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Is it time for a major redesign in technology teacher education? The field of technology education has gone through considerable introspection and revision in recent years. Welty (2003) suggested that over the last twenty years, the recommended curriculum for the study of technology has evolved dramatically in response to a new emphasis on teaching design, the development of standards, and other new initiatives. Welty further stated that,

> In light of these advancements, technology teacher educators are being challenged to evaluate their technical curricula, to look beyond traditions in teacher education, to reflect on the nature of knowledge, and to update both technical and professional courses for undergraduate technology teacher education (p. 74).

The convergence of new standards, accreditation requirements, research on teaching and learning, as well as new state certification policies have forced many technology teacher education programs to consider changes. In addition to these challenges, technology teacher education programs are facing unparalleled external problems. Some of these problems include shortages of entering pre-service teachers, program closures, and shortages of funding to support substantial programmatic adaptations. Pressure also comes from school administrators to maintain or reinstate traditional programs for students with limited abilities, from business and industry to focus on trade-specific courses, from community colleges to prepare students for post-secondary technical programs (Welty, 2003), and from professional associations to include courses related to pre-engineering, design, and technological literacy.

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With the publication of *Standards for technological literacy: Content for the study of technology* (ITEA, 2000) and the professional development standards included in the recently published *Advancing excellence in technological literacy* (ITEA, 2003) as well as the National Academy of Sciences (2002) publication entitled, *Technically speaking: Why all Americans need to know more about technology*, technology teacher educators are receiving increasing pressure to re-focus their programs on design, technological literacy, and engineering.

The *Standards for technological literacy: Content for the study of technology* (ITEA, 2000) identifies appropriate content for the study of technology and sets benchmarks for achieving those standards. These content standards were developed in an attempt to identify appropriate curricular content for the study of technology and technology education classes. In the closing paragraphs of the content standards document, technology teacher educators are urged to consider making substantial changes in their curricular offerings. "Those who educate technology teachers should review and revise undergraduate and graduate degree programs by using *Technology content standards* as the basis for teaching technology" (p. 201).

Meanwhile, *Advancing excellence in technological literacy: Professional development standards* (ITEA, 2003) was created to provide standards of performance and guidelines for teacher professional development providers (i.e., technology teacher education programs). The professional development standards were conceived and developed to complement the content standards and are aligned with the two other sets of *Advancing excellence in technological literacy* standards in the areas of student assessment and program standards. There are seven professional development standards organized around the topics of technological content, student learners, curriculum design and evaluation, instructional strategies, learning environment management, professional growth, and the assessment of professional development programs.

While not issuing a mandate, the publication of content and professional development standards did issue a challenge for all technology teacher education programs: Technology teacher education programs must revise their curricular offerings and teaching methodologies to align with the standards and prepare technology teachers to adhere to the content standards. These standards also introduced, in a not so subtle way, the notion that technology education should facilitate technological literacy, with a focus on design and engineering. In many cases, this was a clear departure from traditional offerings at institutions of higher learning.

In *Technically speaking* (NAS, 2002), the National Academy of Sciences directly called on technology teacher education accrediting bodies to provide incentives for institutions of higher education to transform the preparation of all teachers to better equip them to teach about technology throughout the curriculum. Further, the Academy implied that teachers of technology must approach the subject from an engineering perspective rather than an industrial arts perspective (NAS). These teachers must be fully conversant with the standards for technological literacy and familiar with the materials and techniques for teaching those standards (NAS). The publication concluded by stating, "Teachers at all levels should be able to conduct design projects and use design-oriented teaching strategies to encourage learning." (p. 108).

Purpose

The purpose of this study was to examine the degree to which technology teacher educators support the recently published standards in technology education and determine whether there is a need and/or support for substantial change in undergraduate technology teacher education. The following research questions guided the study:

1. To what degree do technology teacher educators support the *Standards for technological literacy: Content for the study of technology* (Content Standards) and the *Advancing excellence in technological literacy: Professional development standards*?
2. To what degree is substantial curricular and pedagogical change required and/or supported in technology teacher education?

