A Curricular Analysis of Undergraduate Technology & Engineering Teacher Preparation Programs in the United States

Introduction

Technology & engineering teacher preparation programs at colleges and universities in the United States have been in a state of decline since the 1970's. In an editorial published in the Spring 1997 *Journal of Technology Education* Volk indicated that the number of undergraduate students graduating in technology teacher preparation declined by nearly two-thirds between the period of 1970 and 1990. Plotting the downward trend in graduates, Volk estimated the demise of technology education teacher preparation in the United States around the year 2005. While Volk's prediction has not been proven to be entirely accurate, the downward trend in technology teacher preparation has continued. An analysis of the 2002/2003 *Industrial Teacher Education Directory* (Bell, 2002) indicated that there were more than forty programs nationwide with estimated undergraduate teacher preparation enrollments of more than 20 students. Just one decade later the *2012/2013 Technology & Engineering Teacher Education Directory* (Rogers, 2012) indicated that only 24 programs had an estimated undergraduate enrollment of 20 students or more. Of those programs that remain, another concern is that there is still considerable diversity with regard to the curricula that comprise the various technology & engineering teacher preparation programs. For instance, at one end of the spectrum some programs have retained a traditional approach to technology & engineering education that is deeply rooted in hands-on experiences, often through traditional projects that involve material processing with wood or metal along with courses in graphics, electricity and power technology. On the other end of the spectrum are programs that have evolved through schools of engineering. Some of these programs require teacher preparation students to complete the same course work as any typical engineering major along with additional coursework in pedagogy in order to earn teacher licensure.

In the fall of 2013 a study was conducted to compare the required curricula of those 24 undergraduate programs that maintain enrollment of 20 students or more in order to determine what a composite or composite curriculum might look like. A list of those institutions included in the study is provided in Appendix A.

Len S. Litowitz (Len.Litowitz@millersville.edu) is Professor and Chairperson in the Department of Applied Engineering, Safety & Technology at Millersville University of Pennsylvania.

Such a composite curriculum could be useful in the process of updating accreditation guidelines used by the *Council on Technology & Engineering Teacher Education* that have now been in place for more than a decade (NCATE/ITEA/CTTE, 2003).

Methodology

This study utilized a multi-part methodology in order to create a composite curriculum undergraduate curriculum for technology & engineering teacher preparation in the United States. First, technology or technology & engineering teacher preparation programs having an undergraduate population of 20 students or more were identified using the *2012/2013 Technology & Engineering Teacher Education Directory* (Rogers, 2012). Next, basic information about critical aspects of each program were determined. Those critical aspects included the following:

a. Number of credits required to complete the program
b. Number of professional credits required
c. Number of technical credits required
d. Number of general education credits required
e. Highest level of math & science required
f. Technical course work most frequently required
g. Professional course work most frequently required

The composite curriculum that was created addresses several key aspects of all technology & engineering teacher preparation programs in the United States including *professional studies* requirements, *technical studies* requirements and some components of *general education* (sometimes referred to as *liberal studies*) such as mathematics and science that are most closely associated with technology & engineering content.

Limitations of the Study

1. The study was limited to those 24 technology & engineering teacher preparation programs maintaining undergraduate enrollments of 20 students or more and may not be indicative of all technology & engineering teacher preparation programs throughout the United States.
2. Information about the size of programs was acquired from self-reported institutional data in the 2012-2013 *Engineering & Technology Teacher Education Directory (2012, Rogers)* that is presumed to be reasonably accurate but not guaranteed to be accurate.
3. The composite curriculum created as a result of this study was based upon existing curriculum requirements for those programs included in the study. As such, it is simply a composite curriculum of what exists now, and may not be reflective of the most contemporary or progressive curriculum from a philosophical standpoint.

Findings

Table 1 shows the findings regarding credit distribution for a composite curriculum that was determined by reviewing the program requirements for the 24 technology & engineering education programs included in the study.

