# AC 2009-937: ANALYSIS OF A STATEWIDE K-12 ENGINEERING PROGRAM: LEARNING FROM THE FIELD

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# Analysis of a Statewide K-12 Engineering Program: Learning from the Field


## Abstract

Engineering Our Future New Jersey (EOFNJ), an ongoing statewide initiative to infuse engineering into K-12 science, mathematics, and technology curricula, has recently concluded a three-year effort to reach 2,000 elementary, middle, and high school education professionals with professional development activities and an awareness-building campaign. This program, which has focused on teacher professional development using a variety of exemplary K-12 engineering curricula with varying degrees of intensity and classroom support, has reached more than 2,400 education professionals. Quantitative and qualitative results of a multifaceted study of EOFNJ are reported in this paper to demonstrate the impact such programs can have on education and to provide insight on establishing and nurturing these programs through the example set by two school districts.


## Background

Imagine a third grade classroom where a student announces "I want to be an engineer when I grow up." And another chimes in "My dad's an engineer and I never knew what it was and now I understand what my dad does at work." Or imagine an eighth grade class implementing an engineering unit where several students, characterized by their teachers as being disaffected, ask permission to bring their projects home so they can have more time to work on them. For teachers in two New Jersey school districts, these are not imaginings; these are actual experiences resulting from the introduction of engineering activities in their classrooms.

As participants in the Engineering Our Future New Jersey (EOFNJ) Program, these teachers are among the 2,400 elementary, middle, and high school educators in New Jersey who have been introduced to engineering concepts and curricula along with methods for teaching engineering at the K-12 level. EOFNJ has recently concluded the third year of a statewide professional development and awareness-building effort aimed at infusing engineering into K-12 science, mathematics, and engineering curricula. The focus in this ongoing program over the last three years has been on providing teacher professional development using a variety of exemplary K-12 engineering curricula with varying degrees of intensity and classroom support.

While the classrooms described above are actual examples of the positive impact that the program has had on students in classrooms of teachers who have participated in the EOFNJ program, they are examples of classrooms and districts where engineering curricula and related activities have flourished. Not surprisingly, these results have not been realized for all of the participants in the program. In an effort to understand both the impact of the EOFNJ program and the reasons or conditions leading to the adoption and institutionalization of EOFNJ-promoted curricula and programs in some situations, we have conducted an internal evaluation of the program including an online survey of program participants and interviews with faculty and staff at two participating school districts. The results are being presented here in an effort to highlight the potential impact such programs can have on teachers and students and to portray the conditions that will likely increase the probability that other similar programs will have a significant and sustained impact.

**Description of Professional Development**

The EOFNJ initiative is a multi-pronged statewide effort launched in 2005 that includes a variety of approaches to insure that all K-12 students experience engineering, with a focus on innovation, within their required, regular classroom courses by 2010. This mission has encompassed a wide range of approaches, including pre- and in-service teacher professional development (PD), policy initiatives, partnerships and capacity building efforts and promotion, a major component of that effort has been dedicated to preparing teachers to lead students in the application of science and mathematics principles to solve relevant, real-world design problems in the context of the required courses. In addition to increasing students' familiarity with engineering and other STEM careers, the exposure to engineering concepts and design-based activities is hypothesized to improve students' problem-solving abilities in other areas.

The teacher professional development programs under the EOFNJ umbrella provide teachers with a thorough understanding of selected exemplary engineering curricula and the underlying science, engineering, and mathematics concepts through hands-on experiences that frequently result in effective classroom implementation and occasionally in district-wide adoption of the curriculum.[1] Engineering curricula and software included in the various professional development activities are listed in Table 1 below. The length of the PD activities has varied with the programs listed; introductions to some of the programs may be limited to less than an entire day while the longest program extends for two weeks in each of three summers and includes classroom support during implementation.