Methodology

To answer the research questions above, a purposive sample of all technology teacher education faculty members listed in the *Industrial Teacher Education Directory* (Bell, 2002) were asked to respond to a questionnaire generated at Illinois State University. The questionnaire consisted of 57 questions in four sections. The first section of the questionnaire was designed to elicit responses to demographic questions related to age, years of experience, and responsibilities. Sections II and III asked the respondent to estimate the degree to which they supported each content and professional development standard. While respondents were asked to identify the degree to which they supported each of the content and professional development standards, these standards were not specifically identified as standards in the instrument. Rather, the standards were listed as concepts and the respondents were asked to identify the degree to which they agreed that these concepts were important. Section IV asked for the participants to respond directly to questions related to the current state and future purposes of technology teacher education.

The instrument was pilot-tested with six technology teacher education faculty members at Illinois State University and six standards specialists representing the Technology for All Americans Project (TFA). A Cronbach Coefficient Alpha test was conducted on the returned pilot-study questionnaires in order to establish reliability and validity for the instrument. After removing three questions from the survey, a reliability index of .81 was achieved. The refined instrument was used to collect data for the study. The questionnaire consisted of open-ended free-response and Likert-type questions designed to elicit responses concerning the level of support for the content and professional development standards as well as responses concerning the current state and future roles of technology teacher education.

Data Collection

In September 2003, the questionnaire was mailed to all 123 technology teacher education faculty members listed in the *Industrial Teacher Education Directory* (Bell, 2002). Technology teacher educators were identified using the titles provided for faculty members in the directory. All faculty members listed in the directory with the titles of professional, technology education, industrial education, teacher education, and undergraduate education were used. In cases where it was unclear whether undergraduate education referred to technology education or other career and technical areas, the faculty member name was cross-referenced with the Council on Technology Teacher Education membership list.

By the deadline date of October 10, 2003, sixty-five questionnaires were returned yielding an overall return rate of 55.2%. Due to the acceptable return rate and a hard deadline for completing the research (November 6, 2003), no follow-up mailing with non-respondents was conducted. A Microsoft Access database was created and the collected data was analyzed using descriptive statistics to discover the degree to which technology teacher educators support the content and professional development standards and the degree to which substantial change in curricular and pedagogical offerings are necessary in the field. Frequency distribution was utilized to summarize values and to identify the most common responses by the participants.

Findings

Who responded?

Section I of the questionnaire was developed to gather a snapshot of those responding to the survey. An analysis of the demographic data gathered in Section I indicated that the majority of respondents (80%) were over 45 years old, with 38% of those over 55 years of age. Only two respondents (3%) were between 26 and 34 years of age. This seems to indicate that the respondents were veterans in the field of technology teacher education. This assertion was supported by the second question in Section I. Question 2 asked participants to provide an indication of the number of years they had been active in technology teacher education. Over 60% of the respondents indicated that they had been active in the field for over 15 years. Only four respondents (6%) indicated that they had been in the field less than five years. The data may also reveal that the technology teacher education profession is largely directed by veteran teacher educators.

Is There Support for the Standards?

To answer the first research question, the respondents were asked 44 questions within sections II and III of the questionnaire (described above). In Section II, respondents were asked to indicate whether technology teacher education programs should prepare individuals to teach each of the content standards. A brief description of each content standard was listed (although not identified as a content standard), and the respondents were asked to indicate on a scale of 1 to 5 how strongly they felt that the individual concept should be included in a technology teacher education program. In the rating scale, 1 indicated least agreement and 5 indicated strongest agreement.

Of the 22 concept statements representing the 20 content standards, 18 received scores representing strong agreement that the standards should be delivered in technology teacher education programs. The statement concerning the core concepts of technology received the highest mean score (4.8). In fact, 50 of the 65 respondents strongly agreed that pre-service teachers should be prepared to teach the core concepts of technology. The other 15 respondents agreed that pre-service teachers should be prepared to teach the core concepts of technology. Concepts related to medical and bio-related technologies received the lowest mean scores (3.4 and 3.7 respectively), indicating that there is some disagreement concerning the value of these technologies in technology teacher education (see Table 1).

