# Educators', Administrators' and Students' Perceptions of Principles of Technology Programs in Pennsylvania

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***Abstract***

This study assesses the Principles of Technology Applied Science high school courses taught in Pennsylvania. Specifically, this study determines: 1) the number of Level I and II Principal of Technology courses taught; 2) teachers', administrators' and students' perceptions toward the Principle of Technology high school curriculum; 3) Principle of Technology teachers' perceptions of student achievement on state outcomes in science and technology; and 4) how Principle of Technology courses are being infused into the existing curriculum. Findings from this study indicate that both administrators, teachers, and students react favorably to the Principle of Technology Applied Science high school courses.

***Introduction***

The Carl D. Perkins Vocational and Applied Technology Education Act (Title I Vocational Education Assistance to the States Sections 116 and 117) requires each state to (1) conduct an assessment delineating how Perkins funds will be used and (2) evaluate the effectiveness of the programs that are conducted with Perkins funds. Thus, Title III Special Programs Part E of the Perkins Act delineates guidelines for Tech-Prep Education Programs (American Vocational Association, 1990). This feature of the Act led to the creation of mechanisms that incorporate Tech-Prep programs, including Principles of Technology (PT) Applied Science courses, in public high schools in Pennsylvania. For purposes of this study, the following definitions for Applied Science and Principles of Technology were used:

*Workforce Education Forum, Vol. 25, No. 2, Fall 1998, pp 69-86.*

- Applied Science - means a combination of academic mathematics and science concepts integrated with vocational education hands-on learning experiences.
- Principles of Technology (PT) - means an applied science course intended for high school vocational students (Agency for Instructional Technology, 1986).

The Southern Regional Education Board (SREB) consortium indicates that rigorous applied academic courses are an integral component of the Tech-Prep Education Program (Bottoms, Presson, & Johnson, 1992). Ascertaining the existence of a PT course in a school is one way of determining a school's commitment to the integration process. According to the SREB, those completing vocational programs in 1990 at an improving SREB pilot site made statistically significant gains over those completing vocational programs in mathematics (16%) and science (14%) in 1988. The significant gains achieved by vocational students are a result of the Tech-Prep program (Bottoms, Presson, & Johnson, 1992).

Gray, Wang, and Butler (1993) conducted a study on average levels of science completed by graduates from Pennsylvania high schools for the years 1983 and 1990. Findings revealed, for all graduates, the levels were 1.9 years for males and 2.0 years for females. However, for vocational students, the average level of science completed was 1.1 years for males and 1.2 years for females. The results of this study confirm the need for high schools to offer Applied Science courses similar to PT as an alternative to traditional college-preparatory science courses.

### *Purpose of the Study*

The purpose of this study was to assess the Principles of Technology Applied Science courses offered at Pennsylvania's public high schools. More specifically, four objectives guided this study:

1. To determine the number of Principles of Technology courses (Level I and II) being taught at the high schools identified on the selected subjects enrollment list provided by the Bureau of Vocational and Technical Education (BVTE).

2. To assess PT administrators', teachers', and students' perceptions towards the CORD PT curriculum at the high schools identified on the selected subjects enrollment list provided by the BVTE.

3. To assess PT teachers' perception of student achievement of intended state outcomes in the areas of science and technology.

4. To determine how the PT course is being infused into the existing curriculum.

***Background***

PT is an applied science course. This curriculum offers a broad range of instructional activities for current and future non-baccalaureate high school students. Numerous educators agree that this curriculum introduces high school students to the underlying principles of technology (Hammer & Thode, 1989; McCade, 1991; McKinney & Kohan, 1986; O'Malley & Person, 1987; Selland, 1986). These principles are based on four systems: mechanical, fluid, electrical, and thermal. PT courses tend to be divided into two parts covering 14 units over two years. Schools that implemented the PT curriculum in its entirety share key elements that denote success. However, limited information is available about the overall strengths and weaknesses of the PT courses in Pennsylvania. No studies have examined Pennsylvania administrators', teachers' and students' perceptions of the PT curriculum. No data are available to track the progress of recent graduates who have taken the PT course. Many significant questions remain unanswered.

