The Status of Design in Technology Teacher Education in the United States

Scott A. Warner and Laura L. Morford

Introduction

Design is fundamental to the study of technology. McCracken (2000) goes so far as to refer to design as "the creative soul of technology" (p.87). McCracken elaborated on this profound concept by stating:

> As a human soul is to the body, design is to technology. It is important to understand the interdependence and complimentary nature of technology and design. Like the inseparable relationship between body and soul, technology is incomplete without design. Design cannot be fully appreciated without an understanding of technology. If technology is to be fully understood, then the concepts of design need to be understood. (p. 87)

The *Standards for Technological Literacy: Content for the Study of Technology* (*Standards*) (ITEA, 2000) identified the importance of such a holistic grasp of design when developing technological literacy by stating, "To become literate in the design process requires acquiring the cognitive and procedural knowledge needed to create a design, in addition to familiarity with the processes by which a design will be carried out to make a product or system" (p.90). Using design as the fundamental tool to examine and create technology involves the development of the intellectual infrastructure for such an approach. A major part of that infrastructure is formed through the learning experienced by pre-service technology teachers during their undergraduate studies.

Wulf (ITEA, 2000), commenting in the Forward of the *Standards,* emphasized the importance to the profession of the ideals put forth in that document by stating, "It is not enough that the standards are published. To have an impact, they must influence what happens in every K-12 classroom in America" (p.vi). However, this impact cannot happen only in the K-12 classrooms. The system that prepares technology educators in college and university undergraduate programs plays a significant role in both choosing how

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technological literacy will be interpreted through technology education, and in preparing future teachers who will then apply those interpretations in the K-12 classrooms. If the *Standards* are to serve as a common framework for the development of technological literacy, it would then follow that a broad understanding of the influence of design in the study of technology ought to be a matter of importance to the profession.

In the *Standards*, design is a theme that is woven throughout the many benchmarks and is identified specifically as 4 of the 20 overall standards The emphasis on design in the *Standards* begs the need for a definition and description of design. The document describes the characteristics and general processes of technological design by stating:

> Technological design is a distinctive process with a number of defining characteristics: it is purposeful; it is based on certain requirements; it is systematic, it is iterative; it is creative; and there are many possible solutions. These fundamental attributes are central to the design and development of any product or system, from primitive flint knives to sophisticated computer chips. (p.91)

This description of technological design is far more enlightening to the reader than many of the historical definitions that have preceded it in the realm of technical education. Steinen (1977) simply stated, "Design could be defined as a plan" (p.3). Lindbeck (1963) asserted that, "By definition, designing is creative planning to meet a specific need" (p.16). Micheels and Sommers (1963) described the introduction of students "to the broad concepts of design . . . [through] initial experiences in problem solving by the use of tools and materials" (p. 156).

Other professions that deal with technical design, such as architecture and industrial design, provide descriptions and definitions of design from which technology education can benefit. Lawson (1997) used comparisons to sport and music when describing design as a skill:

> Design is a highly complex and sophisticated skill. It is not a mystical ability given only to those with recondite powers but a skill which, for many, must be learnt and practiced, rather like the playing of a sport or a musical instrument. (p.11)

Lawson later makes the point that design, like all skills, requires practice and repeated use for it to become a completely intuitive act. According to Lawson:

> It is in the very nature of highly developed skills that we can perform them unconsciously. So it is with design. We probably work best when we think least about our technique. Beginners however must first analyze and practice all the elements of their skill and we should remember that even the most talented of professional golfers or musicians still benefit from lessons all the way through their careers. (pp. 11-12)

Schön (1983) perhaps best summarizes all of the various attempts to describe and define the process of technical design by stating:

> A designer makes things. Sometimes he makes the final product; more often, he makes a representation – a plan, program, or image – of an artifact to be constructed by others. He works in particular situations, uses particular materials, and employs a distinctive medium and language. Typically, his making process is complex. There are more variables – kinds of possible moves, norms, and interrelationships of these – than can be represented in a finite model. (pp. 78-79)

All of these descriptions of design seem to contain commonalities in their basic conceptual framework. However, the very nature of design leaves plenty of room for unique interpretations of both how the process of design is done and how it can be taught.