Table 1

Credit Distribution for a Composite Curriculum for Technology & Engineering Teacher Preparation in the United States

	Mean	Range
Total Credits Required	126	120 - 139
Total General Education Credits Required	45	30 - 60
Total Professional Credits Required (includes student teaching)	33	24 - 49
Total Technical Credits Required	44	27 - 57

n = 24

The data indicate that a composite curriculum would be reasonably evenly distributed among the three core areas of *general education*, *professional studies* and *technical studies* that comprise all teacher preparation degree programs in the United States. Table 2 addresses mathematics and science requirements for Technology & Engineering Teacher Preparation programs in the United States.

Table 2

Highest Level Math & Science Requirements for Technology & Engineering Teacher Preparation Programs in the United States

Highest Level Math Required	Frequency	Percentage of Total
Calculus II	1	4%
Calculus I	5	21%
Pre-Calc Algebra	3	12.5%
Algebra & Trig	3	12.5%
Algebra OR Trig	1	4%
College Algebra	4	17%
Statistics	3	12.5%
Funds of Math	4	17%
Highest Level Science Required	Frequency	Percentage of Total
Physics II	1	4%
Physics	10	42%
Physics or Bio	2	8%
Physics, Bio or Chem	8	34%
Physics, Earth Science, Chem	2	8%
Undetermined	1	4%

n = 24

The data indicate a wide range of mathematics requirements with regard to programs. Almost 30% of the programs that were reviewed required no greater math than Statistics, but 25% of the programs required at least one Calculus course. Some form of Algebra was the most frequent type of math required by the greatest number of programs. The data indicated greater consistency with regard to science requirements. At least one Physics course was required more than any other type of science, but many institutions allowed for the selection of any natural science course to fulfill general education and/or major requirements.

Table 3 (continued on next page) addresses technical course work required within the curriculum. For the purposes of the study only required course work was considered. Many curricula that were reviewed included optional and/or elective course offerings but these electives were not considered for the purposes of this study since accreditation guidelines typically focus on required coursework.

Table 3
Most Frequently Required Technical Coursework Identified

Technical Content Required	Frequency
Energy & Power	46
Energy	
Power Systems	
Energy, Power & Trans	
Electronics (analog & digital)	
Robotics	
Automation/System Control	
Fluid Power	
Manufacturing	29
Industrial Organization	
Technological Enterprise	
Wood Manufacturing	
Metal Manufacturing	
Production Systems	
Communication	25
Multimedia	
Desktop Publishing	
Graphics	
Printing	
Design	24
Product Design	
Innovation	

Problem Solving	
Industrial Design	
Engineering Design	
Material Processing	23
Material Testing & Statics	
Construction	19
Introductory Drafting/CAD	16
Advanced CAD	10
Architecture	
CAD/CAM	
3-D Solid Modeling	
Civil Engineering/Arch	
Transportation	6
Technology & Society	6
Senior Design Project/ R&D	5
Medical/Agricultural/Bio-related	4
Engineering Principles	3
Other	
Computer Networking	3
Technological Systems	3
Computer Integrated Mfg.	3
Gateway to Technology	2
Technological Decision Making	1
Applications in STEM	1
Exploring Technology	1
Technology Systems II	1
Dynamics	1
Solids	1
Thermal	1
Machine Design	1

n = 24

With regard to technical content, many institutions have designed their curriculum to reflect the *Standards for Technological Literacy (SfTL)* (Dugger, 2000) and more specifically the portion of the *SfTL* referred to as the *Designed World*. The *Designed World* specifically identifies sectors of technology and the economy as communication, transportation, manufacturing, construction, energy & power, and biological, agricultural and medical technologies that are worthy of study toward the goal of technological literacy. Other aspects of the *SfTL* are reflective of the required course offerings indicated in Table 3 as well. For instance, the *SfTL* recognizes Design abilities as essential to becoming technologically literate and as a result many institutions require some type of course dedicated to design in addition to teaching about aspects of design

