An area for improvement that observers identified was the need for additional time and opportunities for participants to reflect on what they had learned and to consider its application in the classroom.
- Participants identified the most significant barriers for implementation as those related to: (1) obtaining buy-in for the work from the different constituencies; and (2) having time for planning and implementation.
- The potential impact of the professional development was reduced by the changes in the list of schools participating in the RttT STEM network.

In this section, we examine the nature and quality of professional development provided through the RttT STEM initiative. As noted above, the list of participating RttT schools was not finalized until November 2011. This means that most of the professional development activities were provided to schools that were initially considered to be RttT schools but that were not ultimately on the final list. Given the delay in identifying the final list of schools, the evaluation team collected data on the professional development experiences for all schools that were initially considered to be part of the network.

Professional development activities, including workshops, institutes, visits to model schools, and on-site coaching, are the main strategies NCNSP used to convey its vision for the STEM schools to the participants in the network, to familiarize them with multiple components of the model, and to provide them with knowledge and tools necessary for successful implementation of the model. As described earlier, the model components include: (1) NCNSP's six Design Principles (Appendix C), which includes specific instructional practices; (2) a specific STEM theme; and (3) a new cross-subject project-based curriculum that addresses one or more of the Grand Challenges of Engineering.

This section of the report is organized into three main sub-sections:

1. Professional development activities, including their content and delivery structure;
2. Quality of the professional development; and
3. Potential barriers and additional support needed for implementing the knowledge and materials from the professional development activities.

### *Professional Development Activities*

Through the end of October 2011, NCNSP provided a total of 10 formal face-to-face professional development opportunities to network schools in addition to on-site instructional and leadership coaching. Table 5 (following page) lists the professional development sessions, their content, and the number of participants at each session. A team of participants attended from each school; these participants were then expected to share the information with their colleagues back at their school. As shown in this table,

most of the workshops were devoted to building an understanding of the Design Principles, with a particular emphasis on the Powerful Teaching and Learning principle of teaching math and science content in new ways.

*Table 5. Professional Development Sessions Offered to Network Schools through October 2011*

| Workshop | Dates | Content | Number of Participants[a] | Number of Schools |
|---|---|---|---|---|
| Summer Institute | June 21–23 | Math and Science content; Grand Challenges of Engineering: Inquiry and Problem-based Learning | NA[b] | NA[b] |
| Math Content (Core Plus) | July 11–15 | Inquiry and Problem-based Learning; CIF; Math content | 12 | 8 |
| Modeling Science | June 28–30 | Inquiry and Problem-based Learning; CIF; Science content | 5 | 4 |
| Environmental Science | July 11–15 | Inquiry and Problem-based Learning; CIF; Science content | 10 | 6 |
| Project Development | July 18–20 | Project-based Learning; Designing Project-based Curriculum | 63 | 14 |
| New Principal Institute | Sept. 14 | NCNSP Design Principles; Observing Classrooms | 10[c] | 10[c] |
| New Teacher Institute | Sept. 28–29 | NCNSP Design Principles; CIF; Role of Instructional Coach | 35[c] | 18[c] |
| Critical Friends Group | Sept. 20–22 | Building Professional Learning Communities | 10 | 5 |
| Common Practices Symposium (CPS) | Oct. 25–26 | Exploring the four STEM themes; exploring various approaches to implementing "engineering"; deepening understanding of issues and current research around school themes; sharing project implementation in the schools | 53 | 26 |
| Learning Lab Schools Visits | multiple | Experiencing/observing the NCNSP Design Principles and CIF in action in model schools | 62 | 17 |

*Note:* CIF = Common Instructional Framework.
[a] Some of these workshops also may have included participants from other NCNSP-supported schools, which are not part of the STEM network. Unless otherwise noted, the numbers only reflect participants from schools originally thought to be part of the network.
[b] The Summer Institute involved all of NCNSP's schools, including many non-STEM schools. Participation numbers for the individual STEM-focused sessions were not available.
[c] These numbers are from the registration information, not from sign-in on the day of the workshop.

*Session Content*

The evaluation team observed sample days of all of these sessions. Almost all of the sessions observed (85%) focused on building participants' pedagogical expertise. This was often done in the context of STEM subject matter. For example, as part of the Core Plus Mathematics training, participants solved math problems in groups, during which they discussed the mathematics in the problem and the instructional strategies necessary to communicate the math problem. During the Modeling Science workshop, the emphasis was on providing teachers with the skills to facilitate project- and inquiry-based

learning in the classroom. During one of these observed science sessions, the participants worked in groups to conduct an experiment to determine the speed of a toy car by measuring distance and time during the car's movement. Participants then represented their results using verbal, pictorial, formula, and graph representations. They further discussed the groups' representations as a whole class, also reflecting on instructional strategies involved during these activities. Finally, participants applied their knowledge by predicting/hypothesizing about the results of an experiment they had not yet conducted.

Almost half of the observed sessions (45%) had a goal of teaching participants to use specific instructional materials. In particular, Core Plus Mathematics helped build teachers' familiarity with the Core Plus materials. The earth science session used the Investigations into Earth Science curriculum. While only a sample of the professional development sessions were observed, observers did not note an explicit focus on the Common Core standards.

Thirty percent of the observed sessions worked to build the general math and science content knowledge of participants, while also working on instructional strategies. For example, during the Core Plus Mathematics sessions, participants developed their mathematical expertise as they worked through the content of Integrated Math 1, including Algebra and Statistics, and as they used graphing calculators, Core Plus curriculum materials and tools, and the Computer Algebra System (CAS) program to conduct investigations.

The observers also paid attention to the extent to which the content of the professional development sessions was reflective of the Common Instructional Framework. Almost all sessions modeled the use of collaborative group work, although these groups were rarely specifically structured with roles. An exception was during the Core Plus Mathematics training, in which participants had cards that indicated their roles in the group. During this session, the observer reported that participants had high-quality collaboration and discussion within groups. The vast majority of the sessions (85%) also incorporated two other strategies from the Common Instructional Framework: Questioning and Classroom Talk. More information on these and other strategies from the framework can be found in Appendix C.

In addition to the formal professional development sessions, NCNSP provides the services of leadership and instructional coaches to participating schools. Through the end of October, leadership coaches visited 12 schools, with an average number of 2.1 visits per school. In general, their visits focused on working with the principals to implement the Design Principles. Instructional coaches visited 12 schools, with an average number of 9 visits per school. These coaches focused on implementing the Common Instructional Framework in all classrooms. Math and Science instructional coaches visited 7 schools, with an average number of 3.3 visits per school. Their visits centered on working with the math and science teachers on implementing inquiry and project-based learning. Of the 12 schools visited, only 5 remain on the current list of RttT STEM Network Schools. NCNSP plans to begin providing leadership and instructional coaching for the new schools on the list in January and February of 2012.

At the end of each visit, the coaches submit reports to NCNSP. The content of both the leadership and instructional coaching reports is structured in such a way that coaches are required to report on their work on each of the six NCNSP Design Principles, and then on general strengths, areas of concern, and next steps. At this point, the reports do not have explicit categories for the STEM themes and new project-based curriculum work. The evaluation team recommends adding these areas to the coaching report template to help the coaches explicitly focus their work on the STEM components. More detailed analyses of the coaches' reports will be completed as part of the Year 2 evaluation.

*Session Design and Delivery*

The external observations focused on examining the design and delivery of the professional development. Overall, the professional development sessions involved delivery methods that required the active participation of attendees. As Table 6 shows, the professional development sessions generally were very active, with almost all of the sessions involving small-group discussions and most involving whole-group discussions led by the facilitator. Most of the sessions also included a formal presentation by the facilitator, usually introducing new content. Over half of the sessions involved developing a product or conducting a hands-on activity. These products could include the integrated projects that schools are expected to develop and implement. Only rarely did the observers note instances of participants presenting information or leading a whole-group discussion.

*Table 6. Types of Strategies Used in STEM Professional Development*

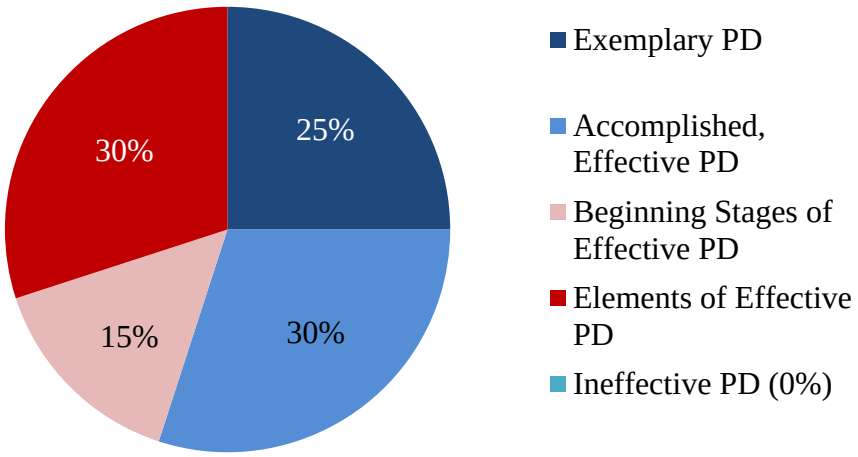
| Activity | Percentage (Number) of Observations Reporting this Strategy |
|---|---|
| Engaged in small-group discussion | 85% (17) |
| Engaged in whole-group discussion led by facilitator | 70% (14) |
| Listened to a formal presentation by facilitator | 65% (13) |
| Developed a product/hands-on activity | 65% (13) |
| Listened to a formal presentation by participant(s) | 10% (2) |
| Engaged in whole-group discussion led by participant(s) | 10% (2) |

These strategies often were integrated within the same professional development session. For example, during a Summer Institute session on Scientific Inquiry and the Common Instructional Framework, teachers participated in a series of activities designed to explore physics concepts. In the first activity, small groups of participants received a handout with an envelope and objects to use for an activity (either a pendulum or a swing). They then were required to create a pendulum with objects they received, swing the pendulum, take repeated measurements, and record their data on a poster. They concluded this activity by discussing the process they followed, what they learned in the activity, and whether they participated in scientific discourse. In the second activity, participants read “Is Inquiry Real?” and discussed the main ideas of the reading with a partner. In the final activity of the session, participants met in small groups to discuss one of the Common Instructional Framework strategies (a different one per group).

*Quality of the Professional Development*

Observers rated the extent to which the sessions represented high-quality professional development, and their assessments were relatively high. As shown in Figure 3 (following page), in the estimation of the observers, none of the observed sessions represented ineffective professional development. Thirty percent incorporated elements of effective professional development, and 15 percent were deemed to be in the beginning stages of effective professional development. Thirty percent were deemed accomplished, effective professional development, while 25 percent of the observed sessions fell in the exemplary professional development category.

*Figure 3. Extent to which Sessions Represent High-Quality Professional Development*




The external observers considered most of the sessions to be very well planned and facilitated. The primary areas for improvement were related to providing participants with opportunities to reflect on what was learned from the activities and how to implement the knowledge in the classroom.

Following are observers' comments from three different professional development sessions:

- "The session was well planned and carried out. Participants were very engaged throughout the session, especially when they were testing different variables in their experiments. The facilitator modeled the strategy very well but there could have been more discussion of its application in the context of the classroom."
- "Overall an excellent session with relevant information, well prepared facilitators and engaged participants. Participants could have benefited from more time in this session to discuss and reflect as a group on the activities."
- "Lots of components of high quality professional development were present. The main problem was the need for more time to discuss the activities and what can be learned from those."

Participants agreed that the sessions were of high quality overall. In evaluations administered by NCNSP for five of the workshop sessions[2] (Table 7, following page), participants generally believed that the sessions were overall well planned, relevant, and useful, with a clear purpose.

[2] Evaluations were developed and administered by NCNSP after each professional development, but the forms were not standardized, and not all included comparable, Likert scale ratings.

*Table 7. Participants' Ratings of Selected Workshops* [a]

| Session | *n* | Well-Planned and Implemented | Relevant and Useful | Clear Purpose |
|---|---|---|---|---|
| Math Content (Core Plus) | 12 | 3.80 | 3.70 | 3.80 |
| Environmental Science | 10 | 4.00 | 4.00 | 3.92 |
| Project Development | 54 | N/A[b] | 3.52 | N/A[b] |
| Critical Friends Group | 26 | 3.93 | 3.78 | 3.83 |
| Common Practices Symposium | 56 | 3.52 | 3.45 | 3.50 |

[a] Scale is from 1 to 4, with 1 = *strongly disagree* and 4 = *strongly agree*.
[b]There was no question related to planning and purpose in the project development evaluations.

Project Development Workshop and Common Practices Symposium received the lowest participant scores (although they were still between *agree* and *strongly agree* for usefulness and good implementation). This may be due to the fact that they were implemented for the first time this year, while other workshops have been conducted by the NCNSP for a few years.

Observers also were asked to rate the extent to which they agreed that specific aspects of the program were implemented with high quality. Table 8 provides a summary of those ratings.