Purpose and Need for the Research

With design taking such a prominent role in the *Standards*, a measure of the current status of such courses in technology teacher education provides a quantitative foundation for further investigation into the nature and role of design toward achieving technological literacy. This research was designed to be the first in a series of studies to determine the nature and scope of the study of design in the undergraduate experience of technology educators. Essentially, this study and its follow-ups are intended to provide reference marks about how the ideals of the practice of design, put forth in the *Standards,* are played out in the preparation of undergraduate students in technology education. The intent of this specific research effort was to take a measure of the status of the study of design as a part of those undergraduate experiences.

Reed (2002), Lewis (1999), Foster (1996), and Foster (1992) found declining numbers of research efforts being conducted in technology education. Furthermore, Lewis also identified a number of areas in need of research. Examples of those areas that directly apply to the need for this study include (a) "Questions pertaining to technological literacy" (p.43), (b) "Questions pertaining to technology and creativity" (p.46), (c) "Questions pertaining to curriculum change" (p.48) and, (d) "Questions that focus on teachers" (p. 50). In a preliminary review of the literature, Warner (2003) found that there was no specific analysis of the status of the study of design in undergraduate technology teacher programs. The increasing importance of the role of design toward the quest for developing technological literacy in students made this finding a key point in recognizing the need for this study. As a result, the identified lack of literature and data for analysis provided the impetus to perform a more detailed investigation.

Method

Limitations

The researchers chose only to examine and then quantify the status of design related courses. Crowl (1993), Tuckman (1988), and Gersten (n.d.) described the nature of such descriptive research as simply observing and describing the variables, as they exist across a given population. Gersten further observed that descriptive research could provide quantitative data, which can then be used to ". . . help us understand common implementation problems and other pressing problems in current practice. However, despite the rich insights they [descriptive studies] often provide, they can not serve as evidence of effectiveness" (p. 2). The researchers felt that a descriptive study of this issue would be a necessary first step toward developing a database for later research on the effectiveness and influence of the different approaches to the study of design in technology teacher education.

Definition of Terms

Two basic descriptors for the study of design courses were agreed upon: technique-based or synergistic. Buchanan (1998), Lawson (1997), and Narvaez (2000) addressed the idea that most design programs in subject areas such as architecture, engineering design, and industrial design organize their programs of study in such a fashion. Specifically, technique-based courses are focused on the technical aspects of design. Buchanan (1998) calls these technical aspects the "basic skills suited to the needs of the trade, but little else" (p. 64). For example, these types of courses might focus on techniques such as technical drawing, mechanical drafting, computer-aided drafting, and model making. Synergistic-based courses combine the technical skills with the overall thinking processes of design. Narvaez (2000) refers to these types of courses as "the meta-structure of design" (p.38) in that they look at and use the design process and all of its constituent techniques in a broad context. Buchanan (1998) argued that the synthesis of the skills of technique with the design thinking process in the synergistic courses "add[s] to these skills other elements of learning that contribute to the formation of a liberally educated professional" (p. 64). Lawson (1997) further expanded on the characteristics of a synergistic approach to technical design by making the connection to the arts through the following statement:

> For many of the kinds of design we are considering, [architecture, interior design, graphic product design, product and industrial design and, urban and landscape design] it is important not just to be technically competent but also to have a well-developed aesthetic appreciation. Space, form, and line as well as color and texture are the very tools of the trade for the environmental, product or graphic designer. The end product of such design will always be visible to the user who may also move inside or pick up the designer's artifact. The designer must understand our aesthetic experience, particularly of the visual world, and in this sense designers share territory with artists. (pp. 10-11)

Generally, synergistic courses were called things such as industrial design, product design, or design processes (Warner, 2003).

Assumptions

It is important to note that from the beginning of the research, the assumption was made that most, if not all, technology teacher education courses used or contained some component of design. However, for the purposes of this research, it was decided to investigate only courses that were explicitly focused on design techniques or the overall design process. It was further assumed that many technique-based courses would include synergistic segments and that synergistic courses might also include aspects of teaching specific design-related skills. Therefore, the researchers sorted the courses based on the primary focus of the content, as determined from the various forms of course descriptions.

The raw data were collected between the months of May and November 2002. It was assumed that the data reflected the most recent structure and content of the undergraduate courses in technology teacher education offered at the universities and colleges included in the final pool. It was further assumed that the review of the list of design-focused courses, completed by the representative from each technology teacher education program, was complete and accurate and reflected only the design-focused courses offered through the program.