**Table 1:** EOFNJ Program Curricula and Software

| Curriculum/Software | Grade Level | Developer | Publisher |
|---|---|---|---|
| Engineering is Elementary www.mos.org/eie | 3-5 | Museum of Science, Boston | Museum of Science, Boston www.eiestore.com |
| A World in Motion www.awim.org | 6-8 | Society of Automotive Engineers | Society of Automotive Engineers www.sae.org/exdomains/awim/teachers/requestkit.htm |
| Building Math www.engineering.tufts.edu/buildingmath/index.html | 6-8 | Museum of Science, Boston | Walch Publishing www.walch.com/search.php?title=building+math |
| CIESE Engineering Lessons http://www.stevens.edu/ciese/engineeringproj.html | 3-12 | CIESE | Center for Innovation in Engineering and Science Education (CIESE) www.stevens.edu/ciese |
| Engineering The Future www.mos.org/etf | 9-12 | Museum of Science, Boston | Key Curriculum Press www.keypress.com/x19890.xml |
| Pro/Engineer Wildfire Software (Schools Edition) www.ptc.com/for/education/schools_program_faq.htm | 6-12 | Parametric Technology Corporation | Parametric Technology Corporation www.ptc.com |

## Impact on In-Service Teachers

Email requests to complete a brief online survey about EOFNJ PD program impact were sent to 1,228 participants in March or May 2008. (All program participants also completed a post-workshop evaluation at the completion of that program; these data are not analyzed here.) Requests were sent to participants at e-mail addresses they had provided. Participants received this request anywhere from two weeks to more than a year after their participation in the program. Incentives were provided in an attempt to increase the response rate: drawings were held for $50 and $25 gift cards from their choice of Nasco (a science supply company), Borders, or Barnes and Noble.

Three versions of the survey were developed to address the different groups of education professionals participating in the program: in-service teachers, pre-service teachers, and other education professionals. This last group consisted primarily of guidance counselors and school administrators. The largest group of participants in the program has been in-service teachers and therefore this group also comprises the largest percentage of the responses to the survey as shown in Table 2. Response rates were calculated according to the procedure recommended by The American Association for Public Opinion Research (AAPOR) for Internet surveys of specifically named persons.[2] Response rates are reported as ranges here because 128 invitations were sent to individuals who had not specified their professional classification at the time of the PD activity. The lowest response rate in the range reported in the table assumes that all of the individuals of unknown classification were of the specified group. For example, 170 responses were received from a total number of in-service teachers that is between 565 and 693 (565 known in-service teachers plus 128 individuals of unknown classification, possibly all teachers).

**Table 2:** Breakdown of the number of survey invitations sent and responses received

| Professional Classification | Invitations Sent | | Responses Received | Response Rate |
|---|---|---|---|---|
| In-service Teacher | 565 | | 170 | 25-30% |
| Pre-service Teacher | 289 | | 21 | 5-7% |
| Administrator | 53 | | 19 | 10-36% |
| Other[1] | 193 | | 10 | 3-5% |
| Unknown | 128 | | – | – |
| **Total** | **1228** | | **220** | |

[1] Other participants include guidance counselors, college faculty, computer coordinators, and several other classifications.

Although the responses from the pre-service teachers, guidance counselors and administrators provide some valuable information with respect to the evaluation of the program, the small sample size and/or the small number of responses limits the ability to draw inferences from the data collected. Although the response rate from in-service teachers is also somewhat low, the number of responses received makes this a richer source of data for evaluating the EOFNJ program. However, caution is advised in drawing inferences regarding the population of even this group due to the limited response.

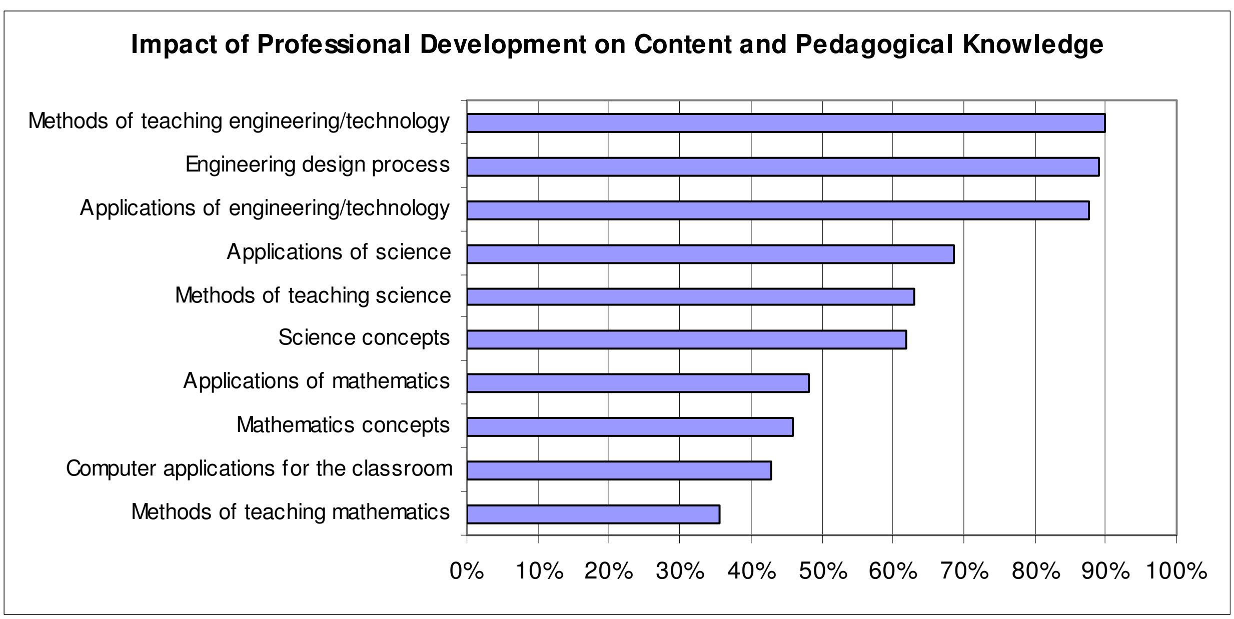
The in-service teacher survey was composed of 26 items, many of them consisting of multiple parts, in the following categories:

- Length, location, and content of the PD activity attended (6 items)
- Value and relevance of PD experience (3 items)
- Impact of PD on teacher knowledge and behavior (3 items)
- Perceived impact on students (1 item)
- Challenges to implementing program activities (1 item)
- School and teacher demographics (12 items)

Data collected from program participants immediately after their PD experience provides useful information primarily related to the participants' satisfaction with the program, but does not provide a sufficient indication of the program's impact. These data are not considered here. Allowing a substantial interval of time to elapse between the PD experience and the data collection phase will likely decrease the response rate of the participants, but improve the probability of more accurately determining the impact of the program. Several of the items on the teacher survey were designed to obtain information regarding the longer term impacts on teachers' attitudes and behaviors, albeit self-reported impacts.

Teachers overwhelmingly reported that the PD experience increased their knowledge of engineering and technology content and pedagogy considerably or moderately. Almost 90% of in-service teacher participants stated that their knowledge of methods of teaching engineering/technology, the engineering design process, and applications of engineering/technology had increased considerably or moderately as a result of their participation in the program as shown in Figure 1. Relatively low values were obtained for some of the categories, specifically the mathematics topics, because far fewer teachers were engaged in these workshops.

**Figure 1:** Percent of teacher participants stating that their EOFNJ PD experience increased their knowledge considerably or moderately in each of the listed areas. (N = 161)



Increasing teacher knowledge of engineering concepts and pedagogy are central to the program's primary goal of exposing all students to engineering in their K-12 classrooms, but it is merely the beginning. The PD activities are intended to provide teachers with increased self-efficacy in this area so that they will feel confident introducing engineering concepts and activities in their classrooms. As indicated in Table 3, almost three-quarters of the teachers responding to the survey stated that they had increased the implementation of the engineering design process after having participated in the EOFNJ program.

**Table 3:** Teacher responses when asked about their use of the listed instructional strategies after having participated in the EOFNJ professional development activities. (N = 156)

| **Instructional Strategy** | **Answer Options** | | |
|---|---|---|---|
| | **Increased** | **Remained the Same** | **Decreased** |
| Implementing the engineering design process | 71% | 28% | 1% |
| Integrating math, science, and technology | 64% | 35% | 1% |
| Telling students about or using new technologies | 61% | 39% | 0% |
| Assigning projects based on real world problems | 58% | 42% | 1% |
| Discussing STEM careers with students | 45% | 55% | 1% |
| Requiring students to make formal presentations of their work | 34% | 65% | 1% |
| Requiring students to use presentation software (e.g. PowerPoint) | 29% | 71% | 1% |
| Using the computer to collect and/or analyze data | 27% | 71% | 1% |
| Using the Internet to collect and/or share data | 26% | 72% | 2% |
| Using computers to design 3D models | 18% | 80% | 2% |

What may be said about commercial products may be true here too: The best salesman is a satisfied customer. The most commonly reported activities that teachers engaged in as a result of their participation in the EOFNJ program was the sharing of materials and resources from the PD activities with other teachers and the recommendation of these activities to colleagues. Table 4 lists the incidence at which teachers reportedly engaged in a variety of activities after participating in the program. The sharing of materials and resources, especially the engineering design activities, among teachers assists in achieving the program goal of exposing students to engineering design concepts, in as much as these teachers implement the activities in their classrooms. The extent to which this has been done has not been measured and would be difficult to measure accurately.