*Table 8. Synthesis Ratings of Quality of Professional Development*

| Dimension | Number of Observations | Mean Rating |
|---|---|---|
| Design of activities | 20 | 3.25 |
| Implementation of activities | 20 | 3.20 |
| Culture of the professional development session | 20 | 3.55 |
| Overall quality of the professional development session | 15 | 3.50 |

*Note*: The scale reflects the extent to which these aspects represent high quality, with 3 = *somewhat* and 4 = *to a great extent*.

The observation team also rated the implementation of specific activities that fell under each of the dimensions. We summarize the key findings here, with detailed ratings in Appendix E.

Relative to the design of activities, the observers noted that 100% of sessions encouraged a collaborative approach to learning. This is consistent with the large amount of group work that was done during the professional development sessions. The lowest ratings were in the areas of adequate time for sense-making and for sharing experiences and insights. This suggests that the professional development sessions overall provided frequent opportunities for group work and hands-on activities but allowed less time for debriefing the activities and their implications for the classroom. For example, during the Earth Science workshops, one observer noted, "There were lots of opportunities for teachers to engage with each other and with the content. The main problem was that there was not enough time for the processing of the inquiry activities." Another observer noted that during the Weapons of Mass Instruction session in the Summer Institute, "Some activities were rushed for the sake of time. Participants appeared to want/need more reflection time."

When examining specific aspects of implementation, observers rated participant engagement as relatively high (3.55 out of 4). Lower ratings were given in the areas of effectively modeling different instructional strategies, including the Common Instructional Framework (3.11), assessment strategies (3.09), and inquiry learning (3.07). Notes from the Project Planning observations highlight the strengths of certain aspects of implementation and room to improve in others:

> The facilitators were both very clear and interacted well with participants. Having the participants do the reading in class slowed down the pace of the session substantially. There was no attempt to learn what participants knew about projects in advance of the reading. The participants were very engaged in the discussion of the different aspects of Project-Based Learning management. They were all very engaged in writing the projects. There was no debrief that would provide guidance about how to ensure that their projects are high quality projects or any opportunity to talk about what might happen with the deliverables.

The Culture of Professional Development session received the overall highest rating (3.55). For most sessions, the observers saw the environment as one in which the participants were comfortable participating and taking risks. For example, an observer of one of the Modeling Science sessions noted: "The facilitators were very respectful of the participants. They made a conscious effort to gently correct participants when they made errors. They used a method of assisting participants that led participants to see and correct their own errors." Similarly, the observer of the Project Planning session noted, "It was a very collaborative culture. In the small groups, teachers were clearly comfortable contributing their ideas and the facilitators were very welcoming."

At this point, the evaluation has not collected any data on the quality of the coaching opportunities. This will be one of the goals of the site visits that will begin in the second year of the evaluation.

*Potential Barriers and Additional Support Needed*

The RttT STEM initiative expects schools to make substantial changes as they work to implement a comprehensive STEM-focused model of school reform. It is therefore worth identifying potential barriers that schools might face and supports they might need as they seek to implement the content and practices from the professional development. In the NCNSP session evaluations and in a focus group conducted with four teachers at the Common Practices Symposium, participants provided information on potential barriers and needed supports.

The barriers identified by participants tended to cluster around two main themes: 1) getting buy-in from staff, students, and the community; and 2) finding adequate time to plan and implement activities, particularly projects.

Obtaining buy-in for school-level activities such as projects or the overall STEM focus was seen as particularly important. Approximately one-third of summer training participants identified buy-in as a key barrier to overcome. For example, a participant at the project planning workshop commented on this barrier, "All teacher support! I feel there will be resistance from some teachers to add this project into their curriculum." Similarly, a participant in the math professional development noted that a challenge would be "getting everyone else on the faculty in the mathematics department to buy into these new, innovative ideas." A participant in the science professional development stressed the importance of buy-in at the district level: "I anticipate the district will give us more of a challenge than anyone else. Curriculum people think they have a corner on the market on what should be taught." In the focus group, teachers commented that it was hard sometimes for the teams from schools who went to the workshop to convey the vision to the rest of the teachers in the school:

> I think two or three people went and then they headed up the professional development session [for the rest of the staff]. So, we had some people who did not go and it was one question after another, or "Why do we have to do this, and why do we have to do this? I feel like it's stupid. I feel like it's wasting my time. I feel like ..." It made a process that could've been easier very, very difficult. But then, for some people they were like, "Wow, I never thought of it," have changed their whole teaching practice based off what they learned from their colleagues. So, we had pluses and the deltas.

Approximately one-fifth of the summer training teachers identified time as a barrier in implementing changes. Some teachers noted that time for planning would be a barrier. As one teacher commented, the biggest barrier in implementing what she learned in the science workshop would be "time needed for planning and changing curriculum." Other participants expressed concern that existing schedules would serve as a barrier, particularly for project-based activities. One participant described the barriers as "the fact that we are locked into a bell schedule, block schedule and share teachers with other schools." Time for planning and collaborating posed particular challenges for the project-based curriculum. More details on the barriers associated with implementing projects are provided in the next section on curriculum development.

In the NCNSP evaluations for three of the workshops and in the focus group, participants described additional support that they would need to implement what they learned in the professional development. The support varied depending on the specific strategies or approaches they were seeking to implement. For example, two-thirds of the science workshop participants reported that they needed funding for the specific supplies or materials that were used in the workshop. On the other hand, 75% of the teachers in the math workshop identified that they needed additional professional development, either through formal training opportunities or through collaborating with other teachers who were implementing integrated math. For implementing project-based learning, the top area of support needed (mentioned by over half of the participants) was the need for buy-in and support from the district and school. One participant in the project-planning workshop wrote, "We will need a LOT of support building the belief in this work from the top down and the bottom up. This team believes in what we have done here ... but we know we will encounter some resistance."

Overall, analyses of observations of professional development workshops and sessions allow us to conclude that both the content and quality of these activities were appropriate for achieving their goals of improving participants' knowledge and skills. The content of the workshops focused on math and science subject matter and on teaching strategies emphasized in the vision for the STEM schools. Although there was some room for improvement, the overall quality and the quality of specific aspects of professional development activities were rated very highly. Taken together with participant perceptions, these analyses of professional development offerings suggest that these activities were implemented well and should lead to the desired improvements in the participants' classrooms. The fact, however, that many of the schools on the final RttT list of STEM schools did not participate in much of this professional development means that the initiative has not made as much progress as was originally projected. Schools new to the network will have opportunities to participate in all forthcoming professional development. Specific recommendations for improving the professional development appear in the Conclusions and Recommendations section.

***III. Development of Integrated Curriculum with Project Units***

There are two different components to NCNSP's work on STEM curriculum. The first component is focused on supporting teachers in instruction with nationally benchmarked mathematics and science curricula such as Core Plus Mathematics or Investigations in Environmental Science. These curricula are geared towards the inquiry- and problem-based learning that is at the heart of NCNSP's Powerful Teaching and Learning Design Principle. NCNSP provides support for teaching with these curricula with summer content-focused workshops and instructional coaching. The second component of curriculum work is focused on designing a 9th through 12th grade integrated curriculum with at least three inquiry-based project unit(s) within each of the four STEM themes. This component is described and analyzed in more detail in the following sections.

Our analyses of project-related activities reveal the following findings:

- NCNSP conducted a number of activities to support the development of project units: a three-day Summer Project Development Workshop; two days of in-school project development; and a two-day Common Practices Symposium in October 2011.
- Most of the 13 schools that participated in the summer are actively engaged in project development; however, only four of those are on the final STEM school network list. The rest of the schools in the network started their project-related professional development in October.
- School staff working on project design encountered a number of challenges, such as: lack of time to do very time-consuming project design work in addition to teacher workload; effective integration of projects with the regular curricula and creation of meaningful experiences for students; and insufficient resources needed for successful project implementation.

This section of the report is organized into four main areas:

1. Overview of project planning work;
2. Project-related activities;
3. Implementation of projects; and
4. Challenges in creating and implementing projects.

*Overview of Project Planning Work*

As articulated in the Race to the Top proposal, the STEM initiative was designed to create a schooling environment that would help prepare students for the 21st century and for solving the Grand Challenges of Engineering. The proposal states, "Preparing students to meet these Grand Challenges requires a project-based approach to teaching and learning and will provide rich opportunities for cross-disciplinary connections and service learning built upon curriculum in science, technology, engineering, and mathematics" (North Carolina Office of the Governor, 2010). As a result, the STEM schools are expected to integrate a project-based approach into their instruction. One of the teachers interviewed commented that being a STEM school means:

> Changing the way we teach, changing the way that we have our kids thinking because right now, we have a generation of regurgitates. All they do is we give them information and they can

> regurgitate it back, but our STEM schools are creating thinkers and learners who are able to apply what they've learned.

NCNSP's Scope of Work outlines the specific strategies that will be used to help the anchor and cluster schools implement high-quality STEM instruction and project-based learning. These strategies include professional development for school staff, on-site instructional coaching, and funding for teachers to work during the summer to "assist in developing STEM curriculum and align assessment strategies."

Over the course of the entire evaluation period, the evaluation team is examining these activities and the extent to which these activities are effective at getting schools to implement project-based learning in their schools.

*Project-Related Activities*

To prepare schools to implement project-based learning, NCNSP is working with teams of teachers and administrators to build expertise in developing projects, with the intent of having these teams then help entire schools to develop and implement projects.

During the summer, teams from 13 Race to the Top-funded schools (4 of them on the final list) participated in a three-day session that introduced the idea of project planning. The rest of the schools in the network started their project-related professional development at the Common Practices Symposium in October. During the summer session, NCNSP provided its STEM Affinity Network members with this definition of a project:

- "A project defines or attempts to solve a real problem (e.g., clean drinking water, dependence on fossil fuels, etc. Think 'Grand Challenges for Engineering')"
- "Students use an 'Engineering Design Process' to attempt to define or solve that problem."

NCNSP staff provided the following expectations for the schools:

- Year 1: A minimum of one theme-based project in every 9$^{th}$ grade class and a grade-level culminating project that they design at the institute.
- Year 2: Expanding work for 9$^{th}$ grade, plus minimum of one theme-based project for 10$^{th}$ grade and culminating 10$^{th}$ grade project.
- Year 3: Expanding work for 9$^{th}$ and 10$^{th}$ grades plus minimum of one theme-based project in every 11$^{th}$ grade class and culminating 11$^{th}$ grade project.
- Year 4: Expanding work for 9$^{th}$–11$^{th}$ grades plus minimum of one theme-based project in every 12$^{th}$ grade class and culminating 12$^{th}$ grade project.

During the Summer Project Development Workshop, participants worked to create a culminating project for their 9$^{th}$ grade, or smaller projects that could be used within a subject area or individual classrooms. Participants were asked to use a format provided by the Buck Institute of Education (an organization focused on project-based learning) to guide their planning. There were also smaller, optional sessions that were focused on providing support in using projects. For example, one topic included managing students' work on projects. Schools also were provided with resources for two days of planning at their schools, and were supposed to do this work before the end of October. Finally, schools were given an opportunity to revisit their project planning during the Common Practices Symposium in October. During this time, they received a rubric, "The Six A's of Designing Projects." They then used the rubric to evaluate

projects from each other's schools. (More detail on the quality of implementation of the professional development can be found in the Professional Development section, above.)

*Implementation of Projects*

The NCNSP staff asked schools to provide copies of their project plans and to reflect on their progress to date. Twelve of the 13 schools that participated in the summer project planning (nine on the initial list and four on the final list of STEM Network Schools) submitted project plans. The theme of food was a common topic, particularly for schools in the Health and Life Sciences network. This is because NCNSP shared a sample project that had a food-based theme at the July training. Appendix F provides a brief summary of the projects for all of the schools that submitted information.

Seven schools indicated that they had begun work on their projects with their students. One school included a description of its project activities on its website:

> 9th grade students … are beginning a STEM investigation titled, "Our Food, Our Choices, Our Future."
>
> These students will be collaborating in all of their courses to investigate how the foods we choose to eat affect our health, our economy, our environment, and our culture.
>
> On Monday, September 19th [2011], the students gathered in the cafeteria to "kick off" this endeavor. Part of the program included student presentations as well as a virtual interview with Cornell professor and award-winning author Dr. Colin Campbell, author of *The China Study*. Dr. Colin interacted with the students via Skype and answered questions about issues regarding the modern diet, the environment. and our nation's culture …
>
> Throughout the year, students will be working collaboratively across classroom subjects to investigate the problems surrounding these issues. This work is part of a larger collaborative effort throughout NCNSP to develop STEM cluster programs in high schools across our state.