Research Questions

The researchers first organized their approach to the study by creating a series of questions and developing a strategy for collecting the raw data. The fundamental questions were:

1. What was the number of undergraduate technology teacher education programs nationwide?
2. What was the number of design-focused courses offered at those programs?
3. What were the titles of those courses?
4. How many design-focused courses were primarily structured to teach the techniques of design and how many were primarily synergistic in their content structure?
5. How many design-focused courses were electives and how many were program requirements?
6. Was there any pattern to the geographic distribution of the technique-based and synergistic design courses?

Data Collection

The strategy for collecting the data involved first identifying the undergraduate programs in technology teacher education and then accessing the specific information about course offerings and course content. The initial selection of programs to be examined came from the list of institutional members of the International Technology Education Association (ITEA) posted on the ITEA web site (http://www.iteawww.org/J4.html) as of May 2002. At that time there were 64 institutional members listed. After filtering for appropriateness for inclusion, the total number of undergraduate technology teacher education programs examined was reduced to 60. Programs were excluded from this study for one or more of the following reasons:

1. The university or college did not have an undergraduate program in technology teacher education.
2. The university or college did not have a technology teacher education program.
3. The university or college was located outside of the United States.

Three additional technology teacher education programs were eliminated because they were in the process of closing, resulting in 57 programs being used for this research.

The primary source for the data collected was the information provided by the university or college on its Web page. Some programs provided the course listings and individual course descriptions on their departmental Web pages. Other departments provided only general program descriptions. In these latter situations, the researchers accessed the university or college undergraduate catalog through the Internet. For the vast majority of programs, the Internet proved to be productive in locating both the program curriculum and the individual course descriptions. For a small number of programs, it was necessary to make personal contact with either the department chairperson or with the admissions director of the university or college to request that a copy of the university catalogue be sent through the regular mail. For a few courses, it was also necessary to contact a representative from the program and ask for additional information concerning course content and/or request a copy of the class syllabus.

The raw data were collected for each school and a list of courses that fit the description of being design oriented were then presented to the respective department chairperson or the identified departmental representative for technology teacher education. The contact with the representative was initially made through an e-mail message. Subsequent contacts were made, as needed, through additional e-mail messages, facsimiles, and direct telephone calls. The departmental representative was asked to confirm the list of identified design-oriented courses or to make changes accordingly. The messages included a brief description of the research, brief definitions of synergistic and technique-based design courses, a list of the identified courses from that college or university, and an indication of the status of the class as being either a requirement for the program of study or an elective. Responses from the program representative were included to help provide direct input into the study from each of the schools. Once the list of courses was confirmed or adjusted by the school's representative, it was then reviewed by the researchers, who then organized them by the published course description and categorized them as being either technique-based or synergistic in approach. The data were tabulated, first for each school, and then as part of a collective database of the status of the study of design across the United States. The results were then used to address the questions set forth by the researchers.

Results

The researchers were persistent in acquiring the data from each of the identified schools (*N* = 57). This persistence paid off in that all responses were received from all of the schools.

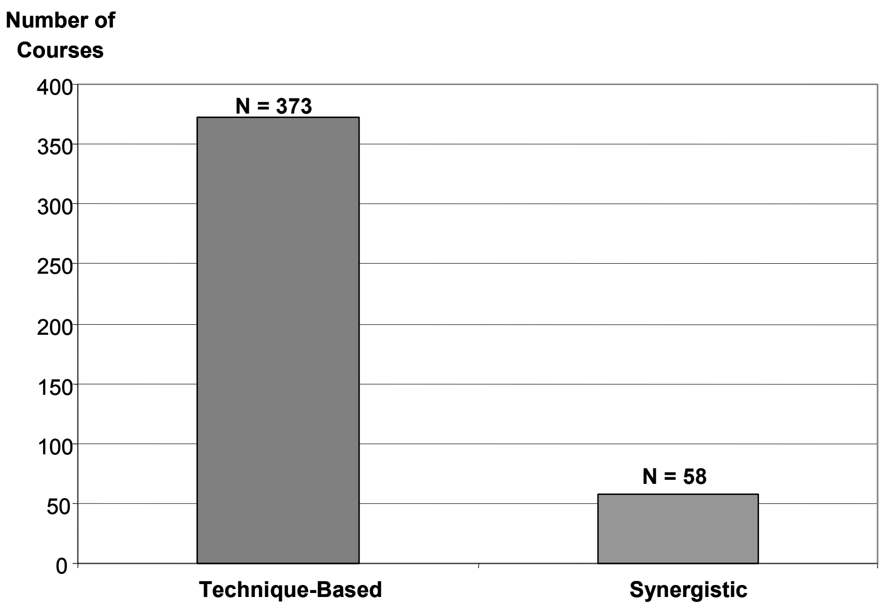

Figure 1. Comparison of technique-based to synergistic design courses.