Research relating to level of adoption is limited; most research has focused on overall impact, and the strengths and weaknesses of PT. A few researchers have found that PT has a positive impact on secondary students' understanding of basic technological principles; however, the literature does not report how secondary students utilize the acquired technical knowledge upon graduating from high school. Most available evaluations are case studies, include self-reported data, on-site observations, and focus group interviews, and are ex post facto in nature. With the exception of one study conducted by the Center for Occupational Research and Development, there are no longitudinal data to track students as they move through secondary education. Although the literature suggests that educators' overall impression of PT is favorable, little is known about the overall effectiveness of the many unique classes whereby the entire PT curriculum is not implemented.

In addition, knowledge is limited regarding student learning gains in the areas of mathematics, science, and physics as they relate to the four universal technical systems (mechanical, fluids, electrical, thermal). Few studies examining student learning of PT have utilized a true experimental design. However, the literature supports the conceptual framework for the methodology being used in this study.

***Methodology***

This study utilized a two phase, descriptive-survey research design. Its scope was limited to:

Phase I:

- Seventy-nine public high schools in Pennsylvania that offered a PT 1 course and/or a PT 2 course during the 1992-93 school year.
- Eighty-eight PT teachers at the 79 public high schools.

Phase II:

- Six administrators in the five schools that participated in site-visits.
- Two hundred sixty-six high school students enrolled in PT courses at the five schools that participated in site-visits.

A modified version of the framework proposed by McCaslin (1990) was used in conducting the assessment.

This data collection of this study was completed in two separate phases. Phase I consisted of a survey of PT teachers (N = 88) at public high schools (N = 79) identified from the Pennsylvania public high schools selected subject enrollments list obtained from the BVTE (Pennsylvania Department of Education, n.d.).

Phase II consisted of five site visits. During the site visits at 5 different school districts, a questionnaire for administrators (N = 6) was hand delivered in an effort to encourage administrator to complete the questionnaire during the site visit. In addition, the questionnaire for students (N = 266) was administered to during class observation visits. For classroom observations in Phase II a modification of the Methodology Participant Observation (MPO) methodology proposed by Jorgensen (1989) was used during the subject observations. Purposive sampling procedures were used to select schools whose administrators and students would be contacted. Schools in Phase II were selected based on the following factors: years of PT implementation, geographic location, and classification of school (Area Vocational Technical, Comprehensive or Academic School). The five schools participating in Phase II of this study were the Columbia-Montour Area Vocational Technical School, York County Area Vocational Technical School, Shikellamy High School, St. Marys Area Senior High School, and Jules Mastbaum Area Vocational Technical School.

### *Instrumentation*

This study utilized research instruments for administrators, teachers, and students to collect data for the study. Information gained from the literature review and focus group participants was used to develop a questionnaire for administrators.

The focus group participants consisted of a representative from the Pennsylvania Department of Education (Bureau of Vocational and Technical Education), two college professors, one high school principal, one high school director of science, and three vocational teachers. These experts were gathered into a focus group to validate the study proposed research objectives and survey questionnaires. The focus group participants were mailed questionnaires and asked to critique the instruments to ensure content, construct and face validity. After two focus group session, the teacher, administrator, and student survey instruments validity was judged to be acceptable and no further revisions were made. Due to the summative scales of each of the instruments, there was no need to calculate a reliability coefficient.

For teachers, a five part questionnaire was developed from information gained from the literature review, focus group participants. Section one solicited data about demographic. Section two contained questions concerning the strengths and weaknesses of the curriculum and course. Section three contained questions relative to the public education process associated with PT and the achievement of intended outcomes in the area of science and technology. The various science and technology categories were developed from a list of learning outcomes published by the Special Vocational Education Services Center (n.d.). Section four elicited data about perceptions of course content, student population, and parental approval. Section five requested information about the level of curriculum adoption, facilities, and support for the course. Items in section five were derived from focus group participants. Items in sections one, two, and four of the teacher questionnaire were modeled after instruments borrowed from the Center for Occupational Research and Development (CORD) (Center for Occupational Research and Development, n.d.), Olympia Technical College and the National Center for Research in Vocational Education (National Center for Research in Vocational Education, 1981).