Section III again asked respondents to indicate on a scale of 1 to 5 how strongly they agreed that the indicated concepts should be included in the professional development standards. A brief description of each professional development standard was listed (although not identified as a professional development standard), and the respondents were asked to indicate their level of agreement as to whether the concept was an important part of the pre-service professional development program at their university. Although all professional development standards-related concepts achieved a mean score representing either agreement or strong agreement, the concepts related to students

Table 1
Section II. In the future, technology teacher education programs should prepare individuals to teach

Concept	Mean
Characteristics and scope of technology	4.6
Core concepts of technology	4.8
Relationships between technology and other fields	4.5
Cultural, economic and political effects of technology	4.6
Effects of technology on the environment	4.7
Role of society in the development and use of technology	4.5
Influence of technology on history	4.5
Attributes of design including design process	4.7
Role of troubleshooting in problem solving	4.6
Role of research and development and use of technology	4.5
Role of innovation and invention in problem solving	4.6
Role of experimentation in problem solving	4.7
Engineering design	4.2
How to use and maintain technology products and systems	4.3
How to assess the impact of technology products and systems	4.5
Core concepts of medical technologies	3.4
Core concepts of agriculture and related biotechnologies	3.7
Core concepts of energy and power technologies	4.5
Core concepts of information/communication technologies	4.6
Core concepts of transportation technologies	4.5
Core concepts of manufacturing technologies	4.6
Core concepts of construction technologies	4.6

N = 65
Numeric value assigned to answers: Strongly agree = 5, Agree = 4, Undecided = 3, Disagree = 2, Strongly disagree = 1

ability to coordinate instructional strategies and students ability to design and manage learning environments received the highest mean scores. Both of these concepts received mean scores of 4.8, indicating strong agreement about the importance of these concepts in an undergraduate degree program. The concept related to students' ability to design and evaluate curricula that cross grade levels received the lowest mean score (4.1), indicating faculty agreement with the importance of this concept. No concept in Section III received a score that indicated anything less than faculty agreement (see Table 2).

Table 2

Section III. First Question: In the future, technology teacher education programs should deliver a program that prepares pre-service teachers to

Concept	Mean
Understand and be prepared to teach the standards for tech literacy	4.4
Incorporate diversity and commonality to enrich learning	4.2
Lead learning opportunities that include cognitive, affective	4.7
Assist learners in becoming effective learners	4.6
Conduct and use research on how students learn	4.3
Design and evaluate curricula that lead to tech literacy	4.7
Design and evaluate curricula that cross grade levels	4.1
Use multiple sources of information to design/evaluate curricula	4.5
Coordinate instructional strategies with curricula	4.8
Incorporate educational technology	4.5
Utilize student assessment	4.6
Design and manage learning environments that promote study of	4.8
Assume a commitment to self-assessment/continuous professional growth	4.6
Establish a commitment to ethical behavior	4.7
Facilitate collaborations with others	4.5
Participate in professional organizations	4.7
Serve as advisors to student organizations	4.4
Provide leadership in education	4.6

Section III. Second Question: In the future, technology teacher education faculty members should

Concept	Mean
Plan in-service programs for practicing teachers	4.6
Model teaching practices that pre-service teachers will use	4.8
Evaluate professional development programs	4.4
Seek and obtain funding for professional development programs	4.4
Create/implement mentoring programs for in-service teachers	4.3

N = 65

Numeric value assigned to answers: Strongly agree = 5, Agree = 4, Undecided = 3, Disagree = 2, Strongly disagree = 1

Is There Support for Change?

Part IV of the instrument presented respondents with open-ended questions regarding the current status, the need for major changes, and the future of technology teacher education. The first question in this section asked respondents to determine whether it was time for a major change in technology teacher education. Over 62% indicated that major change was called for in the field. The primary reasons provided by the respondents included a need for programs to adapt to new technologies (25%) and a need to align with TFA standards (20%). Of those who indicated that major change was not needed (38%), most of those (32%) suggested that change had already taken place or that only minor changes were necessary (24%) (see Table 3).

