PLTW: One State’s Perspective

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Abstract

Despite today’s growth in the age of knowledge, information and technology, the enrollment and conferring of undergraduate degrees in engineering and engineering technology continues to fall short of the nation’s demands. In the state of New Jersey, from 1998-2002, only ~5.3% of the degrees awarded were in engineering and engineering technology (NJ Commission on Higher Education, 2003). In 2002, New Jersey Institute of Technology became the sixth university affiliate of a national pre-engineering program called Project Lead The Way® (PLTW), as one strategy to increase the pool of New Jersey secondary school students interested and prepared to enroll, and graduate from post-secondary, undergraduate engineering-related programs. PLTW trains secondary school teachers to implement one middle school and six high school yearlong courses.

This paper presents a state’s perspective on the impact of the skills development and implementation of PLTW on secondary school educators, students and guidance counselors throughout New Jersey over the past four and a half years. Currently, 68 teachers in New Jersey have been trained to implement this program in 7 middle schools and 20 high schools represented by 21 public school districts. The institutionalization of this pre-engineering program across a profile of different high school environments is examined. We explore the similarities and differences of implementation within a “magnet” high school and a comprehensive school. Perspectives of both teachers and students are included.

Introduction

There has been a dramatic shift in the national workforce over the past decades from an age of information to knowledge. The next decades will require a more knowledgeable high-technology workforce. The National Science Board has reported that the need for engineers is increasing at a faster rate than other professions, yet the current trend in the national enrollment, at the post-secondary level, may not be able to meet the national demand.¹ The authors present one state’s perspective on addressing the issue of increasing the enrollment
and graduation in engineering and engineering technology programs at institutions of higher education through working with secondary students and their educators.

About the State

The state of New Jersey, with the tenth largest state population of ~8.4 million\(^2\) and the largest population density of 1,164 persons per square mile\(^3\), has more than five hundred research and development organizations and is one of the leading states in such industries as telecommunications and pharmaceuticals. According to the New Jersey Department of Education, in the 2002-03 academic year, the state educated nearly 1.4 million school-aged children in over 600 districts throughout the twenty-one counties\(^4\). In 2001-02, the state graduated ~78,000 students despite an annual dropout rate of 2.7\% and mobility rate of 12.0\%.\(^5\) At the post-secondary level, the NJ Commission on Higher Education reported that, in the fall of 2000, nearly 326,000 part-time and full time students were enrolled in undergraduate, graduate and professional degree programs in the three public universities, nine state colleges, nineteen community colleges, and 14 independent colleges with public missions. By 2003, the higher education institutions throughout the state awarded nearly 3,100 degrees and certificates from 230 engineering and 128 engineering-related technologies approved programs, representing 5.26\% of the total awards granted. The state has a five-year annual average of graduating 2,218 (4.07\% of total) and 620 (1.14\% of total) students in higher education, respectively in engineering and engineering-related technology\(^6\). Despite these state trends in feeding the pipeline of engineers, there remains a statewide and nationwide shortage of the workforce in engineering and engineering-technology.

New Jersey Institute of Technology (NJIT), a technical, public research university founded in 1881, is on a 45-acre urban campus in the state’s largest city located in the northern region of New Jersey, about fifteen minutes from New York City. The university offers 35 baccalaureate, 47 masters, and 18 doctoral degrees in six schools. The total annual enrollment is nearly 9,000 full and part-time students with ~420 faculty members. The Newark College of Engineering, the first school of NJIT, offers 8 engineering and 1 engineering technology (for upper two years only) degrees at the bachelors level, 13 degrees at the masters level, and 8 engineering degrees at the doctorate level. Through the Center for Pre-College Programs, the university has been working with students, teachers, guidance counselors, administrators and parents over the past thirty years to strengthen their skills and knowledge in science, technology, engineering and mathematics (STEM). Currently, the Center serves four thousand school-aged students annually. In 2002, NJIT became the sixth university affiliate of a national pre-engineering program, called Project Lead The Way\(^\circledR\) (PLTW), as one of their pre-college thrusts to increase the pool of New Jersey secondary school students interested and prepared to enroll and graduate from undergraduate programs in engineering-related programs.