Another school described in its reflection how it is working to build students' engineering knowledge and skills. All students in the school had been introduced to the 14 Grand Challenges of Engineering. The teachers then engaged their students in an activity in which they created a bridge out of toothpicks, as a way to teach them the engineering design process. All freshmen in their school are enrolled in an Introduction to Engineering college course. These engineering skills would allow them to complete the project, which was to design a boat driven by alternative energy. One of the school's teachers described what they had done so far in an interview:

> We're doing mini projects that build up to a larger [project]. They've started to build bridges just out of toothpicks and glue, and so our engineering teacher will come in and [help] you teach through the project …. Like I taught equilateral triangles because one of [the students] was building theirs out of triangles and that's how you got your bridge more sturdy. And then after that, we're going to solar and then wind and then at the end of the year, they get the choice of—they're going to create their own boat using solar, wind, whatever …. But it's kind of guiding them to that point, just learning the basics of what there are, like the nuclear and the solar and the wind, and geothermal ....

During the focus group, a teacher reported doing the following projects in her school:

> Our students will be able to go out and do energy audits in the community and giving our community information about how to reduce their energy usage and showing them some options that the electric company offers as far as smart boxes and prepaid electricity, and ways that they can reduce the cost, energy efficiency appliances, energy efficient light bulbs.

Three schools had been doing planning work with their teachers, and one school (a brand-new school) was waiting to implement its project until later in the year.

*Challenges in Creating and Implementing Projects*

Although most schools that participated during the summer had made progress in designing and implementing their projects, participants did identify challenges in written reflections and in the focus group interviews.

One of the most frequently mentioned challenges was the amount of time that was necessary to develop high-quality projects, especially for teachers who were engaged in the everyday business of teaching. In a reflection, one staff member wrote, "We are so busy with the daily 'work' of school that we haven't reached the full potential." Following are comments made by teachers in the focus group that highlight the challenge of creating a new curriculum on top of their daily lesson plans and teaching:

> Teacher 1: It really is building curriculum. Trying to make sure it's connected to what you're doing in your classroom.
>
> Teacher 2: There's a lot of project-based learning resources out there, but making it relatable to the network as far as whether it's Energy and Sustainability, or Health and Life Sciences, those resources are rare … So, it's finding those things to pull them together so that the kids have a meaningful experience, and they're learning something and learning the curriculum on top of whatever they're doing as far as a project.
>
> Teacher 3: Because we're developing curriculum … [w]e have to plan a curriculum on top of the curriculum that we are required to teach. That's a lot.

Also, due to the diversity of projects among schools, schools could not cooperate and divide the responsibilities of designing the same project in order to combine their resources of time. Two staff members commented on the need to ensure that the projects were effectively integrated into the school's curriculum and not simply something extra to do. One teacher commented in the interview:

> The most meaningful thing that we can do and the hardest thing to do is to make sure that it's organic to the learning that already is supposed to be taking place. Because the last thing you want to do is say, "Okay, now we have to stop what we're doing so we can spend however many weeks we need to devote to this project," and doing a project so that you're behind in your curriculum. You want it to be—we've termed it organic, I don't know what you all say about it, but it's the fact that whatever I'm teaching every day in my classroom connects to the overall project itself, that I'm not double teaching.

Participants noted the need to ensure that there was buy-in into the process from the teachers and students. One participant wrote in a reflection, "We are concerned about overall logistics and students fully embracing the Capstone Production since there will be a great deal of student independence required to complete this major assignment successfully."

A final challenge involved getting access to the resources they needed to do the projects, particularly in the community. One participant commented that the school staff were worried about the willingness of the cafeteria and restaurants to participate in an analysis of the quality of their food. Another indicated that the fact that they were in a small community made it challenging to obtain resources for the project.

These challenges notwithstanding, results indicate that most schools, out of the ones that initially participated in the Summer Project Development Workshop, have made progress in implementing large-scale projects that are consistent with their school's affinity network theme. However, as noted already, of those schools, only four are on the final STEM network list. Schools currently working on project development created resources for other schools and also created some of the process knowledge for the NCNSP staff, and those resources could help them to be more effective in working on project development with the new schools in the STEM network. Some of the feedback from teachers suggests that NCNSP might consider providing teachers with more background knowledge about the themes and the engineering design process prior to their work on projects.

The results also suggest that designing high-quality projects that work well with the standard curriculum is extremely time-consuming and not necessarily something that teachers can do easily while they are carrying a normal teacher workload. Although some planning time was provided in the summer, this time was not sufficient to design complex year-long projects. It is stated in the proposal that teacher salaries will be extended to summertime in order to work on project design. It is not clear how much time was spent on this task by teachers in their schools or how much time is needed and what support needs to be provided in order to produce high-quality products. To address the challenge of an additional time burden on teachers to create high-quality projects, NCNSP might consider having schools work collaboratively on fewer projects, so that they can combine their human resources.

Finally, it is clear from interviews with NCNSP staff and informal conversations with the NCDPI staff that there is not a shared understanding between NCNSP and NCDPI about the meaning of one action item in the scope of work: "Develop a $9^{th}$–$12^{th}$ grade integrated curriculum with at least three inquiry-based project unit(s) within the themes of Health and Life Sciences, Biotechnology and Agriscience, Energy and Sustainability, and Aerospace [and Security]." As a result, there is no clarity for what a deliverable for this item should look like. As is evident from the conversation with NCNSP staff, they interpret teachers' work on designing projects more as refining and enhancing an extant curriculum, not as creating a new one.

Specific recommendations for project development are included in the Conclusions and Recommendations section, below.

***IV. Partnerships***

Our analyses of partnerships reveal the following findings:

- NCNSP established four Industry Innovation Councils (IIC), one for each affinity network.
- Business and Institutions of Higher Education (IHE) partners started to participate in network face-to-face events and to provide their expertise to teachers and principals about the network themes.
- Teachers found this sharing of information to be useful for their STEM-related work in the schools.

Each of the four affinity networks is getting support from business and higher education partners. To ensure that the partners provide consistent and regular support that is geared towards STEM schools' needs, NCNSP established four Industry Innovation Councils (IIC), one for each affinity network. Each council has between 24 and 29 members consisting of representatives from businesses and IHEs. The IHEs involved in the councils include North Carolina State University, Duke University, the University of North Carolina at Chapel Hill, North Carolina Agricultural and Technical State University, and Craven Community College. The councils also include members from various North Carolina businesses working in the theme industry, and members from research and government organizations such as the EPA, RTI International, National Institute of Environmental Health Sciences, National Institutes of Health, NCDPI, and the Office of the Lieutenant Governor.

According to the NCNSP Industry Innovation Council organizational memo (NCNSP, Internal Memo, August 2011), the councils' roles and responsibilities are to:

- Learn about effective models across the country through case studies and site visits
  - Learn about best practices in instruction and student support
  - Become clear on approaches to curriculum and instruction that foster deeper student engagement and motivation
- Advocate for the schools at the community and state levels
- Leverage connections into the private sector to provide opportunities for students and teachers and to secure funding for improvements to the model.
  - Offer externships for teachers and internships for students
  - Create opportunities for mentoring/job shadowing
  - Collaborate with education professionals in project development
  - Create new paradigms in education/industry partnerships
  - Foster public and private strategic investment in education innovation

In an interview, NCNSP staff also indicated an additional role they would like the councils' members to play:

> I think we see value in them serving on projects panels, so if students feel like they have an authentic product that they are developing or designing and then an authentic audience that's

> going to assess their presentation of whatever they've developed, then that really serves a dual function for us because they get authentic, expert feedback, but then, it's also a way for those groups to experience what's happening in our schools.

The councils are supposed to meet four times a year, and the first meetings for three of the councils occurred in August and September 2011. At these inaugural meetings, the following topics were discussed:

- The history and results of the previous NCNSP work with STEM schools;
- The vision and mission for the future work with the main STEM Affinity Network;
- Teachers' perspective on the Powerful Teaching and Learning Design Principle for STEM schools and on NCNSP work to support them; and
- Ways in which councils will support the four affinity networks

In addition to roles described in the NCNSP memo, small groups came up with the following ways to support the STEM Affinity Network:

- Mentoring students on career development;
- Formalizing partnerships so that professionals can come in and help with teaching part of the curriculum or projects;
- Connecting college students with high school students;
- Having guest speakers on topics of their expertise conduct presentations for high school students;
- Providing real data collected by the businesses for students to analyze;
- Providing tours of local job sites such as SAS solar farms; and
- Developing a bank of real, world-of-work problems to assist teachers in developing projects for classroom use.

Subsequent meetings for these councils took place in November and December of 2011, with additional meetings scheduled for Spring 2012. In addition, industry partners are invited to consult NCNSP staff about the network themes, what businesses across North Carolina are doing related to those themes, and what students need in order to be educated about those themes.

The network has started to receive practical assistance from business and IHE partners; several shared their expertise with teachers and principals of the network schools at the face-to-face Common Practices Symposium in Charlotte, October 25–26, 2011. Experts from a variety of organizations led roundtable discussions with participants on the topics of NASA educational resources; nuclear operations and power generation; the need for professionals in engineering fields and the training that students need to be prepared for college and careers; bioexploration; bioprospects and other projects regarding plants for human health; ways to get students engaged and interested in science based on the experts' work; the difference between traditional engineering and biological engineering; the need to generate new fuels to replace gasoline and diesel; examples of experiments that teachers can do to show biofuel production; coal ash ponds and local versus industrial cattle farms; and thinking beyond renewable energies. The organizations included:

- Babcock & Wilcox Company, nuclear operations and power generation
- Human Health Institute
- North Carolina State University
- North Carolina Agricultural and Technical State University
- NASA Educator Resource Center, UNC–Charlotte
- Energy United

At the teacher focus group during this event, teachers commented on how valuable this experience was for them and that they wished it had happened before the start of their work on projects:

> Teacher 1: And what we did here today should have been done this summer …
>
> Teacher 2: Yeah, what they did today was very valuable … a majority of the professional development on a district level is targeted towards technology, or it's very pedagogically connected and I don't think that's a bad thing, but it's very little of it content connected. And so, you've got to wonder how many of our colleagues are still teaching the same content that they taught 10 years ago?

Overall, analyses of available documents, observations, and interviews allow us to conclude that partnerships are on track for achieving their goals. IICs for three of the four theme networks were created and had their first meeting in the summer. The fourth IIC will meet in the beginning of the next year. Business and IHE partners started to participate in the network face-to-face events and to provide their expertise to teachers and principals about the network themes. Teachers found this sharing of information useful for their STEM-related work in the schools.

**Conclusions and Recommendations**

The NC RttT STEM initiative is engaged in two processes simultaneously: (1) the development of a new STEM school and network model that can be scaled up later to include more schools in the state; and (2) implementation of this model, which is being developed in the four anchor and 16 affinity schools that currently serve as a test-bed and later will serve as exemplars for the STEM school and network model. Our conclusions are organized according to these two aspects. We will first discuss the complexity of the model itself, and then the implementation activities for the four implementation areas. Finally, we discuss some recommendations related to further implementation and evaluation activities.

***Creating an Articulated and Cohesive Model of a Network of STEM Schools***

NCNSP is developing a new STEM school model and STEM school network. Creating a new school model is a complex undertaking that necessarily includes trial and error, as well as refinement of strategies to achieve the desired outcomes. It should be expected that the process of refinement of the model will take a few years.

This new model is building on previously successfully implemented early college and redesigned school models, using NCNSP Design Principles, and it adds a STEM vision that includes (1) incorporating a STEM theme across all subjects in the school; (2) improving math and science teachers' content knowledge and teaching strategies, by providing extensive professional development that includes summer workshops and on-the-job coaching by math and science coaches; (3) designing and implementing a new project-based STEM curriculum around Grand Challenges of Engineering; and (4) becoming a member of the theme-based network of schools and business and IHE partners. The Design Principles and STEM vision currently are not integrated with each other. If the STEM framework and Design Principles are not explicitly woven together, then schools may perceive them as being in conflict with each other or not closely connected. As one of the principals commented after a Common Practices Symposium that focused mainly on STEM themes and projects: "Where do Design Principles and CIF [Common Instructional Framework] fit into this? Didn't hear it mentioned so I wonder where the focus will be. *I* know it fits in, but do the participants need to hear that?"

To address the challenges that schools in the network face in terms of learning about and implementing multiple components of the model, NCNSP should integrate the six Design Principles with the various components of the STEM vision. For example, the Powerful Teaching and Learning Design Principle could explicitly incorporate project- and inquiry-based learning. The Redesign Professionalism Design Principle could explicitly include language about expected face-to-face and online networking with other schools. The College Ready Design Principle may incorporate career readiness and address theme-based career-oriented activities for students and also incorporate project-based STEM curriculum focusing on Grand Challenges of Engineering.

***STEM School and Network Model Implementation***

Based on analyses of RttT project activities to date, the evaluation team concluded that structures for networking, professional development, curriculum development, and partnerships were somewhat on track for achieving intended outcomes for the schools that received implementation services. However, as with any plan or proposal, implementation requires a substantial amount of interpretation of particular proposed activities and development of the details of implementation. In particular, NCDPI and NCNSP differed in their interpretations of two elements of the proposal: (1) the criteria for selection, and therefore the list of schools to be included in the network, and (2) understanding of expectations for the deliverables associated with integrated curricula with inquiry-based project unit(s). Shared understanding between

NCDPI and NCNSP regarding these details of implementation has taken a long time to achieve and ultimately has delayed the implementation process.