through other technical courses as well. The information provided in table 3 also indicates that sometimes traditional courses continue to be required in most programs, but often for good reason. For instance, material processing courses are still very prevalent in various curricula reviewed, but in the current era they are often used as prerequisites to courses such as manufacturing or construction or product design. Also worthy of note is the lack of extensive acceptance within the field to aspects of technology such as agricultural, biological or medical technologies that do not have a longstanding history within the field like manufacturing or communication or construction. Similarly, more references to courses with *engineering* in the title might have been anticipated given the profession's recent turn toward engineering in the United States. Lastly, it is worth noting that the data collection method used may have done a bit of an injustice to subjects like electronics and transportation. These subjects were not separated out from the Energy & Power category the way that Drafting was reported separately from courses in the Communication category. Many of the programs reviewed did require courses in electricity/electronics, and many others taught aspects of transportation in conjunction with energy & power courses, creating a judgment call as to where to record these courses in Table 3. Disappointingly, few schools required specific coursework in robotics or automation even though these subjects are very popular in the middle schools and high schools throughout the United States.

The final area of curriculum that was reviewed was the professional course sequence. This area yielded more diversity in the required courses across institutions than would have been anticipated, given the fact that many of the requirements for teacher preparation like teaching methods courses are similar for all teacher preparation subject areas. Some of the variation can be explained by the fact that in the United States, education is a state's right. Therefore, there are no nationally mandated requirements, so teacher licensure requirements can and do vary from state to state. Analysis of the various professional requirements is provided in Table 4 (next page).

Table 4
Most Frequently Required Professional Coursework Identified

Professional Coursework Required	Frequency
Teaching Methods (General)	45
Instructional Techniques	
Curriculum Development	
Assessment	
Student Teaching Practicum	24
Foundations of Technology & Engineering Education	24
Methods of Teaching TE	16
Educational Psychology	16
Teaching Exceptional Students	14
Students of Special Needs	
Inclusion	
English Language Learners	
Professional/Clinical Field Experiences	10
Student Teaching Seminar	9
Multicultural Education	9
Literacy Through Content	8
Early Field Experiences	7
Observation and Participation	
Practicum	
Exploring Teaching Careers	6
Foundations of Education	5
Technology Lab Design/Management	4
Classroom Management	3
Elementary Technology Education	3
Technology for the Elementary	
Integrative STEM for Young Learners	
Design, Tech & Engineering for Children	
Issues in Secondary Education	2
Philosophy of Education	2
Other	
CTE Student Organizations	1
Standards for Technological Literacy	1
Resources for Technology	1
Integrative Engineering Concepts K-12	1
Learning & Motivation	1
Portfolio Assessment	1
Key Concepts for Middle Level Ed.	1

n =24

Not surprisingly, teaching methods courses were the most frequently identified required professional courses followed by the student teaching experience that is a requirement for all teacher preparation majors at all 24 institutions. More interestingly, it was apparent that virtually all of the institutions in the study maintained at least one departmental foundations level professional course and most maintained and required two professional courses from within the department. The data clearly indicate that courses addressing topics such as Exceptional Children in the Classroom and Multiculturalism are becoming more popular along with increased teaching exploration courses and early field experiences well prior to student teaching.

Conclusions

Technology & engineering teacher preparation programs across the United States have been in a state of decline for more than four decades. There are currently only 24 undergraduate technology & engineering teacher preparation programs in the United States with an enrollment of 20 students or more. Among those programs there exists much diversity about what constitutes a required sequence of courses or curriculum to complete a bachelor's degree and earn teacher licensure. Comparing the required curriculum for those 24 programs with undergraduate majors of 20 or more resulted in the design of the following composite curriculum:

Table 5
Courses that comprise a composite curriculum for technology & engineering teacher preparation in the United States based upon requirements in existing programs