The administrator questionnaire consisted of two sections. Section one elicited data relative to administrators' personal characteristics. These included gender, highest level of education completed, current position, classification of school, years of administrative experience, and type of teacher certification. Section two of this instrument requested information about administrators' perception of PT. This section contained questions relative to curriculum, target group, enrollment, level of importance, need for the curriculum, and parental perceptions.

The student questionnaire contained two sections. Section one solicited data about student demographics and perception of PT. Section

two items were modeled after instrumentation from the Principles of Technology Force Transformers Student Attitude Questionnaire (Center for Occupational Research and Development, n.d.), and the Principles of Technology Applied Mathematics Student Aptitude Questionnaires for Units A, B, C from 1988/1989 field test developed by the CORD (Center for Occupational Research and Development, n.d.).

### *Procedures and Data Collection*

Permission to conduct the study and to contact Pennsylvania public high school administrators was granted in writing. Once approved, a letter was then sent to administrators and prospective focus group participants, inviting them to attend the focus group meetings.

During Phase I of the study, the questionnaire for PT teachers was mailed via first class postage. The questionnaire packet contained:

1. A cover letter requesting their participation in the study.
2. The questionnaire.
3. A pre-addressed, postage guaranteed envelope for returning the questionnaire.

A total of 88 survey forms were mailed in the first mailing. A post-card reminder sent to 40 non-respondents via first class postage after three weeks. Fourteen schools that were omitted from the study because they did not offer PT as a separate course. After two weeks an effort was made to contact each of the non-respondents (N=40) to ascertain if they had received the PT survey. Subjects who had received the survey were asked to return it at their earliest convenience; two of the subjects requested another survey. Further, seven subjects returned their questionnaire and indicated that their school did not offer a course called PT or that they were not teaching PT. These seven subjects were dropped from the study, resulting in a final total population of 81 PT teachers. Using the inter-ocular analysis technique the researchers scanned the responses of early respondents and compared them to the responses of late respondents. A total of 55 usable surveys were returned. The response rate for the entire survey was 70%.

For Phase II of the study administrators were contacted for their approval to arrange a site-visit and administer the questionnaire. Upon receiving permission, a date and time was arranged for the site observation and questionnaire administration.

### *Analysis*

All data were entered and analyzed in SPSS (1988) statistical analysis program. Data were analyzed for each of the three research objectives using descriptive statistics of frequency and percent.

### *Results*

The purpose of this study was to assess the PT course in Pennsylvania public high schools. This assessment of PT was conducted in two phases. Phase I of the study involved teachers. Phase II of the study consisted of five site visits. During the site visits, a questionnaire was given to the administrator(s) of the school as well as students in the PT course. The results are reported according to the research objectives:

1. To determine the number of Principles of Technology courses (Level 1 and 2) being taught in Pennsylvania public high schools.

Approximately one-half of the teachers (46.2%; N=24) reported that their school offered PT 1 and PT 2. The majority of the PT teachers (75.4%; N = 40), reported teaching PT 1 during the 1992-93 school year, but only 1.9% of the PT teachers indicated teaching PT 2 during the 1992-93 school year. About one-fourth of the respondents (22.6%; N=12) reported teaching PT 1 and PT 2 during the 1992-93 school year (see Table 1).

2. To assess PT teachers', administrators', and students', perceptions of the CORD PT curriculum at the public high schools on the selected subjects enrollment list provided by the BVTE.

The majority of the PT teachers (98.2 %; N=54), indicated liking the PT course overall. Seventy-eight percent believed PT met the needs of college bound students. Ninety-eight percent believed PT met the needs of the career directed students.

Of the 54 respondents, 19 (35.2%) believed academic, vocational, and general track students are best served by the PT course; 15 (27.8%) indicated academic and vocational curriculum students; and 12 (22.2%) reported vocational and general curriculum students (Table 2).

Five of the six administrators surveyed indicated generally liking the PT course. Of the six respondents, three strongly believed that teachers saw the need for a course like PT. Five of the administrators indicated that PT is very important in relation to other laboratory and science courses (Table 3). Due to the small size of the administrator group, generalization should not be made.