In this section, we summarize the conclusions and recommendations for each of the four areas of implementation strategies reviewed above, including implications for the development of the STEM school and network model.

*I. Structure of the Network of Stem Anchor and Affinity Schools*

*Implementation*. In its first year, the RttT STEM initiative was on track for enrollment of anchor schools but experienced significant delays in establishing the network of affinity schools due to discrepancies in understandings about school eligibility. These delays affected the effectiveness of the first-year implementation activities, are likely to affect short-term outcomes, and may even affect long-term outcomes. To reduce potential negative impacts, initiative leads should develop a plan for getting those schools that joined the network late rapidly up-to-speed with respect to implementation of all model components.

NCNSP provided many face-to-face networking opportunities and established a web-based platform for online networking among participating schools. The online network developed four types of communities that are mainly used for sharing resources, general information, and announcements, with, so far, a relatively low level of interaction. Teachers appreciated networking opportunities and expressed willingness for a broader collaboration among schools. To increase collaboration among schools, NCNSP should consider assigning groups of schools to complete common tasks or projects together.

*Implications for the Model Development*. The characteristics of schools in the STEM Affinity Network have a strong effect on the process of creating a new school model and its success. Currently, seven of twenty schools are brand-new as of 2011 or 2012, and 11 schools are regular comprehensive schools in their counties. For the duration of this project, these schools have to implement combined multiple components of the six Design Principles and STEM vision, along with the new Common Core Standards and Assessments, new data systems, and other reforms.

Implementation of each goal by itself may require a few years of very intensive and time-consuming work by all school staff in order to achieve success. For the schools that have not worked previously with NCNSP on the Design Principles (which is currently most schools in the network), implementing both the Design Principles and the new STEM vision may present a steep hill to climb. Both parts of the STEM school model have multiple components and will require teachers to undertake significant learning in multiple areas and will need a significant time investment.

Brand-new schools that have just opened as a result of this project will face all of the logistical hurdles that come with opening a new school. They will, however, be able to create a culture from the beginning that incorporates the Design Principles and STEM vision. Existing traditional schools will not have these logistical hurdles but they will have long-established school cultures and procedures that are often difficult to change. In fact, NCNSP's work with redesigned schools and NCDPI's work with turnaround schools shows just how difficult changing the culture of an existing school can be. It will be important to have realistic expectations of all of these schools. It may be expected that the timeline for implementing various components of the model will be delayed for the brand-new schools and schools new to the network. It may also be expected that the anticipated short-term outcomes for these schools will be delayed or weakened as a result of the steep learning curve on multiple dimensions.

Finally, having two brand-new schools as anchor schools may require NCNSP to rethink the role of anchor schools as role models for other network schools, at least in the first few years.

To address the challenges of designing a new complex model with a number of schools that are new to the network, initiative leads may want to consider continuing to use the four NC Learning Lab Schools as sites for study visits by teams from other schools in the network until the anchor schools demonstrate excellence in implementing the STEM vision. Learning Lab Schools demonstrate excellence in the implementation of the six Design Principles and can serve as model schools for this part of the new model.

*II. Professional Development*

Overall, professional development workshops and leadership and instructional coaching were well designed and implemented, as evident from participant evaluations and observations by the evaluation team members, as well as project documents. The potential impact of the professional development, however, was reduced by the changes in the list of schools participating in the RttT STEM network.

Although the professional development generally was of high quality, there are areas for improvement. To increase the potential impact of the professional development and address potential barriers, the RttT STEM initiative may want to consider the following recommendations:

- Provide opportunities for schools that joined the network late to catch up via provision of the professional development they will need for successful implementation of the STEM model.
- Provide participants with additional time and opportunities during the professional development sessions to debrief on the activities and discuss how the activities can be implemented in the classroom. It would be particularly useful to help participants explicitly understand the nature of student learning occurring in the activities and how those activities might address (or potentially reinforce if not done well) students' misconceptions about the content.
- Explicitly address concerns about lack of time by providing models of schedules that provide adequate time for collaboration and planning. Additionally, this year, the STEM initiative provided funding for additional planning days in the summer; it might be worthwhile to find additional resources to continue and expand this option.
- To increase buy-in among staff, consider explicit training for leadership teams on creating a common STEM vision for their staff. Part of this involves creating and communicating a well-defined STEM framework with a compelling rationale for its adoption.
- Add STEM themes and new project-based curriculum areas to the coaching report template to help the coaches explicitly focus their work on the STEM vision components.

In addition, we have recommendations for the improvement of NCNSP's data collection methods. We recommend that both participant evaluations and event sign-up be completed online for easy data collection and analyses. Also, we recommend that all workshops and other forms of professional development use standardized participant evaluation forms, designed in conjunction with the evaluation team. This is essential for the future rounds of the RttT evaluation. These forms may be amended with additional questions specific for each workshop by the PD providers, if needed.

*III. Development of Integrated Curriculum with Project Units*

*Implementation*. Helping build teachers' capacity to plan and implement projects addressing the Grand Challenges of Engineering is a major component of the STEM vision. To support it, NCNSP conducted a number of activities: a three-day Summer Project Development Workshop; two days of in-school project development; and a two-day Common Practices Symposium in October.

Most of the schools that participated in the Summer Project Development Workshop are actively engaged in project development; however, only four of those are on the final STEM school network list. The rest of the schools in the network started their project-related professional development at the Common Practices Symposium.

Development of curricula is an extremely time-consuming and resource-intensive process, as noted by participants. The RttT STEM initiative needs to consider the amount of curriculum development that can be done by school staff at the same time that they are teaching or running a school.

Also, adding a theme and designing projects addressing the Grand Challenges of Engineering related to this theme requires increasing teachers' content knowledge of the theme and of the engineering design process. While only selected teachers from each school currently are participating in theme- and project-related professional development, this knowledge should be increased for everyone who is involved in project work.

Nevertheless, we see significant merit in engaging teachers in the process of developing projects, as it requires them to think differently about curriculum and instruction. Our recommendations include:

- Provide more background knowledge to the teachers about the STEM themes and the engineering design process prior to their work on projects.
- Conduct theme-related webinars to make learning more accessible for everyone in the school.
- Encourage schools to work collaboratively on fewer projects, so that they can combine their human resources.
- Engage instructional coaches in supporting the project work.

*Implications for Model Development*. It is clear from the interview with NCNSP staff and informal conversations with the NCDPI staff that a shared understanding has not been developed between NCNSP and NCDPI about the meaning of developing integrated curricula with inquiry-based project unit(s). As a result, there is no clarity about the expected results or products of this development.

There are two primary interpretations of what the goals of developing an integrated curriculum with an inquiry-based project unit may be:

1. To create a product that is a coherent set of written curriculum materials (similar to a textbook or a written unit) that can be used by any teacher in a separate course or by a group of teachers within their courses in any school.
2. To engage a teacher (or teachers) and students in a creative project design experience, without the burden of creating a product to be shared with others. The emphasis here is on building staff capacity to create and use projects in their classroom.

Each interpretation carries with it a separate and distinct set of considerations for successful implementation. In the first scenario, teachers may still participate in writing during the summer, but it

may also be appropriate to get additional help from people with relevant expertise in curriculum design, project development, engineering design, and theme-related content knowledge. The second scenario is likely to work best if teachers receive appropriate professional development on project design and relevant content knowledge, and then work collaboratively within their own schools to create projects that best suit their schools' idiosyncratic interests. Thus, those carrying out the RttT STEM initiative should consider the following recommendations as they move forward:

- Reach shared understanding of expectations for the deliverables associated with integrated curricula with inquiry-based project units, to ensure that NCNSP and the network of schools developing these deliverables align resources to meet those expectations.
- Consider more active involvement on the part of IHE and business partners in designing a project-based curricula.
- Explore the possibility of contracting with a few highly skilled teachers to develop model projects for each of the four affinity networks. We recognize that current RttT resources may not support this approach, but it may be possible to seek funding from industry partners to support this effort.
- If the goal is to create a curriculum that is to be used by others, do not rely on school staff to do this unless significant resources are made available for this to occur over the summer.

*IV. Partnerships*

Overall, based on analyses of available documents, observations, and interviews, we conclude that partnerships are on track for achieving their goals. IICs for three of the four theme networks were created and had their first meeting in the summer. The fourth IIC will meet in the beginning of the next year. Business and IHE partners started to participate in the network face-to-face events and to provide their expertise to teachers and principals in the relevant network themes. Teachers found this sharing of information useful for their STEM-related work in the schools.

## Limitations and Next Steps

### *Limitations*

This report is qualitative and descriptive in nature, and it presents data about initial steps in the development of the STEM school and network model and the implementation of the proposed activities. It should be considered a formative evaluation report at this stage of project development; our conclusions and recommendations are suggestions, though carefully-considered and evidence-based ones.

### *Next Steps*

The next report for the RttT STEM evaluation is scheduled to be finalized in December, 2012. By that time, we will be able to analyze data collected through the end of the 2011–12 school year. The team will continue to analyze project documents received from NCNSP related to all professional development and partners' activities, as well as monitor online and face-to-face networking. Additionally, we will collect and analyze any products generated by the project development work of participating schools.

In addition, the team will conduct site visits at the anchor schools to observe classroom teaching and project development, and conduct interviews with the principal, teachers, and students. The original schedule for site visits will be revised due to the majority of schools joining the network only in the Fall of 2011. We will analyze coaches' reports and interview selected instructional and leadership coaches about their work and about the effects on schools of participating in the STEM network. We will also conduct at least one focus group with teachers at one of the professional development or face-to-face networking events in the Spring. We will conduct observations of Industry Innovation Council meetings and focus groups with business and IHE partners about supports they provide to the networks.

A more detailed report about RttT-funded NC STEM Collaborative activities will be provided in the Year 2 evaluation report. We will report on the schools in the network supported by the collaborative and will review the collected resources and online platform developed to facilitate collaboration.

A quantitative analysis will be conducted to compare the background characteristics of schools in the network (such as student demographics and achievement levels and teacher characteristics) and compare them with those of other STEM and non-STEM schools in North Carolina in school year 2009–10, before the start of RttT funding.

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**List of Appendices**

## Appendix A. RttT STEM Evaluation Statement of Work

### *Overview*

The evaluation of the Race to the Top STEM schools initiative will provide the descriptive study and documentation of the implementation of the initiative and its outcomes for students, teachers, schools, and school networks. The evaluation will use mixed methods, which will include the use of secondary data at the project baseline and conclusion, and mostly qualitative and survey data and analyses throughout the evaluation. Qualitative data will consist of observations of professional development, site visits to STEM schools, and interviews with providers. Quantitative data will consist of student and school staff surveys and data that links student performance to their teachers and schools.

Due to a pending contract for some of the implementation activities, this scope of work may be further revised to incorporate evaluation of these pending activities.

### *RttT Initiative Context*

*Policy Objective(s)/Purpose(s) of the Initiative*

- Work with partners to support the development of a small set of anchor/model STEM high schools that will serve as laboratory schools and sites for professional development around project-based learning.

*Initiative Activities*

1. *Structure*
    a. STEM High Schools: Develop/establish 4 anchor schools and recruit, interview and select 16 network schools.
    b. Create infrastructure for the face-to-face and online collaboration.
    c. Support technology purchases to outfit classrooms to support STEM education in the anchor schools.