**Table 4:** Activities teachers reportedly engaged in as a result of their participation in the EOFNJ Program. (N = 151)

| Activity | % of Teachers |
|---|---|
| Shared materials or resources from the professional development activities with other teachers | 70% |
| Recommended EOFNJ professional development activities to other teachers and/or administrators | 60% |
| Implemented a lesson in the classroom that was presented at the professional development session | 48% |
| Used contacts or experiences from the professional development sessions to obtain new resources for the classroom | 27% |
| Implemented a lesson in the classroom that you developed as part of the professional development session | 25% |
| Read (more) scientific/engineering journal articles | 23% |
| Organized or facilitated in-service workshops for other teachers/school personnel on issues related to the professional development session(s) | 13% |
| Other | 11% |

Many of the professional development projects conducted under the umbrella of the EOFNJ Program target teachers in urban school districts and districts with a high percentage of low socioeconomic status students as measured by the percentage of students who qualify for free and reduced meal (FARMS) programs. The intent is to improve student outcomes in these high need districts. While it is apparent that the EOFNJ program has had a positive impact overall on teacher participants based on the survey responses, the question of whether there is a greater impact on teachers in the high needs district is one that was deemed worthy of additional consideration. Responses to the three multi-part teacher impact items and a single student impact item (discussed in the next section) on the survey were converted to numbers and tallied to provide scores in each of the four areas. These individual scores were then summed to create a "composite impact score" indicating the overall impact the PD activities had on the participants. Higher scores within a category represent a greater perceived impact.

Table 5 lists the impact scores for program participants as a function of the socioeconomic status (SES) category of the school where the participant is a teacher. The scores for teachers in the high needs schools, >50% FARMS, are higher than those in the most affluent schools with the exception of actions taken. An initial statistical analysis using ANOVA indicates that these differences are statistically significant for three score categories:

- Change in content and pedagogy knowledge ($F = 7.308$, $p = .008$)
- Change in use of targeted instructional strategies ($F = 5.301$, $p = .023$)
- Composite impact score ($F = 7.161$, $p = .009$)

**Table 5:** Comparison of the impact of professional development on teachers in low SES schools (>50% eligibility for free and reduced meals) with teachers in more affluent schools (<25% FARMS). See text for explanation of the scores. (N = 104)

| SES Category | | Change in Content and Pedagogy Knowledge | Change in Use of Targeted Instructional Strategies | Student Impact | Actions Taken | Composite Impact Score |
|---|---|---|---|---|---|---|
| <25% FARMS | Mean | 15.96 | 3.58 | 1.49 | 2.65 | 23.68 |
| | N | 71 | 71 | 71 | 71 | 71 |
| | Std. Deviation | 7.551 | 2.950 | 1.874 | 1.716 | 11.562 |
| >50% FARMS | Mean | 19.91 | 4.97 | 1.97 | 2.97 | 29.82 |
| | N | 33 | 33 | 33 | 33 | 33 |
| | Std. Deviation | 5.358 | 2.687 | 1.794 | 1.704 | 9.268 |
| **Maximum possible score** | | **30** | **10** | **7** | **8** | **55** |

However, this conclusion is not upheld on further analysis. Teachers in high needs districts were more likely than other teachers to have participated in longer term PD activities as shown in Table 6. Using ANCOVA to adjust for the length of the PD activities, none of the differences between the two SES categories of teachers is significant, although one impact is very nearly so: change in content and pedagogical knowledge ($F = 3.693$, $p = .057$).

**Table 6:** Comparison of the number of teachers from high and low SES schools attending the various length professional development programs. (N = 103)

| Length of Professional Development | <25% FARMS | | >50% FARMS | |
|---|---|---|---|---|
| | No. of Teachers | % of Teachers | No. of Teachers | % of Teachers |
| **Less than 1 day** | 20 | 29% | 4 | 12% |
| **1 Day** | 24 | 34% | 9 | 27% |
| **2-4 Days** | 16 | 23% | 4 | 12% |
| **5-9 Days** | 3 | 4% | 2 | 6% |
| **10 Days** | 7 | 10% | 14 | 42% |
| **Total** | **70** | **100%** | **33** | **99%** |