Table 1

Teachers' Information on the Number of PT Courses Offered at Pennsylvania Public High Schools.

| Course | Number | Percent |
|---|---|---|
| Principles of Technology 1 | 40 | 75.4 |
| Principles of Technology 2 | 1 | 1.9 |
| Principles of Technology 1 and 2 | 12 | 22.6 |
| | 53 | 100.0 |

Table 2

Teachers' Perceptions of the Type of Students Best Served by the CORD PT Curriculum.

| Student Curriculum | Number | Percent |
|---|---|---|
| Academic | 1 | 1.9 |
| Vocational | 4 | 7.4 |
| General track | 0 | 0.0 |
| Academic & Vocational | 15 | 27.8 |
| Academic & General Track | 3 | 5.6 |
| Vocational & General Track | 12 | 22.2 |
| Academic, Vocational & General Track | 19 | 35.2 |
| | 54 | 100.0 |

Table 3

Administrators' Perception of the CORD PT Curriculum.

| Self-reported Attitude | Number | Percent |
|---|---|---|
| Extent Principals Like PT Curriculum | | |
| Yes, a lot | 5 | 83.3 |
| Yes, a little | 1 | 16.7 |
| | 6 | 100.0 |
| Administrators' Perceptions of Teachers Belief in a Need for PT | | |
| High level of belief | 3 | 50.0 |
| Moderate level of belief | 2 | 33.3 |
| Low level of belief | 1 | 16.7 |
| | 6 | 100.0 |
| Administrators' Perception of Importance of PT in Relation to Other Lab and Science Courses | | |
| Very important | 5 | 83.3 |
| Somewhat important | 1 | 16.7 |
| | 6 | 100.0 |

The majority of the secondary school students—57.4% (N=152), indicated that they liked the PT course overall. Of the 266 respondents, 59.6 % (N=155) reported most preferring the hands-on lab component; 21.5% (N=56) reported no preference; and 11.9 % (N=31) preferred the video component. The majority—84% indicated that the material in their PT class is very important (Table 4).

3. To assess teachers' perceptions of student achievement of state learning outcomes in the area of science and technology. The Pennsylvania Department of Education has identified eight outcomes for science and technology.

The teachers were asked to rate the extent to which the CORD PT curriculum had achieved the outcomes in the area of science and technology identified by personnel at the BVTE. Responses for each item ranged from 0 to 2, with 2 = totally achieved; 1 = partially achieved; and 0 = not achieved at all.

Table 4

Students' Perceptions of the CORD PT Curriculum.

| Self-reported Attitude | Number | Percent |
|---|---|---|
| Extent Students Liked the PT Curriculum | | |
| Yes, a lot | 72 | 27.2 |
| Yes, a little | 152 | 57.4 |
| No, not at all | 41 | 15.5 |
| | 265 | 100.0 |
| Best Liked Curriculum Components of PT | | |
| Written | 9 | 3.5 |
| Video | 31 | 11.9 |
| Math Labs | 9 | 3.5 |
| Hands-on-labs | 155 | 59.6 |
| No preference | 56 | 21.5 |
| | 260 | 100.0 |
| Importance of Material | | |
| Yes, very | 90 | 34.0 |
| Yes, very sort of | 132 | 44.8 |
| No, not very | 27 | 10.2 |
| No, not at all | 16 | 6.0 |
| | 265 | 100.0 |

Respondents reported that 17 (85%) of the 20 student learning outcomes were either totally or partially achieved. In addition, they reported that the PT curriculum did not achieve two of the 20 student learning outcomes. Seventy-one percent indicated that the PT curriculum did not achieve the outcome "students are able to explain how scientific principles of biological phenomena have developed and relate them to real-world situations." Fifty-eight percent of the respondents indicated that the PT curriculum did not achieve the outcome, "students are able to evaluate the impact on contemporary and future life of the development of agricultural products." In light of the fact that the CORD PT curriculum is an applied science course, one can conclude that the two aforementioned student learning outcomes are not related to applied science. In one additional student learning outcome, the respondents' opinion was equally split. Forty-five percent of the respondents indicated that the PT curriculum had partially achieved the outcome, "students are able to explain how scientific principles of chemical phenomena have developed and relate them to real-world situations"; 47% reported non-achievement of this outcome (Table 5).