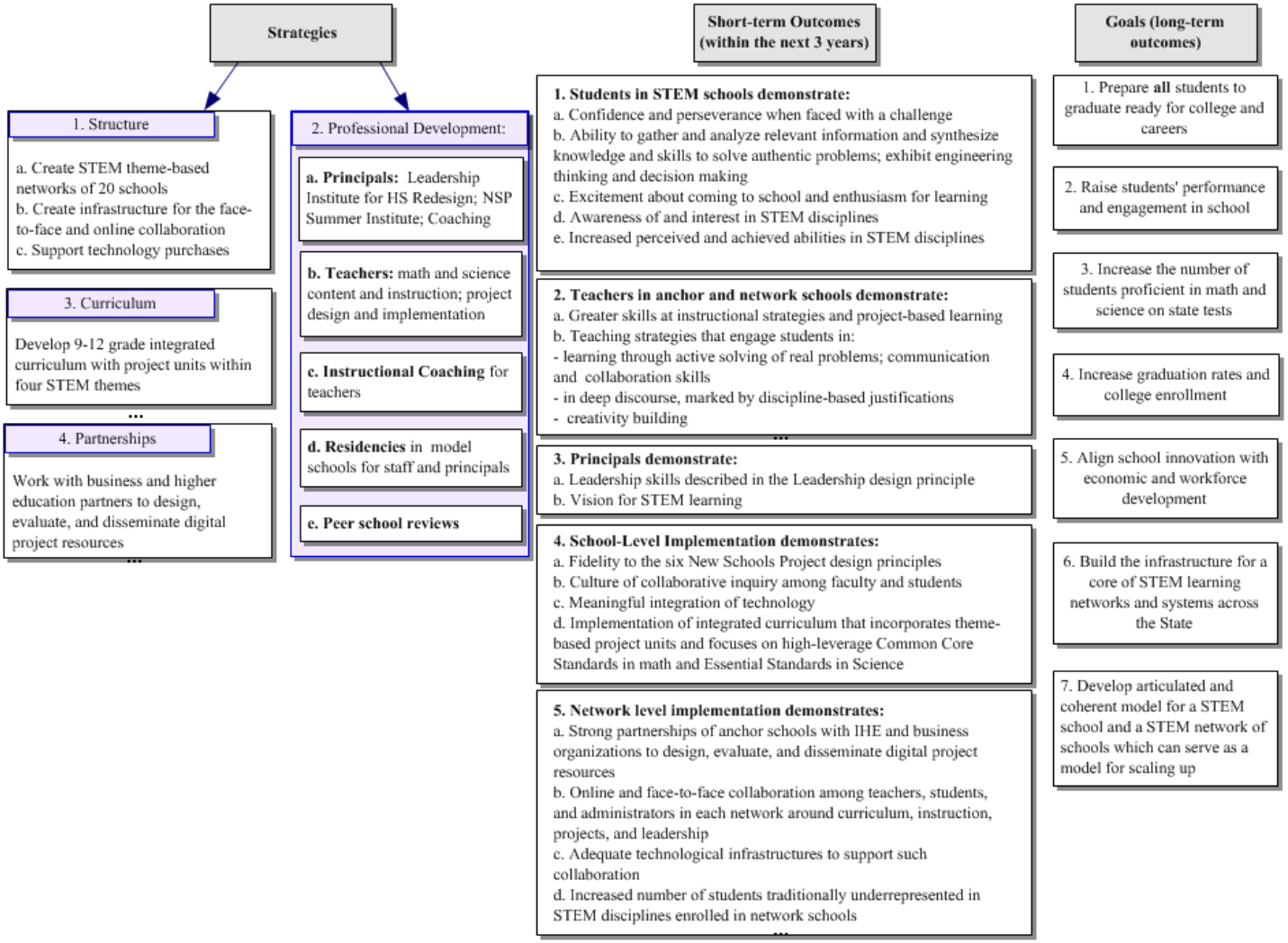
2. *Project-Based Learning Curriculum:* Develop a $9^{th}$–$12^{th}$ grade integrated curriculum with at least three inquiry-based project unit(s) within the health and life sciences, biotechnology and agriscience, energy and sustainability, and aerospace and security themes.

3. *Professional Development*
    a. Principals: Provide on-site leadership coaching for principals in the STEM network schools for approximately 12 days per year to support their development as effective leaders. Provide Leadership Institute for principals. Also, take each principal on one study visit to a national model school.
    b. Teachers: Teams of teachers from anchor and network schools participate in professional development focused on content and instruction in math and science. Teachers will have access to "Critical Friends Group" and facilitated Peer School Reviews, as well as other programs.
    c. Instructional Coaching: Provide instructional coaches to work on-site with classroom teachers at the STEM network schools for approximately 60 days per school per year to improve teaching practices.
    d. Residencies in Model Schools: One-week residencies in national-model schools for staff from each STEM network schools.

e. Peer School Reviews

4. *Partnerships:* Work with Industry and other STEM partners to design, evaluate, and disseminate all digital project resources to a broader range of NC schools.

***Logic Map of Initiative***



***Evaluation Goal(s)/Purpose(s) of the Evaluation***

- Provide formative evaluation for all RttT activities performed to develop STEM schools network during the RttT period.
- Provide the descriptive study and documentation of the implementation of the initiative in participating schools.
- Evaluate the initiative's outcomes for students, teachers, schools, and school network.
- Evaluate the sustainability and scalability of the initiative and provide recommendations about the continuation and expansion of this initiative to other schools and districts.

***Overall Approach to Evaluation***

Mixed-method: Evaluation questions to be addressed by applying analyses from multiple qualitative and quantitative sources.

*Table A1. Research Questions and Anticipated Data Sources*

| **Evaluation Question** | **Document/ Course Review** | **Educator Eval Tool Results** | **Observations** (Classroom/Institute/ Workshop/ Other) | **Interviews** (Teacher/ Admin/ Other) | **Focus Groups** (Student/ Teacher/ Other) | **Surveys** (Student/ Teacher/ Other) | **Quant. Analysis** | **Admin. Data Review** | **Accounting Data Review** |
|---|---|---|---|---|---|---|---|---|---|
| **Implementation Evaluation** | | | | | | | | | |
| To what extent has the structure of the network of STEM anchor and affinity schools been implemented as intended? | X | | X | X | | | | | X |
| To what extent has the curriculum of STEM schools been implemented as intended? | X | | X | X | | | | | X |
| To what extent has the professional development for STEM school teachers and principals been implemented as intended? | | | X | X | | X | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| To what extent have the partnerships between STEM schools and higher education institutions, community, and businesses been developed? | X | | | X | | | | | X |
| **Outcome Evaluation** | | | | | | | | | |
| What are the academic outcomes of the network of STEM anchor and affinity schools (i.e. EOCs)? | | | X | | X | X | X | X | |
| Have the RttT STEM anchor and affinity schools expanded the academic outcomes and reach of current NC STEM programs? | | | | | | | X | X | |
| Are teachers demonstrating the appropriate instruction? | | X | X | X | X | X | | | |
| Do schools demonstrate collaborative culture and implement integrated curriculum and design principles? What are the outcomes for principals and school-level outcomes? | | X | | X | X | X | | | |
| **Sustainability Evaluation** | | | | | | | | | |
| How does the STEM network support other schools in their region and in the state? | X | | | X | X | X | | X | |
| What mechanisms and funding are put in place for the sustainability and scaling up of the model? | | | | X | | | | | |

### *Evaluation Activities*

*Anticipated Procedure*

Each year, initiative implementation strategies and short-term outcomes will be studied using the methods outlined above. Representative samples of professional development activities will be observed. Visits to anchor and network schools will be conducted each semester to evaluate both implementation activities and short-term outcomes for students, teachers, and schools through

observations and interviews. Additional student and staff perception and attitudes will be assessed using survey data. Quantitative analyses will be used to gather selected student and school outcomes and compare them to baseline measures

*Anticipated Schedule*

- First stage (January 2011–June 2011)
  - Meetings with stakeholders
  - Research design, including development of observation protocols
- Second stage (July 2011–June 2013)
  - Regular formative evaluation feedback to organizations implementing the initiative
  - Observations of professional development activities
  - Research design, including development of site visit protocols and surveys
  - Site visits to schools that include observations, interviews, and focus groups with students, teachers, and administrators
  - Collecting demographic data from applicants and admitted students
  - Collecting records of implementation
  - Conducting a baseline quantitative descriptive analyses of existing STEM schools in North Carolina
  - Evaluating the infrastructure, content, quantity and quality of school staff use of virtual community
  - Administer teacher and student survey
- Third stage (July 2013–June 2014)
  - Continuation of qualitative and quantitative evaluations, including assessment of student achievement and on-track-to-graduate rates
  - Summative evaluation; development of recommendations

***Major Evaluation Deliverables***

- Baseline Summary: Descriptive baseline scan of current STEM high schools 9/30/2011
- Initial Report: Descriptive quantitative analyses and PD observations 12/31/2011
- Year 2 Report: Qualitative assessment of Y1 and Y2 implementation 9/30/2012
- Year 3 Report: Qualitative assessment of Y3 implementation 9/30/2013
- Final Report: Outcomes, summative evaluation, and policy recommendations 6/30/2014

**Appendix B. Measures Used for the Data Collection**

Appendix B contains three protocols developed by the project: (1) Professional Development Observation Protocol, (2) Interview Protocol for the Teacher Focus Group, and (3) Protocol for Monitoring the Online Networking Site.

**A. Professional Development Observation Protocol: 2011**

(Adapted from Horizon Research, Inc.)

Observer:_____ Session Title:_____

Observation date: _____ Time Start: _____ End: _____

Facilitator(s): _____ Facilitator(s) affiliation:_____

**1. Background Information (Check all that apply)**

a. Project_____ b. Location_____

c. Subject(s) Targeted in this Session _____ d. Grade Levels___

e. Duration

- 1 hour 2 hours 3 hours Half-Day Full-Day Other_____

f. What is the total number of participants attending this session? _____

g. Participants were:

- Teacher Leaders
- Other (non-lead) Teachers
- Administrators
- Other_____

i. Participants' Gender: Number of Males _____ Number of Females _____

j. Participants' Race/Ethnicity: % Minorities _____

h. Indicate the major professional development approach used in this session

- Workshop Institute Course Semester Webinar
- Learning teams School-based meetings Coaching Mentoring
- Other_____

k. Session Context

In a few sentences, describe the session you observed. Include: (a) whether the observation covered a partial or complete session, and (b) where this session fits in the project's sequence of professional development for those in attendance. (open ended)

**2. Session Focus**

A. Indicate the *primary intended purpose(s)* of this professional development session based on the information provided by the project staff or session organizer/facilitator. Indicate the *major mathematics/science content area(s)* addressed in this professional development session, whether

increasing content knowledge was a stated purpose or the mathematics/science content was simply a vehicle for achieving other purposes. Provide the title of student curriculum materials being used if applicable. (Open ended)

- ☐ Increasing content knowledge of participants
- ☐ Learning how to use specific instructional materials in the classroom
- ☐ Learning how to use technology in the classroom.
- ☐ Learning pedagogical/classroom management strategies
- ☐ Considering issues of access, equity, and diversity
- ☐ Designing or scoring student assessments
- ☐ Other_____

**RttT Priority areas:**

- ☐ Transition to New Standards (Common Core and Essential Standards)
- ☐ NC's Formative Assessment Learning Community's Online Network (NC FALCON)
- ☐ Formative Assessments strategies, not connected with NCFALCON
- ☐ Balanced Assessments and/or Summative Assessments
- ☐ Data Literacy for Instructional Improvement (Instructional Improvement System (IIS))
- ☐ Technology for Teaching and Learning
- ☐ LEA/School Capacity Building
- ☐ STEM
- ☐ School Turnaround
- ☐ Other, specify: _____

**3. Indicate the major activities of participants in this session (check all that apply)**

- ☐ Listened to a formal presentation by facilitator
- ☐ Listened to a formal presentation by participant(s)
- ☐ Engaged in whole group discussion led by facilitator
- ☐ Engaged in whole group discussion led by participant(s)
- ☐ Engaged in small group discussion
- ☐ Develop a product/ hands-on activity
- ☐ Other, specify: _____

**4. Describe the *major activities* of participants in this session: (open ended)**

Examples of and comments on quantity and quality of activities (modeling and reflection) that aim at increased use by teachers of Common Instructional Framework (Six strategies: 1) Collaborative group work; 2) Writing-to-learn; 3) Questioning; 4) Scaffolding; 5) Classroom talk; 6) Literacy groups)

(Open ended)

Examples of and comments on quantity and quality of activities (modeling and reflection) that aim at increased use by teachers of inquiry learning (away from procedure-based; problem- and experience-based; student-centered; geared toward student understanding and scientific process; justifications are discipline-based vs. outside authority)

(Open ended)

Examples of and comments on quantity and quality of activities (modeling and reflection) that aim at greater use by teachers of applied core content embedded in real context

(Open ended)

**Ratings:**

**5. Design of activities**

Scale range: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree, DK= don't know or not observed; NA = not applicable to class or activity being observed

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. The session incorporated tasks, roles, and interactions consistent with a CIF strategies | (1) | (2) | (3) | (4) | DK | NA |
| 2. The session incorporated tasks, roles, and interactions consistent with a spirit of inquiry learning | (1) | (2) | (3) | (4) | DK | NA |
| 3. The session incorporated tasks, roles, and interactions that had applied core content embedded in real context | (1) | (2) | (3) | (4) | DK | NA |
| 4. The session provided opportunities for participants' to share knowledge of content, teaching, learning, and/or the reform process. | (1) | (2) | (3) | (4) | DK | NA |
| 5. The session encouraged a collaborative approach to learning. | (1) | (2) | (3) | (4) | DK | NA |
| 6. The session provided opportunities for participants to consider classroom applications of resources, strategies, and techniques. | (1) | (2) | (3) | (4) | DK | NA |
| 7. Adequate time and structure were provided for "sense-making," including reflection about concepts, strategies, issues, etc. | (1) | (2) | (3) | (4) | DK | NA |
| 8. Adequate time and structure were provided for participants to | (1) | (2) | (3) | (4) | DK | NA |

| | | | | | | |
|---|---|---|---|---|---|---|
| share experiences and insights. | | | | | | |
| **Synthesis Rating for Design** | (1) | (2) | (3) | (4) | DK | NA |

**6. Implementation of activities**

Scale range: 1 = not at all, 2 = not much, 3 = somewhat, 4 = to a great extent, DK= don't know or not observed; NA = not applicable to class or activity being observed

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. The facilitator(s) effectively modeled CIF strategies | (1) | (2) | (3) | (4) | DK | NA |
| 2. The facilitator(s) effectively modeled inquiry learning | (1) | (2) | (3) | (4) | DK | NA |
| 3. The facilitator(s) effectively modeled teaching applied core content embedded in real context | (1) | (2) | (3) | (4) | DK | NA |
| 4. The facilitator(s)' presentation(s) included in the session were carried out effectively. | (1) | (2) | (3) | (4) | DK | NA |
| 5. The facilitator(s) effectively modeled questioning strategies that are likely to enhance the development of conceptual understanding (e.g., emphasis on higher-order questions, appropriate use of "wait time," identifying prior conceptions and misconceptions.) | (1) | (2) | (3) | (4) | DK | NA |
| 6. The facilitator(s)' management style enhanced the quality of the session. | (1) | (2) | (3) | (4) | DK | NA |
| 7. The pace of the session was appropriate for the purposes of the professional development | (1) | (2) | (3) | (4) | DK | NA |
| 8. The session modeled effective assessment strategies. | (1) | (2) | (3) | (4) | DK | NA |
| 9. Participants were engaged with the session. | (1) | (2) | (3) | (4) | DK | NA |
| **Synthesis Rating for Implementation** | (1) | (2) | (3) | (4) | DK | NA |

**7. Exploring Pedagogy/Instructional Materials**

**Only** complete this category if exploring classroom practice/instructional materials was a key purpose of the session.