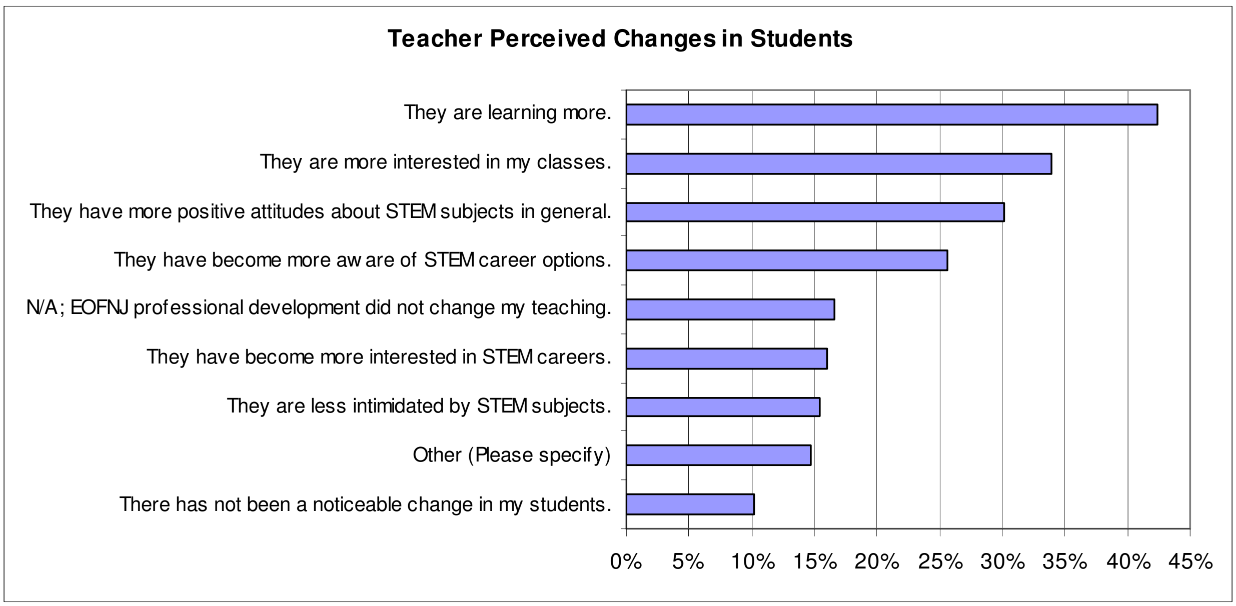
From a research perspective these results do not support the hypothesis that same length PD activities will have a greater impact on teachers in low SES districts than those in more affluent districts. From a program standpoint, however, these results are important because it suggests that the EOFNJ program has been successful in making a larger impact on education in high needs districts due to the longer term PD activities in which teachers from these schools have been involved. And, research has demonstrated that the more sustained the PD involvement, the greater will be the impact.[3,4]

## Impact on Students

The impact of the EOFNJ program is important only in as much as it results in an impact on students. Self-reports from teachers suggest that they have experienced an increase in both their self-efficacy and their actions with respect to implementing engineering concepts and activities in their classrooms. However, the question remains as to whether these changes have impacted students. Evidence that demonstrates an impact on students comes from two sources: teacher reports and data from student assessments.

One of the items posed to teachers in the online survey asked them to identify changes in student behavior and attitudes as a result of the teacher's participation in the EOFNJ program. While positive responses were relatively common, the incidence of reported impacts on students is considerably less than the rate at which impacts on teachers were reported. The most frequently cited changes that teachers reported noting in their students were that students are learning more (42%) and students are more interested in their classes (34%). Rates at which teachers reported other changes in students are shown in Figure 2.

**Figure 2:** Teacher participants' perceptions of changes in student behavior and attitudes as a result of the teachers' participation in the EOFNJ Program. (N = 156)




## Conditions Leading to Program Impact on Adopting Districts

Other relevant information about the impact of this program on students was gathered in focus group discussions with teachers implementing engineering curriculum materials in their classes. These discussions were initiated primarily to determine the reasons for and conditions under which engineering curricula were taking root and flourishing in some districts more than in others. Three focus groups were conducted with a total of 14 teachers and one administrator in two NJ school districts at both the elementary and middle school level. In the course of all three of the focus group discussions, teachers stated that the engineering design activities they implemented in their classrooms were successful because they were meeting the needs of all of the students in their classes. In each of these discussions, teachers also specifically linked increased student performance of students with special needs to engineering design activities.