Table 5
PT Teacher's Opinion About Whether the CORD Curriculum Has Achieved the State Learning Outcomes for Science and Technology, 1993.

| Intended Course Outcomes | Totally Achieved N | % | Partially Achieved N | % | Not Achieved N | % | Total N | % |
|---|---|---|---|---|---|---|---|---|
| *Students are able to explain how:* | | | | | | | | |
| Scientific principles of chemical phenomena have developed and relate them to real-world situations. | 4 | 7.8 | 23 | 45.1 | 24 | 47.1 | 51 | 100.0 |
| Scientific principles of physical phenomena have developed and relate them to real-world situations. | 25 | 46.3 | 29 | 53.7 | 0 | 0.0 | 54 | 100.0 |
| Scientific principles of biological phenomena have developed and relate them to real-world situations. | 3 | 6.1 | 11 | 22.4 | 35 | 71.4 | 49 | 100.0 |
| Develop and apply skills of observation. | 27 | 50.9 | 26 | 49.1 | 0 | 0.0 | 53 | 100.0 |
| Develop and apply skills of data collection. | 33 | 61.1 | 21 | 38.9 | 0 | 0.0 | 54 | 100.0 |
| Develop and apply skills of analysis. | 20 | 37.7 | 33 | 62.3 | 0 | 0.0 | 53 | 100.0 |
| Develop and apply skills of pattern recognition. | 21 | 39.6 | 32 | 60.4 | 0 | 0.0 | 53 | 100.0 |
| Develop and apply skills of conducting scientific experiments. | 25 | 46.3 | 29 | 53.7 | 0 | 0.0 | 54 | 100.0 |
| Describe the impact of major technologies in economic and civic life. | 16 | 30.2 | 37 | 69.8 | 0 | 0.0 | 53 | 100.0 |

Table continues...

Table 5, continued
PT Teacher's Opinion About Whether the CORD Curriculum Has Achieved the State Learning Outcomes for Science and Technology, 1993.

| Intended Course Outcomes | Totally Achieved N | % | Partially Achieved N | % | Not Achieved N | % | Total N | % |
|---|---|---|---|---|---|---|---|---|
| *Students are able to explain how:* | | | | | | | | |
| Describe how modern technologies have developed from and now influence scientific developments. | 14 | 26.4 | 37 | 69.8 | 2 | 3.8 | 53 | 100.0 |
| Construct systems using models to explain or predict outcomes. | 19 | 36.5 | 26 | 50.0 | 7 | 13.5 | 52 | 100.0 |
| Evaluate systems using models to explain or predict outcomes | 18 | 34.6 | 28 | 53.8 | 6 | 11.5 | 52 | 100.0 |
| Generate hypotheses about scientific phenomena. | 13 | 25.0 | 37 | 71.2 | 2 | 3.8 | 52 | 100.0 |
| Design and conduct experiments which test those hypotheses generated. | 14 | 26.9 | 32 | 61.5 | 6 | 11.5 | 52 | 100.0 |
| Evaluate the advantages associated with the application of science and technology to the solution of real-world problems. | 21 | 40.4 | 29 | 55.8 | 2 | 3.8 | 52 | 100.0 |

Table continues...

Table 5, continued
PT Teacher's Opinion About Whether the CORD Curriculum Has Achieved the State Learning Outcomes for Science and Technology, 1993.

| Intended Course Outcomes | Totally Achieved N | % | Partially Achieved N | % | Not Achieved N | % | Total N | % |
|---|---|---|---|---|---|---|---|---|
| *Students are able to explain how:* | | | | | | | | |
| Evaluate the disadvantages associated with the application of science and technology to the solution of real-world problems. | 13 | 25.5 | 35 | 68.6 | 3 | 5.9 | 51 | 100.0 |
| Evaluate ethical considerations associated with the application of science and technology to the solution of real-world problems. | 3 | 5.9 | 28 | 54.9 | 20 | 39.2 | 50 | 100.0 |
| Evaluate the impact on contemporary and future life of the development of varied energy forms. | 10 | 19.2 | 34 | 65.4 | 8 | 15.4 | 52 | 100.0 |
| Evaluate the impact on contemporary and future life of the development of natural and synthetic materials. | 3 | 5.8 | 29 | 55.8 | 20 | 38.5 | 52 | 100.0 |
| Evaluate the impact on contemporary and future life of the development of agricultural products. | 2 | 3.8 | 20 | 38.5 | 30 | 57.7 | 52 | 100.0 |

4. To determine how the PT course is being infused into the existing curriculum.

Eighty-eight percent of the teachers indicated that PT had become a science course in their school's curriculum. Of this group, 75% indicated that the PT course was recognized as part of a Tech-Prep articulation model; 49% indicated that it was used in the industrial arts program; 54.9%, as a traditional competency-based program; and 38%, in a cluster concept (Table 6).