General Education (45 Credits) Including:	**Professional Studies (33 Credits) Including:**	**Technical Studies (44 Credits) Including:**
College Algebra and 1additional College Mathematics course	At least 2 teaching methods courses addressing topics such as instructional techniques, curriculum, and assessment	2 courses in Energy & Power including Electricity/Electronics and Transportation
1 Physics course	At least 1 methods course specifically in technology & engineering education (most programs required 2 such courses)	1 course in Manufacturing
	1 course in Educational Psychology	1 course in Communication
	1 course in Special Needs children in the classroom	1 course in Construction
	Full semester student teaching experience	1 course in Design
		1 course in Material Processing
		1 course in Drafting/CAD

Only courses that were required by at least half of the 24 programs in the study were included in the composite curriculum provided in Table 5 above. Most of the courses would align quite well with the *Standards for Technological Literacy* (Dugger, 2000). Yet, notably absent are courses like biological, medical and agricultural technologies that are also referenced in the *SfTL.* This data would indicate that more than 12 years after the *SfTL* were published this content has failed to gain widespread acceptance in technology & engineering teacher preparation programs throughout the United States. Similarly, the study identified few courses that specifically embrace the engineering movement by title, although course titles do not speak to the types of activities delivered in existing courses that may help to address engineering content. Lastly, it is important to acknowledge that one significant limitation of this study was that

the composite curriculum was derived from existing curricula. As such, it is not necessarily representative of a more progressive curriculum that an accrediting body might wish to foster.

Recommendations

1. As a follow-up to this study program coordinators or department chairpersons should be surveyed to determine factors influencing the design of their required curriculum for technology and engineering teacher preparation, along with factors influencing the recruitment of qualified teacher candidates. Such a survey has been tentatively developed and is provided in Appendix B.
2. The ITEEA's Council on Technology & Engineering Teacher Education (CTETE) should consider updating their accreditation guidelines for teacher preparation programs given recent changes in the field. These guidelines have been in place for more than a decade and were developed in conjunction with the NCATE accrediting agency. ITEEA and CTETE no longer maintain an affiliation with NCATE.

References

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Rogers, G. E., Editor (2012-2013) *Engineering & Technology Teacher Education Directory*, CTTE and NAITTE, College of Technology, Purdue University, West Lafayette, IN

Volk, K. S. (1993). Enrollment trends in industrial arts/technology education from 1970—1990. *Journal of Technology Education*, 4(2), 46-59.

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Appendix A - Institutions Included in the Study

1. Central Connecticut State University
2. Colorado State University
3. Illinois State University
4. Ball State University (Indiana)
5. Indiana State University
6. Purdue University (Indiana)
7. University of Northern Iowa
8. Fort Hays State University (Kansas)
9. Pittsburg State University (Kansas)
10. Montana State University
11. Wayne State University (Nebraska)
12. The College of New Jersey
13. State University of New York at Oswego
14. Buffalo State University (New York)
15. Appalachian State University (North Carolina)
16. North Carolina State University
17. California University of Pennsylvania
18. Millersville University of Pennsylvania
19. Valley City State University (South Dakota)
20. Brigham Young University (Utah)
21. Utah State University
22. Old Dominion University (Virginia)
23. University of Wisconsin – Stout
24. University of Wisconsin – Platteville

Appendix B - SURVEY

Factors Affecting the Design of Technology & Engineering Curriculum at Your Institution

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
1	2	3	4	5

1. The *Standards for Technological Literacy* have a major influence on the design of our curriculum.
2. The engineering movement has influenced changes in our required curriculum.
3. Increased math and science requirements would be beneficial but could cost us enrollment.
4. Our curriculum is moving toward an integrative STEM approach for Technology &Engineering education majors.
5. Our curriculum has increased field experience requirements in recent years.
6. The loss of our NCATE SPA affiliation has negatively impacted the perception of our program with administration.
7. ITEEA/CTETE should work on developing a revised set of accreditation guidelines to more accurately reflect current trends in the field.

Directions:
Please provide a limited response to the question provided below.

8. Please identify the single greatest factor shaping the nature of your curriculum at present.