The research determined that there were 431 courses focused on the study of design at the 57 programs examined. The breakdown of the courses into their respective categories was 373 technique-based courses and 58 synergistic courses (see Figure 1). The average was 7.6 courses per program that focused on the study of design. The statistical outliers of this particular measure had one school with 21 design courses and two programs with just one such class (see Figure 2). The required courses numbered 140 technique-based and 35 synergistic-oriented (see Figure 3). Only 38% of all technique-based courses were identified as required toward graduation, whereas 60% of the synergistic courses were identified as required for the completion of the degree (see Figure 4). The nationwide ratio of technique-based courses to synergistic courses was a little more than six to one. However, some programs were notable in the extremes of their class ratio. One extreme had several schools with a large number of technique-based courses and few or no synergistic courses. A specific example had 15 technique-based courses and no synergistic courses. Several other schools had similar ratios. At the other extreme, a few schools had a large number of synergistic courses. The most notable example had six synergistic courses and no specific technique-based courses.

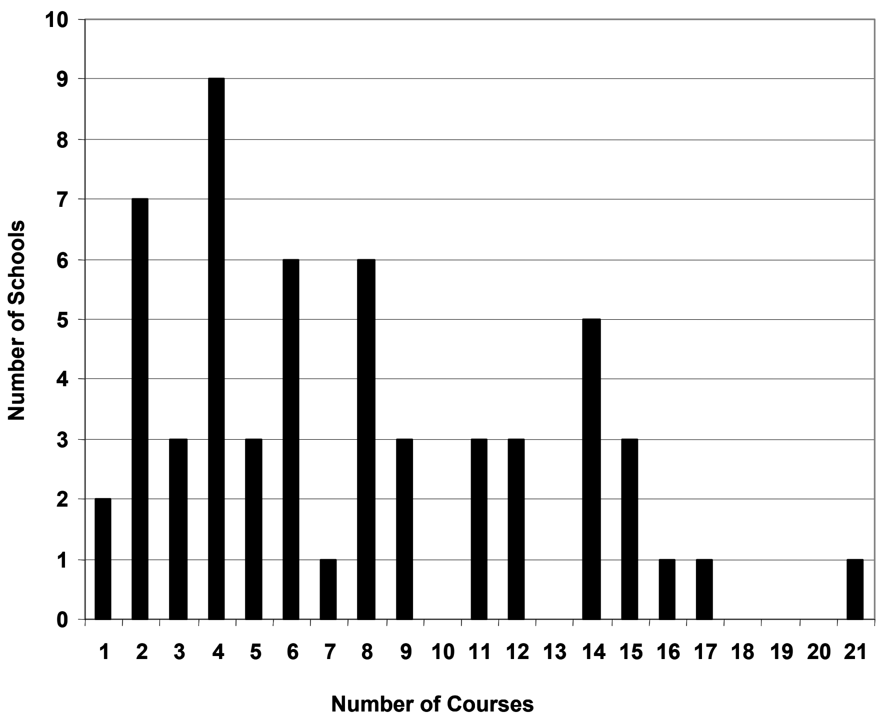

Figure 2. Distribution of design courses among the programs studied ($N = 57$).

The titles of the more popular courses in each of the two categories are reported in Table 1. Not surprisingly, the most popular technique-based course title, with 79 courses, was Computer Aided Drafting (CAD), or some variation associated with the use of computers in drafting and design. Other popular titles for technique-based courses focused on Architectural Drafting and Design, Engineering Graphics, variations on Graphic Communication, and Technical Drafting. As might be expected, the titles of the synergistic courses were more reflective of a broader approach to the study of design. Courses with the title of Industrial Design were by far the most common. There were ten such courses with that title. Other popular class titles included things such as Product Design, Research and Experimentation, and Design and Technology.