Scale range: 1 = not at all, 2 = not much, 3 = somewhat, 4 = to a great extent, DK= don't know or not observed; NA = not applicable to class or activity being observed

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. Attention was paid to student thinking/learning. | (1) | (2) | (3) | (4) | DK | NA |
| 2. Attention was paid to classroom strategies. | (1) | (2) | (3) | (4) | DK | NA |
| 3. Attention was paid to instructional materials intended for classroom. | (1) | (2) | (3) | (4) | DK | NA |

**8. Culture of the Professional Development Session**

Scale range: 1 = not at all, 2 = not much, 3 = somewhat, 4 = to a great extent, DK= don't know or not observed; NA = not applicable to class or activity being observed

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. There was a climate of respect for participants' experiences, ideas, and contributions. | (1) | (2) | (3) | (4) | DK | NA |
| 2. Interactions reflected collaborative working relationships between facilitator(s) and participants. | (1) | (2) | (3) | (4) | DK | NA |
| 3. Participants were encouraged to generate ideas, questions, conjectures, and propositions. | (1) | (2) | (3) | (4) | DK | NA |
| 4. Participants were willing to generate ideas and take intellectual risks | (1) | (2) | (3) | (4) | DK | NA |
| 5. Participants provided constructive criticism and/or challenged ideas. | (1) | (2) | (3) | (4) | DK | NA |
| **Synthesis Rating for Culture** | (1) | (2) | (3) | (4) | DK | NA |

**9. Overall Quality of the Professional Development Session**

**Level 1**: Ineffective Professional Development (passive learning, activity for activity's sake)
**Level 2**: Elements of Effective Professional Development
**Level 3**: Beginning Stages of Effective Professional Development
**Level 4**: Accomplished, Effective Professional Development
**Level 5**: Exemplary Professional Development

**B. Interview Protocol for the Teacher Focus Group**

Your school is participating in a STEM Affinity Network. In this interview, we would like to focus on how this affiliation affected both you as a teacher and your school as a whole. We would like to explore three aspects of your and your school's participation: with regard to STEM (science, technology, engineering, and mathematics); with regard to your school's theme; and with regard to various activities you have access to and/or committed to do through the network. So let's start.

1. What is the name of your school? To which Affinity Network do you belong?
   *Facilitator: have everyone in the group answer this first question in order. The rest of the questions don't have to be answered by everyone, and participants can volunteer when to respond.*
2. What is your understanding of what it means for your school to be a STEM school?

    a. What will your school be doing as part of the Affinity Network?

3. What is your understanding of what it means for you as a teacher to be a member of the STEM school?

    a. What will you, as a teacher, be doing as a participant in the network?

4. What activities have you completed as part of the network starting this spring? What activities have other members of your school completed?

   *(Listen for and probe for such PD activities as summer and fall workshops, project design, residencies in model schools, study visits to model schools, instructional coaching.)*
   *Probe on the take always of PD: What impact did these activities had on you?*

5. What interactions do you have with other schools or partners in the network?

6. How has your school changed, if at all, as a result of being in the STEM Affinity network or participating in these activities so far?

   (*Listen for and probe for such in-school activities as implementing integrated curriculum, changing instruction, providing authentic STEM-related experiences for students, incorporating technology into instruction, project-based learning, working with businesses)*

7. How will your school do things differently as a result of participation in this network?

8. What challenges do you face and what help will your school need to become a high quality STEM school?

9. Is there anything else you would like to tell us?

**C. Protocol for Monitoring the Online Networking Site**

For each network in the online community, the following data was collected in an Excel spreadsheet:

Network name
Name of reporter
Date of the report
Number of members
Date of the first post
Date of the last post
Number of Postings by moderators
Number of Postings by participants
Average number of responses per post by moderator
Average number of responses per post by participant
Topics that generated most responses
Topics that had the greatest numbers of posts
Name and number of new technology features/interactive features added (e.g., polls, newsletter sign-up, calendar, and RSS feeds)
Overall impressions/description of changes
A list of resources shared

**Appendix C. NCNSP Guiding Documents**

The documents in this appendix include: (1) NCNSP Design Principles; (2) NC New Schools Project STEM Vision; (3) NCNSP Common Instructional Framework; and (4) STEM Initiative Outcomes, Measures, and Supports, 2010-2011.

***NCNSP Design Principles***

*Overview*

The North Carolina New Schools Project partners with local school districts and higher education institutions to help secondary schools become nimble, rigorous and focused institutions that graduate every student prepared for college, careers and life. NCNSP's goal is to spark and support deep instructional change by purposefully and dramatically rethinking traditional high schools' organization to promote more effective teaching and learning. Our essential premise is straightforward: to improve public secondary schools everywhere, individual schools must be encouraged and assisted to invent and implement more effective means of serving students. The successes that these schools achieve must be sustained, their processes supported, and their new structures for success replicated.

***Design Principles***

Each child in every school is entitled to achieving high academic and affective outcomes. To that end, the following six design principles for NCNSP schools are non-negotiable for all involved in leading secondary school transformation:

1. ***Ready for College:*** NCNSP schools are characterized by the pervasive, transparent, and consistent understanding that the school exists for the purpose of preparing all students for college and work. They maintain a common set of high standards for every student to overcome the harmful consequences of tracking and sorting.
2. ***Require Powerful Teaching and Learning:*** NCNSP schools are characterized by the presence of commonly held standards for high quality instructional practice. Teachers in these schools design rigorous instruction that ensures the development of critical thinking, application, and problem solving skills often neglected in traditional settings.
3. ***Personalization:*** Staff in NCNSP schools understand that knowing students well is an essential condition of helping them achieve academically. These high schools ensure adults leverage knowledge of students in order to improve student learning.
4. ***Redefine Professionalism:*** Evident in NCNSP schools are the collaborative work orientation of staff, the shared responsibility for decision making, and the commitment to growing the capacity of staff and schools throughout the network.
5. ***Leadership:*** Staff in NCNSP schools work to develop a shared mission for their school and work actively as agents of change, sharing leadership for improved student outcomes in a culture of high expectations for all students.
6. ***Purposeful Design:*** NCNSP schools are designed to create the conditions that ensure the other five design principles: ready for college, powerful teaching and learning, personalization, leadership and redefined professionalism. The organization of time, space, and the allocation of resources ensures that these best practices become common practice.

***NC New Schools Project STEM Vision***

*STEM schools*:

- Provide the tools and space for exploration and invention;
- Foster a culture of collaborative inquiry among faculty and students.

*STEM curriculum*:

- Emphasizes connections within and between the fields of math and science;
- Heavily and meaningfully integrates technology;
- Introduces and engages students in the engineering design process;
- Highlights the role of STEM in the global society and economy.

  *Beyond the classroom, extracurricular activities, summer programs, and internships increase students' awareness of and interest in STEM.*

*STEM teaching*:

- Engages students in learning through active solving of real problems;
- Regularly engages students in deep discourse, marked by discipline-based justifications;
- Beyond content knowledge
  - Values and cultivates creativity;
  - Develops problem solving, communication and collaboration skills.

*Beyond standard measures of achievement*:

- Excitement about coming to school and enthusiasm for learning
- A passionate interest in the world
- Confidence and perseverance when faced with a challenge
- Ability to gather and analyze relevant information and synthesize knowledge and skills to solve authentic problems

***NCNSP Common Instructional Framework***

Every student reads, writes, thinks, and talks in every classroom every day. This common framework for instruction drives the instructional practice at NCNSP partner schools and has supported their success because it defines common practices that are used consistently from classroom to classroom. These strategies give all students of all skill levels access to the complex information needed to meet state and college-ready standard and engage all students, requiring each to take an active role in their own learning.

***Collaborative Group Work:*** Collaborative group work involves bringing students together in small groups for the common purpose of engaging in learning. Effective group work is well planned and strategic. Students are grouped intentionally with each student held accountable for contributing to the group work. Activities are designed so that students with diverse skill levels are supported as well as challenged by their peers. Collaborative group work uses questioning, scaffolding, and classroom talk and centers literacy groups.

***Writing to Learn:*** Writing to learn is a strategy through which students can develop their ideas, their critical thinking ability, and their writing skills. Writing to learn enables students to experiment every day with written language and increase their fluency and mastery of written conventions. Writing to learn can also be used as formative assessment and as a way to scaffold mid- and high-stakes writing assignments and tests.

***Literacy Groups:*** Literacy groups provide students with a collaborative structure for understanding a variety of texts and engaging in a higher level of discourse. Group roles traditionally drive literacy groups by giving each student a role to play and a defined purpose within the group. The specific roles or discussion guidelines may vary for different content areas, lengths of texts, or student level of sophistication using this strategy, but the purpose of literacy groups is to raise student engagement with texts by creating a structure within which they may do so.

***Questioning:*** Questioning challenges students and teachers to use good questions as a way to open conversations and further intellectual inquiry. Effective questioning (by the teacher and by students) deepens classroom conversations and the level of discourse students apply to their work. Teachers use this strategy to create opportunities for students to investigate and analyze their thinking as well as the thinking of their peers and the authors that they read in each of their classes.

***Scaffolding:*** Scaffolding helps students to connect prior knowledge and experience with new information. Teachers use this strategy to connect students with previous learning in a content area as well as with previous learning in an earlier grade. Scaffolding also helps facilitate thinking about a text by asking students to draw on their subjective experience and prior learning to make connections to new materials and ideas.

***Classroom Talk:*** Classroom talk creates the space for students to articulate their thinking and strengthen their voice. Classroom talk takes place in pairs, in collaborative group work and as a whole class. As students become accustomed to talking in class, the teacher serves as a facilitator to engage students in higher levels of discourse. Classroom talk opens the space for questioning, effective scaffolding and successful collaborative group work and literacy groups.

