Promoting STEM through Professional Development: Learning from Evaluation

Karen Chen*, Laurie Ruberg, & Judy Martin
Center for Educational Technologies®
Wheeling Jesuit University, Wheeling, WV

ABSTRACT

This study evaluated a longitudinal teacher professional development program designed to increased student interest, participation, ability, and career awareness in science, technology, engineering, and mathematics (STEM). We employed a mixed-method design and gathered data from teachers, students, school team leads, and school administrators. We analyzed surveys, teachers' electronic portfolios, focus group interviews, and state report card results. The findings revealed emerging trends consistent with our quantitative results. The study yields important implications for evaluating professional development that seeks to improve STEM teaching practice and student learning.

RESEARCH STATEMENT

The NASA Explorer Schools (NES) project provides curriculum materials, professional development, and technology support for low performing, socioeconomically challenged, ethnically diverse schools serving grades 4-9. The focus of NASA's support is on improving teacher abilities and student achievement in science, technology, engineering, and mathematics. Schools participate for a three-year period. Our team at the Center for Educational Technologies® at Wheeling Jesuit University in Wheeling, WV, evaluated the quality of the program to determine its impact on teachers, students, and schools. We adopted a theory-based professional development framework (Supovitz & Turner, 2000) to assess the project's effectiveness in its first three academic years from 2003 to 2006.

More information about the NES evaluation model and results can be found at www.cet.edu/research/nes.html

METHODOLOGY

Beginning with the project's theoretical framework, we took a realist approach, analyzing a range of quantitative and qualitative data.

Quantitative

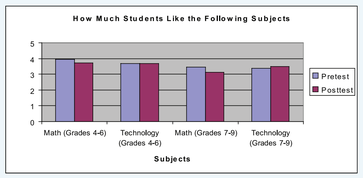
Data Analysis. A total of 149 schools from all 50 states and Puerto Rico participated in NES since the project's inception in 2003. We based schools as a cohort based on the year they joined the program. Students responded to surveys at the beginning and end of the academic year. The assessment disseminated in fall 2005 was slightly modified from the survey used the first two years. In spring 2006 we distributed two versions of the career interest assessment. We performed a mixed-design ANOVA data analysis to examine changes in students' perceived competence, knowledge, and interest as well as family/outside-of-school involvement in STEM and career-related activities. In this study we report the findings from the survey data based on 580 matched students in grades 4-6 (representing 38 teachers) and 1,440 matched students in grades 7-9 (representing 16 schools).

Qualitative

Data Analysis. Our research team employed an interpretive, multiple case study approach to help us understand how the NES intervention was implemented at the school level. We selected 29 case study schools from a cluster-based randomized sample design that provided one school per regional NASA field center per year for each of the three years of this analysis. The data sources included telephone interviews with the teams, questionnaires, school implementation plans, and teachers' electronic portfolios. We sorted all of the data collected into the interpretational and reflective structure provided by the theory-based framework. Each school's students were treated as a unique case for study, and from individual cases we generated an understanding of what effect the program was having on student learning. The results of the case study provided the emerging themes with detailed supporting examples that are categorized under each of the following research questions. Any discrepancy on the themes or examples were discussed among three researchers until we reached a consensus.

Quantitative Results | Qualitative Results

1 Research Question 1. **Does the NES teacher professional development have an impact on students' interest and participation in STEM? If yes, in what way?**



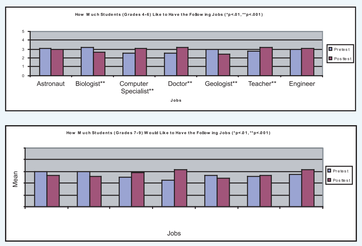
Theme 1. *Participate productively in STEM practices and discourse.*
- "NES has brought many attainable activities to the students that they would not normally have participated in until they got to high school." (A42)

Theme 2. *Show noticeable curiosity in STEM-related topics and events.*
- "Students are now watching the Discovery Channel or Animal Planet and playing games that are science-related, like the virtual reality landing on Mars game." (A42)
- "Kids now got excited about the things related to NASA because they know they are associated with it. They would come in and say they saw it on TV. They were excited when they knew they were participating in research that NASA would actually use." (I59)

Theme 3. *Change attitudes about learning.*
- "Kids have just become jaded about their experiences. They take for granted that astronauts come to lunch and that an astrophysicist talks to them. Kids go on to middle school and complain about no science. They want science like they had in elementary school." (D109)
- "We have incorporated having NASA science nights up here since we have become a NASA Explorer School. And that is showing my students out there and bringing speakers in that (that) is what is really out there for them." (J65)

Theme 4. *Active participation in hands-on and authentic scientific research.*
- "Students conducted an experiment that went up into the upper atmosphere to see the effects on a CD. Students tracked solar weather, took sun spotters, followed the sun spots, listened to the sun, and tried to predict which of these spots would have an impact on Earth. They put data into the computer and saw data from other schools across the country." (H99)
- As documented in NES C103's e-Folio, students attend the Department of Defense program called STARBASE. Students launch rockets, fly a flight simulator, watch movies about space, hear guest speakers, and gain a great deal of knowledge about Earth science and physics.