Direct quotes from the focus group discussions best illustrate the teachers' point that all students benefit from incorporating these activities in the classroom:

| | |
|---|---|
| Grade 4 Teacher: | *I think the greatest benefit (of the program) was just the ability of* ***all*** *the students to be involved and to excel. It was just amazing to see.* |
| Grade 4 Teacher: | *I had students with special needs that were mainstreamed into my classroom and it was great to see them excel.* |
| Grade 6 Teacher: | *More classified students were placed in the class because of the hands-on component. They love it and are successful. They don't necessarily follow directions; they learn by trial and error.* |
| Grade 6 Teacher: | *This (engineering design project) addresses all the learning styles of all the students.* |
| Administrator: | *In American schools… we tend to want to have our kids do well so we do a lot of the thinking for them perhaps. And this was a perfect vehicle, I think, that in a very engaging way had all kids struggling at a problem.* |

Grade 4 students at Arbor Intermediate School in Piscataway, NJ engaged in an engineering-design activity.

Parents of students in these school districts have also commented to the teachers on the impact that the program has had on their children. Students talk about their engineering design tasks at home, from the frustrations of the challenges they have faced to the excitement of their successes. And some students have created new designs at home for the projects they were working on at school.

While testimonials from teachers are remarkable indicators of the impact of the program on students, in this age of accountability in education, quantifiable empirical evidence that demonstrates increased student learning is often considered the strongest evidence of student impact. Data collected in two separate, extensive studies in projects under the EOFNJ umbrella provide evidence of the learning gains achieved by students whose teachers participated in the program.[5,6] Middle and high school students demonstrated increased knowledge of gears, electricity, and buoyancy after designing and building robots to perform tasks in an underwater environment, a curriculum module led by their teachers after participating in the EOFNJ Program.[7] And, elementary students posted statistically significant higher gains in their knowledge of science and engineering concepts than a comparison group of students after their teachers implemented curriculum materials for which they received PD in the EOFNJ program.[8]

## School Success Stories – Behind the Scenes

Survey results, interviews with teachers, and data from student test scores all indicate that the EOFNJ program is successful in reaching teachers and, as a result, having a positive impact on classroom practices and student learning in many instances. And yet, while there has been adoption, expansion, and institutionalization of EOFNJ programs and curricula in some of the participants' schools and districts to expose students to engineering and engineering design activities, in other schools/districts the effort either has not taken root or has failed to thrive. The dichotomy posed in that statement is what led to the focus group discussions described previously. Two school districts that have expanded their inclusion of engineering-related materials and activities in their curricula were asked to share their experiences to provide information that might be used to modify the EOFNJ program to better meet the needs of teachers and schools that have not experienced as much success.

The primary criterion for selecting districts to discuss their experiences was their relative success in implementing curricula containing engineering design activities as evidenced by an expanding teacher population attending EOFNJ PD activities. Secondary considerations included the socioeconomic status and the diversity of the student body. The two school districts selected are Piscataway Township School District and Teaneck Public Schools. Both of these districts are slightly above the state median with respect to SES according to the District Factor Group (DFG) classification formulated by the NJ Department of Education.[9] And, while per-pupil spending in Teaneck is among the top ten K-12 districts in the state at $16,087 for the 2007-08 academic year, per-pupil spending in Piscataway is the median for the state at $12,182.[11] Both districts have a racially and ethnically diverse student body and a significant number of students who are FARMS eligible as indicated in Table 7.

**Table 7:** Demographic information for the two NJ school districts selected for a case study.[10]

| Demographic Group | Percentage of Student Body | |
|---|---|---|
| | Piscataway | Teaneck |
| White | 24.4 | 15.5 |
| Black | 33.9 | 47.1 |
| Hispanic | 14.5 | 25.2 |
| Asian | 26.9 | 11.5 |
| Native American | <0.1 | 0.5 |
| Hawaiian Native | <0.1 | 0.2 |
| Two or More Races | 0.2 | 0 |
| Eligible for FARMS Program | 19.3 | 21.7 |

As would be expected, in both instances there are one or more champions supporting the adoption of engineering-related activities and who are motivated to support the effort in their districts. In the Teaneck school district, a middle-school teacher, who is a former engineer, received permission from school administrators to pilot the Motorized Toy Car module from the SAE curriculum A World in Motion (AWIM) in his classroom after participating in an EOFNJ professional development workshop. His positive experiences led to a change in the grade 6 science curriculum initially at his school and eventually at the second middle school in the district. Although he is now a grade 8 teacher looking to implement an engineering related curriculum module in his current classes, he still serves as a mentor to the grade 6 teachers as they become more comfortable with the gears, motors, and engineering design concepts that are the focus of the Motorized Toy Car module.