** This Common Instructional Framework was first implemented schoolwide at University Park Campus School in Worcester, MA.*

***STEM Initiative Outcomes, Measures, and Supports, 2010–2011***

| Outcomes | Measures | Supports |
|---|---|---|
| STEM schools provide the tools and space for exploration and invention and foster a culture of collaborative inquiry among faculty and students.<br><br>The curriculum emphasizes connections within and between the fields of mathematics and science with heavy and meaningful integration of technology. Courses that introduce and engage students in the engineering design process span the high school course sequence. The arts and humanities further integrate the STEM disciplines, and all courses highlight the role of STEM in the global society and economy.<br><br>Throughout the school, teachers engage students in learning through active solving of real problems, bolstering student motivation and understanding. Students regularly engage in deep discourse, marked by discipline-based justifications. Beyond content knowledge, these schools value and cultivate creativity and develop the problem solving, communication and collaboration skills that drive innovation.<br><br>Extracurricular activities, summer programs and internships provide learning experiences that increase students' awareness of and interest in STEM.<br><br>In addition to standard measures of achievement, indicators of success include student excitement about coming to school, enthusiasm for learning and a passionate interest in the world. Students exhibit confidence and perseverance when faced with a challenge and further demonstrate the ability to gather and analyze relevant information and synthesize knowledge and skills to solve authentic problems. | • NCNSP Annual Self-Assessment<br>○ STEM Appendix<br>○ Course of Study<br>• Annual School Progress Review<br>• STEM Director school visits<br>• Annual Student STEM Survey (Youth Truth with STEM addendum)<br>• Quarterly NCNSP STEM Newsletter submissions<br><br>Future:<br>• College and Work Readiness Assessment (CWRA) or<br>• College-Readiness Performance Assessment System (C-PAS) | • NCNSP IS4<br>• Math and science curriculum and instruction<br>○ *Core-Plus Mathematics* (MSP)<br>▪ Two-week summer workshop<br>▪ Two school year follow up meetings<br>▪ Site-based coaching<br>▪ NCIM support website<br>○ Modeling Science (MSP)<br>▪ Three-week summer workshops<br>▪ Three school year follow up meetings<br>▪ Site-based coaching<br>▪ Online access to curriculum materials<br>○ SEPUP Global Issues Biology<br>▪ Two four-day summer workshops<br>○ Investigations in Environmental Science<br>▪ Curriculum materials<br>▪ GIS computer software<br>▪ One-week summer workshop<br>• Math and science leadership<br>○ Secondary Lenses on Learning<br>• Annual STEM PBL Conference and Student STEM Symposium<br>• Youth Technology Corps<br>○ Summer computer camp<br>○ Spring international computer competition<br>• 4-H and FIRST Robotics<br>○ Start-up support for after school 4-H club<br>○ Start-up support for rookie FRC team |

## Appendix D. NCNSP 2011–2012 Professional Development Calendar

### Affinity Network Schools with New Principals

| ***New Principal Institute*** | |
|---|---|
| Professional development designed for principal.<br><br>September 14, 2011<br><br>Location: Bennett College<br><br>900 East Washington Street<br>Greensboro – 336-517-2100 | The New Principal Institute provides principals the opportunity to develop an understanding of the NCNSP Design Principles and Common Instructional Framework.<br><br>This support session is required for any new principal in the NCNSP network.<br><br>CEU Distribution: 0.5 CEUs for this session |

| ***New Teacher Institute*** | |
|---|---|
| Professional development designed for ANY principal and/or teacher <u>new to the NCNSP network</u> at the start of the school year.<br><br>Note: Two teachers are supported in your partnership agreement; additional teachers may participate for a cost of $500 per person.<br><br>September 28-29, 2011<br><br>Sheraton Imperial Hotel & Convention Center<br><br>4700 Emperor Blvd.<br><br>Durham - 919-941-5050 | The New Teacher Institute provides teachers or principals new to the NCNSP network the opportunity to develop an understanding of the Common Instructional Framework including the six instructional strategies being implemented at their school.<br><br>Follow-up support for this institute is provided at the school level by the school instructional coach.<br><br>CEU Distribution: 1 CEU for this session.<br><br>Note: Two teachers are supported in your partnership agreement; additional teachers may participate for a cost of $500 per person. |

| ***Counselor and College Liaison Support Sessions*** | |
|---|---|
| Professional development designed for the school counselor and early college liaison.<br><br>Western Region: October 6, 2011 and February 21, 2012<br>Crowne Plaza Hickory<br>Hwy 70 1385 Lenoir Rhyne Blvd., SE<br>Hickory – 828-323-1000<br><br>Eastern Region: October 4, 2011 and February 23, 2012<br>Hilton New Bern<br>100 Middle Street<br>New Bern – 252- 638-3585 | Support for school counselors is centered on the development of counselor programs, supporting teaching and learning, and creating a college-going culture in order to support the functions of the counselor. Counselor supports also provide opportunities for school counselors to collaborate with peers and explore best practices.<br><br>Support for college liaisons includes consulting with peers, sharing effective strategies, and exploring how to further support the work of early college high schools on a college campus.<br><br>CEU Distribution: 1 CEU for attending both support sessions |

***Common Practices Symposium I & II***

| | |
|---|---|
| Professional development designed for the principal and one teacher.<br><br>Session I: October 25-26, 2011<br>Location: Hilton Charlotte Center City<br><br>Session II: select a region:<br><br>Western Region:<br>November 16-17, 2011 & February 8-9, 2012<br>Crowne Plaza Hickory<br>Hwy 70 1385 Lenoir Rhyne Blvd., SE<br>Hickory – 828-323-1000<br><br>Eastern Region:<br>November 2-3, 2011 & February 15-16, 2012<br>Hilton New Bern<br>100 Middle Street<br>New Bern – 252- 638-3585 | The Common Practices Symposia are designed as a day and a half of reflection, sharing promising practices, learning new skills, planning improvements, and networking and collaboration with colleagues.<br><br>For CPS I, the STEM Affinity Network schools will all meet together in Charlotte to focus on Powerful STEM Teaching and Learning.<br><br>For CPS II, all NCNSP schools will choose from one of two regional locations.<br><br>CEU Distribution: 1 CEU per event |

***STEM Affinity Network Fall Study Visit to NC Learning Lab Schools***

| | |
|---|---|
| A team of four including a principal, lead-teacher and two other participants are encouraged to participate in this professional development experience.<br><br>Included in the visit:<br><br>• Two days of professional development<br>• Materials<br>• Overnight accommodations<br>• Breakfast<br>• Two lunches<br>• Networking dinner<br>Locations/Dates:<br><br>**Caldwell Early College High School**: Sept. 22-23, 2011; November 2-3, 2011; Jan. 25-26, 2012<br><br>**Cross Creek Early College High School**: Sept. 20-21, 2011; Oct. 4-5, 2011; Nov. 7-8, 2011; Jan. 18-19, 2012<br><br>**Hillside New Tech High School:** Sept. 27-28, 2011; Oct. 13-14, 2011; Nov. 9-10, 2011; Feb. 28-29, 2012<br><br>**Wayne School of Engineering:** Sept. 14-15, 2011; Oct. 11-12, 2011; Feb. 1-2, 2012<br><br>All visits will run from 10:00 a.m. on Day One to 2:00 p.m. on Day Two. | Study visits provide networking opportunities among peers in similar school environments, as well as with other STEM professionals and stakeholders across the state.<br><br>In addition to observing classrooms focused on Powerful Teaching and Learning and Redefined Professionalism, visitors will participate in collaborative discussions with the LLI teachers and students around school culture, student engagement and other participant identified areas of interest<br><br>CEU Distribution: 2 CEUs |

| ***STEM Affinity Network Spring Study Visit*** | |
|---|---|
| Professional development designed for the principal and one teacher.<br><br>Date/Location: TBD – out-of-state | Study visits provide networking opportunities among peers in similar school environments, as well as with other STEM professionals and stakeholders in North Carolina and from across the nation.<br><br>CEU Distribution: 1 CEU |

| ***Project-based Learning Conference and Student STEM Symposium*** | |
|---|---|
| Learning and sharing opportunity for teachers and up to three teams of no more than four students each from each school.<br><br>Date – April 16-18, 2012<br><br>Sheraton Imperial Hotel & Convention Center<br><br>Durham | This is a multi-day conference where:<br><br>1. Teachers learn from each other and from PBL experts to begin or refine implementation of project-based learning by sharing their challenges and successes with PBL, as well as ideas and resources for projects.<br>2. Teams of high school students from STEM schools present their learning through projects to each other.<br><br>The following website provides information from the 2011 PBL Conference and Student STEM Symposium and will be updated with details and registration for the 2012 event around the new year:<br><br>https://sites.google.com/a/newschoolsproject.org/student-stem-symposium-pbl-conference/ |

| ***Schoolwide Instructional Rounds*** | |
|---|---|
| Designed for principal and teachers.<br><br>Session I:<br><br>Occurs anytime between September 26- December 15<br><br>Session II:<br><br>Occurs anytime between February 1 – March 15<br><br>Session III:<br><br>Occurs anytime between March 16 – April 29<br><br>Location:<br><br>Located on the campus of each school | The Schoolwide Instructional Rounds process seeks to make classroom and school-wide practice public to improve student achievement. With the goal of conducting instructional rounds on an ongoing basis, teachers will focus on student work across classrooms and offer meaningful feedback to colleagues. Emphasis on the school-wide implementation of the Common Instructional Framework will provide a framework for the process. |

| ***Regional Action Planning Session*** | |
|---|---|
| Designed for the principal and one teacher leader.<br><br>LIN Groups 1, 4, 5:<br><br>November 29<br><br>LIN Groups 2, 3, 6:<br><br>December 1<br><br>Location:<br><br>Coordinated by LIN Group | Building upon the NCNSP Self-Assessment Action Plan and Design Principle rubrics, the Regional Action Planning Sessions engage principals in high quality professional development with NCNSP staff, leadership coaches, instructional coaches and their peers. Principals work in small regional groups, leveraging the influence of their colleagues in a professional community of learners.<br><br>CEU Distribution: 2.0 CEUs for attending two LIN sessions and the Regional Action Planning Session. |
| ***Leadership Innovation Network (LIN)*** | |
| Designed for the principal.<br><br>Session I:<br><br>Occurs anytime between September 1 and October 1<br><br>Session II:<br><br>Occurs anytime between March 1 and April 1<br><br>Location:<br><br>Coordinated by LIN Group | Building upon the NCNSP Design Principles, the Cambridge Education Executive Coaching Model and Critical Friends Group professional development, LINs engage principals in high quality professional development with leadership coaches, NCNSP staff and their peers. Principals work in small regional groups, leveraging the influence of their colleagues in a professional community of learners. LIN groups will meet twice during the school year with dates determined by the leadership coach and principals.<br><br>CEU Distribution: 2.0 CEUs for attending two LIN sessions and the Regional Action Planning Session. |
| ***Counselor/College Liaison Webinars*** | |
| Designed for the counselor and for the early college high school college liaison.<br><br>All webinars will take place from: 10:00 – 11:30 a.m.<br><br>September 8, 2011<br><br>December 1, 2011<br><br>March 22, 2012<br><br>May 3, 2012 | These webinars will provide opportunities for counselors and college liaisons to engage in collective problem solving to address challenging issues, share promising practices, and learn of new state and NCNSP priorities. |

***Critical Friends Group Training***

| | |
|---|---|
| Professional development designed for the principal and the same 2 teachers, attending all of the dates.<br><br>Dates:<br><br>September 20 - 22, 2011<br><br>February 21 – 23, 2012<br><br>Location:<br><br>Embassy Suites Crabtree Valley<br><br>4700 Creedmoor Rd.<br><br>Raleigh – 919-881-0000 | The NCNSP supports the development of Critical Friends Groups (CFG) at each school that promote honest and productive conversations with colleagues focused on improving student learning and improving teacher practices. Participants in this strand will become CFG leaders who are able to support teacher collaboration and growth by using protocols for examining student and teacher work, for solving problems, setting goals, observing peers, examining inequities in the classroom and building teams.<br><br>Participants in this professional development are school-based champions who will implement Critical Friends Groups during the school year.<br><br>CEU Distribution: 2 CEUs |

***Peer School Reviews***

| | |
|---|---|
| Designed for principal and teachers.<br><br>Occurs anytime between October 3 – October 31<br><br>Location:<br><br>Coordinated through LIN Groups. | The NCNSP peer school reviews are dedicated to providing opportunities for rich reflection and discussion of the Design Principles with a focus on Powerful Teaching and Learning. Peer School Reviews are coordinated with schools in the LIN groups with school visits according to the rounds model for professional development. The rounds model is patterned after medical school clinical rounds that includes pre- and post-rounds discussions.<br><br>CEU Distribution:<br><br>0.6 CEUs for presenting schools<br><br>0.5 CEUs for visiting schools |

***Secondary Lenses on Learning: Part I***

| | |
|---|---|
| Professional development designed for a school team.<br><br>SLoL is professional development designed for building-based mathematics leadership teams. Schools are strongly advised to include the following roles in their seminar teams:<br>- school principal<br>- influential mathematics teachers<br>- guidance counselor<br>- district curriculum director<br><br>Other leaders are also suggested to join the team as fits the setting, for example: curriculum facilitator, special educator. Up to five participants are allowed to attend. It is important that the all team members commit to attend all sessions. | The Secondary Lenses on Learning seminar series will address two primary goals:<br>* To provide your team with experiences, information, and resources needed to guide your team in key areas of school practice known to have an impact on secondary students' mathematical learning.<br>* To develop your capacity to work together, as a coherent mathematics leadership team, in order to strategically advance the work of the mathematics program in your school.<br><br>There will be three day-long sessions scheduled during the upcoming 2011-2012 school year focused on curriculum, instruction and assessment, followed by three additional sessions in 2011-2012. |

| | |
|---|---|
| Dates/Locations: Will be chosen geographically based on participant teams. The expectation will be that these three sessions will be held in the east, central and western parts of the state. | CEU Distribution: 4 CEUs for completion of the two-year program |

***Coaching Support***

*Leadership Coaching*

In order to meet the diverse challenges of leading innovative high schools, principals need consistent mentoring and support from experienced and reform-minded educational leaders. Ongoing partnerships between NCNSP leadership coaches and individual principals allow for customized services while focusing on developing powerful teaching and learning through strategic action planning. Leadership coaches serve principals on-site with school visits scheduled throughout the school year.

