Promoting STEM through Professional Development: Learning from Evaluation

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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 results important implications for evaluating professional development that seeks to improve STEM teaching practice and student learning.

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 the project's inception in 2003. We identified two primary sources for data collection. The first source was the NESP survey, a self-administered survey that collected data on the implementation of the NESP and the impact on students. The second source was the state report card, which provided data on student achievement and school performance. We used statistical methods to analyze the data, including descriptive statistics, inferential statistics, and regression analysis.

Qualitative Data Analysis. Research questions were developed based on the project's theoretical framework and the research questions were guided by the research questions. The data collected from the surveys and state report cards were analyzed using qualitative methods, including content analysis and thematic analysis. The qualitative data were coded and categorized to identify patterns and themes.

RESEARCH STATEMENT

The NASA Explorer Schools (NES) project provides curricular 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

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?

- Thematic 1: Participatory in STEM projects and discourse
  - "The students have many opportunities to participate in activities that they wouldn't normally participate in until they got to high school." (T142)
  - "Students are now watching Discovery Channel or Animal Planet and playing games that are science-related. The virtual reality land on Mars games," (T25)
  - "Kids grow excited about the things related to NASA because they know that they are associated with it. They would come in and say, 'I saw that on TV. They were excited when they knew that people were participating in research that NASA would actually use.' (T35)

- Thematic 2: Change attitudes about learning
  - "Kids have just become excited about their experiences. They take for granted that astrophysics is just something that you do in school but in the NES program," (T29)
  - "We have incorporated NASA science right up here even though we have become a NASA Explorer School, and that is showing my students out there and bringing experiences that they are really relevant for them," (T26)

- Thematic 3: Active participation in hands-on and authentic research science
  - "Students concluded an experiment that went up into the upper atmosphere to see the effects on a CD. Students tracked water rocket, took sun spots, found a way to predict which of these spots would have an impact on earth," (T28)
  - "For documented in NES CIS's, students attend the Defense of Defense program called STEAMBASE, students launch rockets, fly a flight simulator, watch movies about spacecraft, have guest speakers, and gain a great deal of knowledge about Earth science and physics." (T29)

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

- Thematic 1: Change in self-identity
  - "Most of the students are from low socioeconomic backgrounds, and many of them say that being able to be successful in the new STEM environment. NES gives students the idea that they can and will do more than they thought they were capable of doing, which changes their perception of where they fit in society," (T139)

- Thematic 2: Increased understanding of and enthusiasm about STEM careers
  - "The teachers have brought in more conversational science things to allow kids to see where careers are in science, what is available to them, and what they can do to become them," (T139)
  - "In NES programs students get to the front of the line and most people who were very close to them, and they never thought they could see themselves in NES," (T139)

- Thematic 3: Technological knowledge in STEM education
  - "One of the 9th graders was the executive editor of a science fiction magazine, said she could not read...to go up into space so that she could see herself," (T139)

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

- Thematic 1: Understanding and use scientific explanations of the natural world
  - "When the human body is involved, they are able to understand what happened because they can relate to it one on one," (T139)

- Thematic 2: Understanding 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 computing. One of the tools did all the computer technology for them, and he would come in and tell them what they need to know," (T139)

- Thematic 3: Increase achievement tests in math and language arts
  - "Student achievement has increased. Our state testing scores are higher than usual," (T142)

CONCLUSIONS/RECOMMENDATIONS

Our paired and outcome results for students in grades 4-8 and 7-9 showed that students' interest in STEM subjects was sustained and well above the average (2.5 on a 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 became more aware of other STEM-related careers. For example, they would 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 after the course of participation in NES. The number of NES participating schools meeting annual year 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.

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