When asked if the program with which they were affiliated offered the ideal curriculum, over 80% indicated that it did not (see Table 4). While some suggested that an ideal curriculum in technology teacher education was an impossible and unattainable goal, many suggested more discernable reasons for their belief that their programs offered a less than ideal curriculum. Over 19% of those who indicated that their curriculum was less than ideal cited bureaucracy and a lack of support as the primary reason for the shortfall. This perceived lack of support manifested itself through a shortage of enrolling students, a lack of funding, or a shortage of faculty needed to support curricular change. Another 13% cited a lack of faculty support for curricular change as the culprit. It should be noted that an additional 13% indicated that their curriculum was less than ideal, but that the program was currently in a state of revision. This response was also provided by 54% of those who indicated that their program offered the ideal curriculum. Another 10% indicated that their program had been or was slated to be closed and therefore did not offer any curriculum, ideal or otherwise. It is interesting to note that of the 25 respondents (38%) who indicated that there was no need for a major re-design in technology teacher education (see Table 3), only 52% of those 25 indicated that their program was ideal (see Table 4).

Table 3
Do you believe that it is time for a major re-design in technology teacher education?

Yes (N = 40; 62%)

Reason	n	%
Need to adapt to new technologies and respond to new models in teacher education	10	25
Need to align with model standards in teacher education programs	8	20
TTE does not reflect current technology education practice	5	13
Too many anchors to the past; survival demands change	4	10
Need to shift focus from teaching to learning; focus on the pre-service learning needs of students	4	10
Need more emphasis on literacy, less on skill development and industry	3	7
Need to reduce the use of courses designed for other majors	3	7
Need to improve public and university-wide perception	2	5
Need to go back to our technical/industrial roots	1	4

No (N = 25; 38%)

Reason	n	%
Technology teacher education has already implemented significant curricular changes	8	3
Minor changes, not major changes, are needed	6	24
Need to have clearly defined curriculum before changing	3	12
We change too much; stop trying to please everyone	2	8
Certification requirements must change before programs change	2	8
Programs will be cut regardless of changes	2	8
A major re-design would be unpopular with students	2	8

The third question in Section IV asked participants to project how a future technology teacher education program might differ from programs currently offered in the field. Over 35% of the respondents indicated that future programs would be more responsive to the *Standards for technological literacy: Content for the study of technology* and the *Advancing excellence in technological literacy: Professional development standards.* In

Table 4
Do you believe that your technology teacher education program offers the "ideal" kind of curriculum?

Yes (N = 13; 20%)

Reason	n	%
We just completed a major revision of our TTE program	7	54
We are accredited by NCATE and address all current standards	4	31
We blend cognitive and psychomotor learning activities	1	8
Graduates are successful, have good technical and philosophical expertise	1	8

No (N = 52; 80%)

Reason	n	%
Bureaucracy and lack of support prevent change	10	19
Program is in a state of revision	7	13
Faculty disagree or lack vision on curricular focus	7	13
Program has been discontinued	5	10
Laboratories designed for traditional or industrial content dictate content	5	10
Program is not standards-based and does not reflect current practice in the field	5	10
Program is too heavily focused on industry	4	8
Program has been combined with other disciplines to be more cost effective	2	4
Program needs to focus more on pre-engineering	2	4
Program is too heavily focused on modular education	2	4
Not offering technical courses reflective of standards	1	2
Program has not responded to societal changes	1	2

apparent support of this emphasis on the standards, another 15% suggested that future technology teacher education programs will include a greater emphasis on technological literacy and less emphasis on skill development and the use of traditional tools. In contrast, 8% of the respondents suggested that technology teacher education would return to an emphasis on skill development, traditional projects and job training in the future (see Table 5).

Table 5
If change is called for, how would a future program differ from the one currently offered?