This middle school teacher in Teaneck provided the stimulus for implementing engineering-based activities and is a significant driving force contributing to the continuation of these activities and the growth of the program in the district. His colleagues attest to the fact that without this teacher's efforts at piloting and advancing the engineering-based activities, they would not be implementing such activities and witnessing the expansion of the program throughout the district. In this instance, a single teacher can be credited for establishing the program in the district and contributing to its growth, but this teacher and his colleagues also acknowledge the support of administrators and other teachers in the district for the program.

In Piscataway, the driving force behind the implementation of engineering curriculum materials in the schools was also a single person, but in this case, an administrator: the Assistant Director of Curriculum for Math and Science (AD). Coincidentally, she also selected the Motorized Toy Car activity for implementation in the middle schools in this district. Although Piscataway is phasing out the use of AWIM due to scheduling changes at the middle school level, the commitment to expose students to engineering design activities remains strong. Teachers in grades 3 and 4 began incorporating modules from the Museum of Science, Boston's Engineering is Elementary (EiE) curriculum last year after participating in EOFNJ professional development activities. And there are plans to implement a module in grade 5 classes in the near future.

Implementation at the elementary level involved recruiting interested teachers to be lead teachers in their schools. These teachers participated first in the professional development activities and be the first to implement the module in their classrooms. Following this initial implementation, the remaining teachers received professional development training from EOFNJ trainers, a training session that was also attended by the lead teachers to provide an opportunity for them to share their experiences with the modules in their classes. The lead teachers then provided support for the newly trained teachers as they implemented the modules in their classes.

Much of the credit for establishing a program that involves engineering design in Piscataway rests with the AD. However, as in Teaneck, the program in Piscataway would not be thriving without the support and cooperation of others. The support and cooperation of the teachers, particularly the lead teachers, is an essential element of the success of this program. This support for engineering-design activities is clearly evident at the elementary level, where EiE is in the second year of implementation, as well as the middle-school level, where the AWIM module is being phased out.

Discussions with the teachers and an administrator in these districts suggest that there are several key elements to introducing and sustaining an effort to incorporate engineering design curricula in K-12 schools, beginning with at least one motivated person, though it need not be an administrator. Each group of teachers described factors that they felt were important in implementing and sustaining these efforts, some of which were unique to their situations. The common elements that were cited by teachers in all focus group discussions as being important include (in no particular order):

- Piloting the materials with one or a small group of teachers initially. These individuals then can serve as lead teachers or mentors to provide guidance to other teachers when the effort is scaled up.

- External professional development for *all* teachers (as opposed to the lead teachers/mentors only) provided in stages as the program moves from being piloted to going full scale. Include the lead teachers/mentors in the PD activity for the remaining faculty members as their experiences can enrich the PD.
- A common planning period for teachers is desirable, particularly in the first few years of implementation.
- An engineering "buddy." Cultivate a professional relationship with a current or former engineer if none of the faculty has a family member or friend who is an engineer. This person can serve as a valuable resource especially when students ask questions for which the answers are not provided in the book.
- Support of other faculty members, administrators, and parents. The enthusiasm of the few who initiate the effort will not be matched by all of the other stakeholders, but active opposition will prevent the initiative from taking root.
- Plan for the materials that will be needed for implementation. Engineering design activities often require a variety of materials, sometimes in large quantities. The cost and time required to purchase and/or collect materials is an important consideration. Even kits such as that used in the AWIM module will need replacement parts to be purchased periodically.

## Final Comments

The EOFNJ program has been shown to have an impact on participating teachers' knowledge of science and engineering concepts and pedagogy and their classroom practices, which in turn has increased student interest and learning in science. These are all important outcomes of this program, but the one fundamental change that could impact a student's career choice is simply an increase in awareness. Without that, engineering is not among the choices. And, when asked what the greatest benefit was of being a participating school in this program, one teacher stated "Increase in awareness of just what engineering is. The kids had no idea, nor did I, to be perfectly honest, what an engineer actually did until going through this program."

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