2 Research Question 2. **Does the NES teacher professional development have an impact on students' interest in STEM careers? If yes, in what way?**

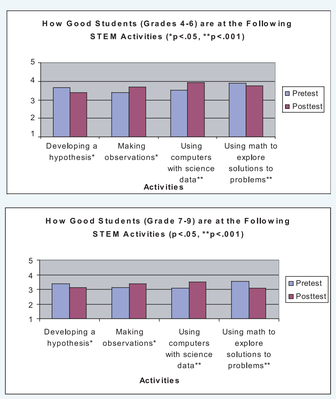


Theme 1. *Change in self-identity*
- "Most of the students are from low socioeconomic backgrounds, and they sometimes equate that with not being able to be successful in their own future. NES gives students the idea that they can and will do more things than they thought they were capable of doing, which changes their self-perception of where they fit in society. Kids feel special and are more confident about what they can actually accomplish." (H99)
- "Hispanic role models as engineers and astronauts coming to the school and talking to the students have helped make the program more effective." (I16)

Theme 2. *Increased understanding of and enthusiasm about STEM careers.*
- "The teachers have brought in more career-oriented science things to allow kids to know what the careers are in science, what is available to them, and what they have to do to get there. Let the students participate in some of the careers and act as actual scientists." (G145)
- "In Kennedy students got to go to the front of the line and meet people who the regular public did not get to meet. One of the little girls said she was so impressed talking to the astronaut that the astronaut was telling her how it looked from space. She said she could not wait . . . to go up into space so that she could see it herself because she could hardly believe what he told her." (A126)

Theme 3. *Share information with peers and parents.*
- As documented in NES E98's e-Folio, the school projected 125 eighth grade students would present Journey to Mars activities to fifth grade students to demonstrate what it means to be an NES school.

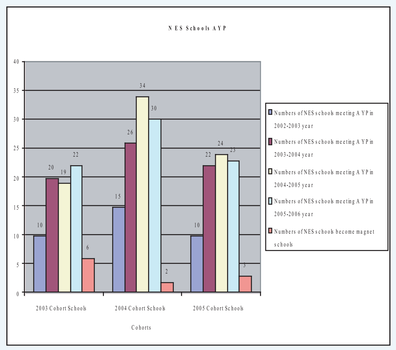
3 Research Question 3. **Does the NES teacher professional development have an impact on students' academic performance? If yes, in what way?**



Theme 1. *Understand and use scientific explanations of the natural world.*
- "When the tsunami occurred, they were able to understand what had happened because they had just finished a unit on forces that shape the Earth." (A42)

Theme 2. *Understand how to use and interpret the data obtained from technology tools to support STEM-related inquiry activities.*
- "The kids in the special program had found ways to be part of this program with their specific gift. Many of them are very adept at computers. One of the boys did all the computer technology for the Wallops rocket launch, and he is doing very well in high school. This is a boy whom we almost lost." (H99)
- "In August 2006 student specialists were challenged to research and make posters and essays celebrating Dryden's 75th anniversary. Twelve of them participated. We had eight that met all the criteria of competition and sent them to Dryden." (B103)

Theme 3. *Increase in achievement tests in math and language arts/reading.*
- "Student achievement has increased. Our state testing scores rose seven points." (A42)
- "Students' test scores improve dramatically, especially in math (haven't have science tests yet). We really think that the improvement is because of the Explorer School involvement. The score went from level 4 to level 5, which was the highest you can get. There is a significant gain in math, and we attribute that in great deal to the NASA program." (E57)



CONCLUSIONS/ RECOMMENDATIONS

Our paired survey results for students in grades 4-6 and 7-9 showed that students' interest in STEM subjects was sustained and well above the average (2.5 on a 1-5 scale). Our qualitative data revealed that the integration of instruction in skills from weaker subjects into subjects where students were already highly engaged and learning rapidly was important for shortening the differences in performance. For example, teachers who sought out ways to match STEM activities with physical education had great potential for making science, math, and technology topics more accessible and interesting to a broader youth audience.

For career choices grades 4-6 showed significant increases in liking the following jobs: computer specialist, doctor, and teacher. Grades 7-9 showed significant increases in liking these jobs: computer specialist, doctor, and engineer. These findings indicated that students in grades 7-9 become more aware of other STEM-related careers. For example, they will consider engineering for a career. Our qualitative data revealed that students' exposure to technology use in the classroom or by their teachers has a major impact on their liking or interest in the technology-related fields.

In the students' ability to perform STEM-related activities, students generally felt they were good at making observations and using computers with science data. The school report card data was an indirect source to measure student achievement both before and over the course of participation in NES. The number of NES participating schools meeting annual yearly progress doubled for each of the cohort groups. While this measure cannot be represented as a direct result of NES, as evidenced in our qualitative data, teachers contributed to the students' academic gains as the results of NES. Such gains in student achievement in high stakes testing also shows schools that successfully implement the program demonstrated significant gains in student performance on achievement tests.

Challenges

A challenge that emerged in the data analysis process was reconciling the findings from the data collected through the formal project communication channels with school reviews posted on consumer advocate websites. Another challenge was our lack of a direct connection with students influenced by the program. Follow-up interviews with the students would have provided more insight and valuable information for the evaluation of outcomes.

Contact information
*kchen@cet.edu

This poster presentation was partially funded by the West Virginia Space Grant Consortium