Response	n	%
More emphasis on content/professional development standards	17	35
More emphasis on tech literacy; less on tools/skills development	7	15
More emphasis on forming closer ties to other disciplines	6	13
Greater focus on engineering and design	4	8
Return to a focus on skill development, traditional projects, and job training	4	8
Form closer ties to practicing teachers/expand clinical experience	3	6
Curriculum revisions that focus on concept-driven learning experiences/less activity-driven experiences	2	4
Greater focus on design and technological literacy; less on traditional curriculum organizers	2	4
More online courses and alternative delivery modes	2	4
More emphasis on assessment; base program on research findings	1	2

In an effort to ascertain the responses from the participants regarding their beliefs about appropriate core content for technology teacher education, the fourth question in Section IV asked respondents to list content areas that should be included in the ideal technology teacher education program. In a result that seems to support the *Standards for technological literacy*, design (28%) and engineering design (22%) received the highest number of responses. Technological literacy as a content area received an additional 11% of the responses. Although mentioned, skill development received the least number of responses, with only one person suggesting that skill development should be a priority in the future (see Table 6). It should be noted that although only two respondents indicated that modules should hold an important place in the technology teacher education preparation program of the future, numerous respondents took this opportunity to write disparaging remarks about the value of modules in the margins of the questionnaire.

Table 6
What content base should be at the core of an "ideal" TTE program (i.e., engineering, industrial, modular, design, etc)?

Content Base*	n	%
Design	32	28
Engineering/design	25	22
Technological literacy/standards	12	11
Technology	9	8
Problem solving	7	6
Industrial technology	6	5
Instructional methods	6	5
Industrial design/curriculum organizers	3	3
Technology and society	3	3
Integrated	3	3
Modules	2	2
Technological assessment	2	2
Cognition	1	1
Skill development	1	1

*Most respondents provided more than one response

The fifth question asked respondents to list competencies that employers (public school administrators) are seeking from technology-teacher-education-program graduates. Over 20% indicated that employers continue to seek teachers who are capable of delivering courses related to traditional technical content areas (see Table 7). The second highest number of responses (12%) listed standards-based technological literacy as the competency most valued by employers.

Responses to the sixth question in Section IV indicate that there is strong support for core general education courses in mathematics and science among technology teacher educators. Twenty-seven percent of the responses to the question "what core general education content should be included in the ideal technology teacher education program?" included references to mathematics and an additional 22% included references to science. Although respondents were encouraged to respond with

Table 7
What competencies are employers (public school administrators) demanding of your graduates?

Competencies*	n	%
Traditional technical content (ability to teach curriculum organizers)	16	20
Standards-based technological literacy	10	12
Classroom/laboratory management skills	9	11
Anyone with a valid teaching certificate	8	10
Ability to transform an outdated program	7	9
Problem solvers	7	9
Expert in methodology	7	9
Computers and networking	5	6
Ability to help students achieve on standardized tests	4	5
Traditional shop	2	3
Modules	2	3
Vocational and pre-vocational	2	3

*Some respondents provided more than one response

as many core concept areas as possible, almost all respondents included mathematics and science concepts. Of those references to science, physics and general science were the most often suggested courses. In mathematics, general mathematics was the most often suggested course (see Table 8).

Faculty participants were asked to identify the primary pedagogical methods to which pre-service technology teachers should be exposed in the seventh question of Section IV. While most respondents listed a number of individual instructional approaches, many (15%) also suggested that pre-service teachers should be exposed to as many differing methods as possible. Cooperative learning, problem solving, and other constructivist teaching approaches all ranked high in the list of responses to the question (see Table 9).

The final question in Section IV asked participants to speculate about the components of a model technology teacher education program if they were afforded the opportunity to start a program with a clean slate. It is interesting to note that while a

Table 8
What core general education content should be included in the ideal TTE program?