About Project Lead The Way\(^\circledR\)

In 1997, Project Lead The Way\(^\circledR\), a not-for-profit organization based in upstate New York, began to develop and disseminate a series of full-year courses “to introduce students to the
scope, rigor and discipline of engineering and engineering technology prior to entering college. Today, PLTW offers one middle school and six high school courses to 640 schools representing 413 districts throughout 38 states in America. PLTW is not only a curriculum-based program, but also is implemented on the foundational principle that partnerships between schools, higher education, private sector and community are critical to the involvement, achievement and success in preparing secondary students to consider and achieve a post secondary education in engineering-related programs. To become part of the PLTW network, districts form a partnership agreement with the national organization whereby any school within the district may choose to join as a PLTW school. All schools commit to identifying and sending their teachers for a two-week, intensive summer training prior to teaching each PLTW course, as well as supporting on-going professional development. These summer institutes provide a forum for teachers to experience the curriculum, software, materials and equipment that are integral to the implementation of the program. All teachers may communicate with other PLTW teachers nationwide through the Internet and receive year-round technical support through the staff at the state affiliates, National Technical Training Center located at Rochester Institute of Technology, and national PLTW office. Nationwide, 2,138 teachers have trained in one or more of the PLTW courses. Guidance counselors must attend at least one annual conference held nationally or locally. The goal of the annual conference is to inform counselors from existing and potential PLTW schools about the program and careers in the field of engineering. To foster collaboration, a partnership team is established within each PLTW school that comprises members from each of the key stakeholders, e.g. teachers, students, parents, guidance counselors, administrators, local post secondary institutions and the community.

Skills and Content Knowledge - PLTW Courses

The middle and high school curricula are developed for student-centered, project-based learning where the teacher serves as facilitator. Six key elements are used as the guiding principles for curriculum development:

1. Incorporation of national standards in science, mathematics and technology;
2. Student-driven projects;
3. Student-centered, teacher-facilitated instruction;
4. Authentic assessment;
5. State-of-the-art, grade level appropriate and industry significant resources;
6. Valuing of diversity and equity.

Upon completion of the PLTW courses, at either level, students will acquire such general skills as team building, organizational, communication (oral and written), research, and information synthesis/interpretation. Examples of science content that utilize the application of mathematical skills in real-world applications are thermodynamics, statics, dynamics and electricity/electronics. Examples of valuable engineering skills acquired are orthographic drawing, three-dimensional solid modeling, circuit design and analysis, prototyping, engineering design, reverse engineering, cost analysis, and problem solving.

At the middle school level, for grades 6-8, the program offers Gateway To Technology (GTT), a four-unit, ten-weeks per unit course. Upon completion of the GTT course, students will know the engineering design process using solid modeling; basic circuit design;
mechanics of motion; energy transfer and conversion; automation and robotics; engineering problem-solving; and careers in engineering. At the high school level, there are three tiers of yearlong courses, e.g. foundational, specialization and capstone. The foundational tier provides for student the Principles of Engineering (POE), Introduction to Engineering (IED) and Digital Electronics (DE) courses. The specialization tier offers a Computer Integrated Manufacturing and Civil Engineering/Architecture course. At the final tier, students apply all of their knowledge acquired in a capstone course called Engineering Design and Development. Additional units and courses are under development for both middle and high school students.

PLTW in New Jersey

The first New Jersey district to offer a PLTW course was a comprehensive high school in the central region of the state in 1999. Today, the statewide network has 64 teachers trained to implement one or more of the courses in 27 schools representing twenty-one districts in 14 counties. About one third of the schools serve middle school students. At the high school level, 55% are public schools, 40% are vocational-technical schools, and 5% are charter schools. Throughout the state, there is a fairly even distribution of specialized academies/magnet schools versus comprehensive high schools. As the sixth state affiliate, NJIT augured its first summer training for teachers in July 2003 offering two of the high school courses, e.g. Introduction to Engineering Design (IED) and Digital Electronics (DE). A local counselor conference was held in the fall of 2003 for guidance counselors in the area.

Evaluation and Impact

The impact of Project Lead The Way® in the state of New Jersey as a strategy to increase the pool of secondary school students for post-secondary engineering-related programs is measured through on-going assessment of students, teachers, and guidance counselors through the Pre-Engineering Instructional and Outreach Program (PrE-IOP), a joint collaborative between the Center for Pre-College Programs and Newark College of Engineering at NJIT. PrE-IOP is a three-year project funded by the New Jersey Commission on Higher Education. At NJIT’s first summer training for teachers, a concerns-based inventory for implementation and teacher preparedness survey was developed and administered at the end of the two-week training to examine the effectiveness of the training. Students’, teachers’ and guidance counselors’ attitudes towards engineering and knowledge of engineering careers are measured with the student instrument administered pre- and post PLTW course implementation. The guidance counselors survey was administered at the national and NJ counselor conference.

References

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