### *Conclusions and Implications*

This study revealed that the CORD PT course offered in Pennsylvania public high schools is perceived as a course well liked by administrators, teachers, and students. Several perceptions of the PT course were identified consistently by school administrators, teachers, and students. In addition, teachers provided their perceptions of the achievement of intended state outcomes for the areas of science and technology, and infusion of the PT course into the existing curriculum.

Approximately one-half of the teachers (46.2%; N=24) reported that their school offered a PT 1 and PT 2 course during the 1992-93 school year. Majority of the teachers (75.4%; N=40) reported teaching PT 1 and about one-fourth of the teachers reported (22.6%; N=12) teaching PT 1 and PT 2 during the 1992-93 school year.

As noted earlier, administrators, teachers, and students indicated liking the PT course overall. School administrators and teachers believe that the PT course meets the needs of both the career-directed and college-bound student. During the site visits, one teacher stated, "The armed services recruiters have shown a significant interest in students that have successfully completed the PT course." One of the focus group participants shared success stories about prior students that had taken PT and had successfully matriculated into a technical post-secondary degree program. School administrators and teachers corroborated the focus group member contentions that vocational, academic, and general track students can all benefit from taking an applied science course like PT. The PT curriculum adequately (totally or partially) addressed 17 of the 20 (85%) student learning outcomes.

The findings revealed that the CORD PT course offered in Pennsylvania public high schools is an integral component in the adoption of the Tech Prep articulation model. The course is one of the foundation courses for students who are on the Tech Prep "track." However, students' access to the course is not limited to those who are Tech Prep

Table 6

Utilization of PT Within the School Curriculum Structure.

| Program | Yes | | No | | Total | |
|---|---|---|---|---|---|---|
| | f | % | f | % | f | % |
| Tech-Prep | 39 | 75.0 | 13 | 25.0 | 52 | 100.0 |
| Industrial Arts | 24 | 49.0 | 25 | 51.0 | 49 | 100.0 |
| Competency Based Program | 28 | 54.9 | 23 | 45.1 | 51 | 100.0 |
| Cluster Concept | 19 | 38.0 | 31 | 62.0 | 50 | 100.0 |

directed; the PT course is open to all students. Seventy-five percent of the teachers indicated that the PT course was recognized as part of a Tech-Prep articulation model; 49% indicated that it was used in the Industrial Arts program; 54.9%, as a traditional competency based program; and 38%, in a cluster concept.

Finally, teachers at the five schools visited were very optimistic about the CORD PT curriculum. This optimism among teachers also was reported in the Oklahoma State Department of Vocational and Technical Education (1990) and Selland (1986), and the focus group participants. In a study conducted by personnel in the Oklahoma State Department of Vocational and Technical Education (1990), teachers reported positive feelings towards the PT course. One teacher stated, "I'm convinced every day that it is needed, that its necessary; that its necessary at the high school level" (p. 5). Selland (1986), in summarizing a report on the first two years of PT, concluded that students appear receptive to the PT class. This study confirmed these findings.

During the next five years, Principle of Technology Applied Science course implementation will provide vocational educators and researchers a better understanding of the strength, weaknesses, challenges and successes of vocational and academic curriculum integration. Vocational teachers, general academic teachers, administrators, students, and parents must perceive programs, such as Principles of Technology, as a step forward in student learning. Without acceptance from these individuals our innovative programs cannot succeed. Research must be continued to investigate curriculum integration if model programs such as this example are to continue to receive funding in their current, or future, appearance.

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***Article Footnote***

*The authors wish to acknowledge the support of Penn State University, the Pennsylvania Department of Education, and the Bureau of Vocational and Technical Education for making this research possible.*

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