General Education Content*	n	%
Science Physics, 9; Chemistry, 5; Biology, 4; Earth science, 1; Physical science, 1; Ecology, 1; Environmental science, 1; General science 17	39	27
Mathematics Logic, 1; Quantitative analysis, 1; Algebra, 3; Trigonometry, 1; Statistics, 1; Calculus, 3; General Mathematics, 22	32	22
Social Science History, 7; Sociology, 4; Ethics, 1; History of technology, 5; Science-technology-society, 1; Political science,1	19	13
Communications English, 9; Composition, 3; Literature, 3; Language arts, 4	19	13
Arts/Humanities Art, 3; Economics, 1; Psychology, 4; Anthropology, 1; Humanities, 4; Philosophy, 2	15	10
Education Educational psychology, 1; Curriculum design, 2; Facility design, 1; Educational philosophy, 1; General methods, 3; Special populations, 2	10	7
Other Public relations, 1; Engineering, 2; Computer science, 2; Instructional technology, 1; Heritage, 1, Impacts of	10	7

technology, 2; Internships, 1

*Most respondents provided more than one response

model program based on technological literacy, design, and engineering achieved the highest number of responses (22%), an equal number of respondents suggested that a program started

Table 9

To what primary pedagogical methods should pre-service teachers be exposed?

Method*	n	%	Method*	n	%
A large variety of methods	18	15	Research and development	2	1
Cooperative learning	11	9	Question-based	2	1
Problem solving	11	9	Simulations	2	1
Constructivist	8	7	Discovery-based	2	1
Demonstrations	8	7	Service learning	2	1
Lecture/discussion	7	6	Behaviorism	2	1
Experiential	7	6	Critical thinking	1	—
Design-based	6	5	Theme-based	1	—
Modular	5	4	Computer-based	1	—
Project method	4	3	Lab supervision	1	—
Inquiry-based	3	2	Community based	1	—
Assessment-based	3	2	Debate	1	—
Hand-on learning	3	2	Group Activity	1	—
Individualized instr.	3	2	Case studies	1	—
Skill training	2	1	Shop talks	1	—

*Respondents provided multiple responses to this question

Table 10

If you were provided with a "clean slate," what major components would a model TTE program include?

Major Components	n	%
Technological literacy, design, engineering	14	22
Industrial curriculum organizers and technical skills	14	22
Integrated curriculum closely allied with mathematics,	9	14

science, and the arts		
Standards for technological literacy: content standards	9	14
Vocational-technical or trade areas	7	11
Technology, society, culture, values, etc.	5	8
Professional development/clinical experience/prof. practice	4	6
Appropriate teaching-learning theories with a reduced emphasis on technical areas	2	3

with a clean slate should focus on industrial curriculum organizers like manufacturing and construction (22%). And even more surprising were the seven (11%) respondents who suggested that a modern technology teacher education program initiated with a clean slate should be based on vocational and trade areas—receiving only one fewer response than those suggesting that a modern program should be based on the *Standards for technological literacy* (see Table 10).

Conclusion

Although Sections II and III suggest that there is strong support for the recently published content and professional development standards, it is clear that there is some disagreement in technology teacher education as to the curricular offerings that would deliver these standards at the undergraduate level. The data seem to suggest that while many support technological literacy, design, and engineering as major components of an undergraduate program, an almost equal number resist this idea and prefer an undergraduate program that revolves around more traditional industrial curriculum organizers. At first glance, this resistance seems to contradict the strong support for basing an undergraduate teacher certification program on the content and professional development standards. However, this resistance may be grounded in the belief that the standards can be delivered in a more traditional program. It does appear that in many cases, potential employers continue to seek more traditionally prepared graduates. This may be preventing curricular changes at the university level. Based on the responses to several questions, it also seems likely that many technology teacher education programs are resisting curricular change due to a lack of support among departmental faculty members and the presence of more traditional laboratories and technical courses. While the data indicate that most respondents recognize the shortcomings of their respective programs, it is less clear whether these respondents are preparing to address those shortcomings.

It is encouraging to note that many of the respondents suggest that their respective technology teacher education programs have undergone substantial curricular and programmatic changes in recent years and have done so in response to the *Standards for technological literacy*. It is also encouraging to note that while disagreement abounds as to the curriculum that should be implemented to reach the destination, almost all respondents agreed that the *Standards for technological literacy* are a worthy target for technology teacher education.

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