*Instructional Coaching*

Instructional Coaches support teachers to adopt and implement a Common Instructional Framework that helps students read, write, think and talk in every class every day. STEM Affinity Network schools will receive 36 days of instructional coaching for all staff members, 12 days of math-focused instructional coaching, and 12 days of science-focused instructional coaching.

Instructional Coaches provide schools the following services:

- Facilitating whole-staff professional development to support research-based practices in every classroom.
- Conducting demonstration lessons or co-teaching in various classrooms so that teachers can see the research-based practices in a classroom setting.
- Supporting an instructional rounds model to assist classroom teachers in reflection on their own practice and help them determine appropriate next steps.
- Helping faculties use data effectively for instructional planning.
- Partnering with principals as instructional leaders to plan professional development for the school year.

## Appendix E. Professional Development: Additional Tables

### *Analyses of Participants' Evaluations*

*Table E1. Response Rates for PD Workshops, 2011*

| Workshop | Response Rate |
|---|---|
| Math Content (Core Plus) | 92% |
| Environmental Science | 100% |
| Project Development | 73% |
| New Principal Institute | 59% |
| New Teacher Institute | 91% |
| Critical Friends Group | 100% |

*Note*. Response rates were calculated based on total number of attendees who signed in at the event.

*Table E2. Summer 2011 STEM PD Response Rates – Support Needed for Successful Implementation*

| Session | Need Financial Support | Need Personal Support from Fellow Teachers, Administration, and District-Level Staff |
|---|---|---|
| Math Content (Core Plus) | 8% | 17% |
| Environmental Science | 10% | 30% |
| Project Development | 13% | 57% |
| *Total Proportion of Responses* | 12% | 47% |

*Note*. Percentages represent the proportion of respondents who provided feedback related to theme.

*Table E3. Summer 2011 STEM PD Response Rates – Potential Challenges to Implementation*

| Session | Getting Other Teachers to "Buy-In" to Changes | Time for Planning Changes | Engaging Students with the New Changes |
|---|---|---|---|
| Math Content (Core Plus) | 8% | 17% | 0% |
| Environmental Science | 10% | 20% | 50% |
| Project Development | 39% | 24% | 22% |
| *Total Proportion of Responses* | 30% | 22% | 22% |

*Note*. Percentages represent the proportion of respondents who provided feedback related to theme.

*Table E4. New Principal Institute 2011 Most Reported Themes*

| | How to use the "Instructional Rounds" process for observing teachers and providing them support and feedback | Strategies for communicating "Design Principles" to faculty |
|---|---|---|
| Response Rate | 58% | 25% |

*Table E5. Critical Friends Group Most Reported Themes*

| | Immediate application: Implementation of protocols with staff and colleagues | Long-term application: Developing community, seeking help with lesson design | Long-term application: Create culture where CFG is the norm |
|---|---|---|---|
| Response Rate | 77% | 42% | 23% |

*Table E6. Most Valuable Part of PD Workshop, 2010–2011*

| Session | Learning New, Specific Instructional Strategies | Networking with Other Teachers |
|---|---|---|
| Math Content (Core Plus) | 58% | 50% |
| Environmental Science | 60% | 10% |
| Project Development | 9% | 30% |
| New Principal Institute | 0% | 58% |
| New Teacher Institute | 53% | 35% |
| Critical Friends Group | 4% | 15% |
| *Total Proportion of Responses* | 35% | 34% |

*Note*. Percentages represent the proportion of respondents who provided feedback related to theme.

***Analyses of External Observations***

*Table E7. Content of Professional Development Sessions, 2010–2011*

| Purpose | Percentage of Observations Reporting this Focus |
|---|---|
| Learning pedagogical/classroom management strategies | 85% |
| Learning how to use specific instructional materials in the classroom | 45% |
| Increasing content knowledge of participants | 30% |
| Considering issues of access, equity, and diversity | 15% |
| Learning how to use technology in the classroom. | 5% |
| Designing or scoring student assessments | 5% |

*Table E8. Implementation of Common Instructional Framework Strategies, 2010–2011*

| Instructional Strategy | Percentage (Number) of Observations Reporting this Focus |
|---|---|
| 1) Collaborative group work | 95% (19) |
| 2) Writing-to-learn | 55% (11) |
| 3) Questioning | 85% (17) |
| 4) Scaffolding | 60% (12) |
| 5) Classroom talk | 85% (17) |
| 6) Literacy groups | 50% (10) |

*Table E9. Design of PD Activities, 2010–2011*

| Indicator | Percentage of Agree or Strongly Agree | Average Rating |
|---|---|---|
| The session encouraged a collaborative approach to learning. | 100% | 3.74 |
| The session incorporated tasks, roles, and interactions consistent with CIF strategies | 85% | 3.40 |
| The session incorporated tasks, roles, and interactions that had applied core content embedded in real context | 89% | 3.37 |
| The session provided opportunities for participants to consider classroom applications of resources, strategies, and techniques. | 85% | 3.30 |
| The session incorporated tasks, roles, and interactions consistent with a spirit of inquiry learning | 75% | 3.13 |
| The session provided opportunities for participants to share knowledge of content, teaching, learning, and/or the reform process. | 84% | 3.11 |
| Adequate time and structure were provided for sense-making— including reflection about concepts, strategies, issues, etc. | 70% | 3.00 |
| Adequate time and structure were provided for participants to share experiences and insights. | 65% | 3.00 |

Scale range: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree

*Table E10. Ratings for Implementation of Activities, 2010–2011*

| Indicator | Average Rating |
|---|---|
| Participants were engaged with the session. | 3.55 |
| The facilitator(s)—management style enhanced the quality of the session. | 3.28 |
| The facilitator(s) effectively modeled teaching applied core content embedded in real context | 3.25 |
| The facilitator(s)—presentation(s) included in the session were carried out effectively. | 3.21 |
| The facilitator(s) effectively modeled questioning strategies that are likely to enhance the development of conceptual understanding (e.g., emphasis on higher-order questions, appropriate use of —"wait times— identifying prior conceptions and misconceptions.) | 3.21 |
| The pace of the session was appropriate for the purposes of the professional development | 3.16 |
| The facilitator(s) effectively modeled CIF strategies | 3.11 |
| The session modeled effective assessment strategies. | 3.09 |
| The facilitator(s) effectively modeled inquiry learning | 3.07 |

Scale range: 1 = not at all, 2 = not much, 3 = somewhat, 4 = to a great extent

*Table E11. Culture of the Professional Development Session*

| Indicator | Average Rating |
|---|---|
| There was a climate of respect for participants' experiences, ideas, and contributions. | 3.74 |
| Participants provided constructive criticism and/or challenged ideas. | 3.60 |
| Interactions reflected collaborative working relationships between facilitator(s) and participants. | 3.55 |
| Participants were willing to generate ideas and take intellectual risks | 3.47 |
| Participants were encouraged to generate ideas, questions, conjectures, and propositions. | 3.45 |

Scale range: 1 = not at all, 2 = not much, 3 = somewhat, 4 = to a great extent

**Appendix F. Development of Integrated Curriculum with Project Units**

*Table F1. Schoolwide Project Topics by Affinity Network Theme*[3]

| School Number | Affinity Network | Project Title/Content | Duration | Key Activities |
|---|---|---|---|---|
| 1 | Health and Life Sciences | "How can our food and health choices affect our future?"<br><br>Cultural, economic and political factors affecting food selection | Spring semester | Students will complete a performance assessment in each content area, leading to a summative presentation on a website. |
| 2 | Health and Life Sciences | "Our Food, Our Choices, Our Future"<br><br>Nutrition; ecology/ecological footprints and disposal of packaging; food borne diseases; conditions caused/aggravated/ameliorated by food choices | Year-long | Students will complete a series of six mini investigations on topics such as the ecological footprint of your diet. They will produce a 30-second PSA that will be edited and reviewed by staff at a local radio station. |
| 3 | Health and Life Sciences | Food choices<br><br>Analyze quality of food choices made by students | Fall semester | Students will collect data on students' eating habits and will examine the nutritional benefits of different options. They will create a brochure on healthy eating. |
| 4 | Health and Life Sciences | "How Can Our Food and Health Choices Affect Our Future?"<br><br>Agriculture, role of food in civilizations, nutrition and role of biochemistry in food, ecological impact of food choices | Fall semester | Define a problem related to food in the community and develop possible solutions. Students will present their ideas orally and in a reflective essay. They may implement their ideas in the community. |
| 5 | Health and Life Sciences | "How Can Our Food and Health Choices Affect Our Future?"<br><br>Ecological impact of food choices, nutrition, role of food in civilizations | Year-long | Students will work in teams to define and then solve a problem regarding food and health choices in their community. They will present their final solutions to the community. |

[3] We do not provide names for any schools in this report.

| School Number | Affinity Network | Project Title/Content | Duration | Key Activities |
|---|---|---|---|---|
| 6 | Health and Life Sciences | "Why Do We Eat What We Eat?"<br><br>Patterns of food production and consumption over time, impact of changes in those patterns | 4 weeks | Students will create an oral presentation and a product of their choice to represent a solution to a problem they identified. |
| 7 | Biotechnology and Agriscience | "How Can Life be Sustained?"<br><br>Bio-fuels, food production, and waste management | Year-long | Students will research a problem within this field that currently does not have a solution, and use the engineering design process to create a solution. Activities include a research paper, presentation, and final video. |
| 8 | Energy and Sustainability | "Sustaining our Present—Protecting our Future"<br><br>Alternative energy and sustainability | Year-long | Students will create and present an alternative energy plan for increasing the sustainability of a specific aspect of the high school (e.g., paper usage, transportation, etc.). |
| 9 | Energy and Sustainability | "My Carbon Footprint: What is it and why does it matter?"<br><br>Carbon footprint, role of consumption | Year-long | Students will complete a series of smaller projects, such as an energy audit, leading to the creation of a research paper, webpage, and educational brochure. |
| 10 | Energy and Sustainability | "The Foundation of Alternative Energies"<br><br>Alternative energy, the engineering process | Year-long | Students will undertake a variety of smaller projects that will lead to the creation of a boat powered by alternative energy. |
| 11 | Energy and Sustainability | Energy/Environment Project<br><br>Sustainable energy practices | | Students will participate in the eCYBERMISSION contest. They will investigate a local (North Carolina) environmental or energy problem, create a solution, build a prototype, test the prototype, draw conclusions, and determine next steps for implementation. |
| 12 | Energy and Sustainability | "Comprehensive Sustainability Plan"<br><br>Resource use, power generation, manufacturing, agriculture | Year-long (part of four years) | Students will create a sustainability plan for their school, focused on reducing their carbon footprint. The project will be judged, and the winning plan will be instituted in the school. |

**Appendix G. Attributes of Effective STEM Schools**

*(from the North Carolina Science, Technology, Engineering, and Mathematics (STEM) Education Strategic Plan – Priority 1: Improving STEM Achievement)*

Increasing student interest and performance in STEM require a relevant, rigorous curriculum, delivered by educators that have mastered integrated content across subjects, pedagogy, and 21st century instructional tools and assessments. Students and educators will operate in schools that have both effective instructional leaders and the support of parents, business and industry, and the community.

*Goals:*

- Increase student interest in STEM fields and in continuing their education
- Increase STEM achievement of K–12 students
- Increase the graduation rate of students in STEM programs
- Decrease the postsecondary remediation rates
- Increase the number of educators prepared and delivering integrated STEM education

*Strategy:* Adopt a set of attributes for STEM schools and programs, aligned with 21st Century skills, to assist public and private organizations to align, coordinate, and advance STEM skills for all students.

North Carolina has strong pockets of promising practices and many strengths to be leveraged across the state. However, we lack a framework to scale what works and a clear declination of the characteristics of a quality STEM education.

Beyond focusing on science, technology, engineering, and mathematics, STEM education provides the opportunity to teach students what to do when they do not know what to do, how to process and take action in new and uncomfortable situations, and how to understand, interact, and lead in the jobs, communities, and world in which they live. Effective STEM schools and programs are characterized by the following attributes.

**Integrated STEM curriculum aligned with state, national, international, and industry standards**

- Project-based learning with integrated content across STEM subjects
- Connections to effective in- and out-of-school STEM programs
- Integration of technology and virtual learning
- Authentic assessment and exhibition of STEM skills
- Professional development on integrated STEM curriculum, community/industry partnerships, and connections with postsecondary education
- Outreach, support, and focus on underserved, especially females and minorities and economically disadvantaged

**Ongoing community and industry engagement**

- A communicated STEM plan adopted across education, communities, and businesses
- STEM work-based learning experiences, to increase interest and abilities in fields requiring STEM skills, for each student and educator
- Business and community partnerships for mentorship, internship, and other STEM opportunities that extend the classroom walls

**Connections with postsecondary education**

- Alignment with students' career pathway with postsecondary STEM program(s)
- Acquisition of postsecondary credit and industry credential while in high school

These attributes are central to the 21st Century skills expected to be the overall goal of all education in North Carolina.