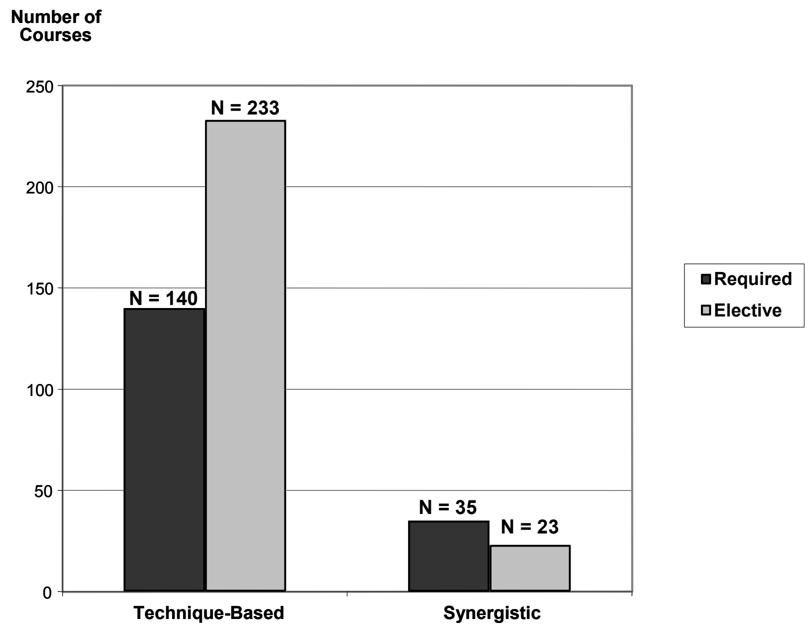

Figure 3. Comparison of required versus elective design courses by course type.

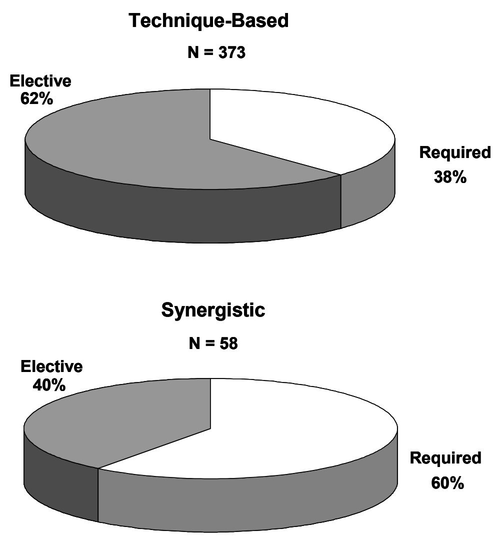

Figure 4. Percentage comparison of required versus elective design courses by course type.

Though several schools specifically required or recommended that certain courses be taken in a study of design course sequence, the researchers were not able to ascertain a consistent nationwide pattern on this matter. A possible reason for this might include how schools administratively organize their curriculum (i.e., processes, systems, clusters, etc.). Another explanation may have been that materials that express such a course sequence were available to academic advisors and students at the colleges and universities, but were not readily available through other public forums.

Table 1
The Most Popular Course Titles for the Study of design

Technique-based		Synergistic	
Course Title	***n***	**Course Title**	***n***
Computer Aided Drafting	79	Industrial Design	10
Technical Drafting/ Drawing	34	Design and Technology	9
Architectural Drafting and Design	29	Product Design	8
Engineering Graphics	14	Research and Experimentation	7
Graphic Communications	8	Design Problems/Problem Solving	7

The material examined for this research provided no indication as to whether any of the courses were specifically organized to address the design components of the *Standards*. A possible explanation for the lack of evidence on this matter is that the *Standards* were less than three years old when the data were collected, and thus, such changes were only just beginning to be made. Also, specific references to the *Standards* as an organizing force for a class may have been imbedded in the less public course material, such as the course syllabus and activities list.

An examination of the geographic distribution of technique-based and synergistic courses simply reflected the distribution of technology teacher education programs (see Figure 5). The researchers thought that there might be a geographic pattern to the way that design-related courses were distributed, perhaps reflecting regional differences in the interpretation of design as a component of technology teacher education or influences by government agencies, school programs, and groups or individuals toward that interpretation. However, the distribution of the two types of courses appears to be entirely random.

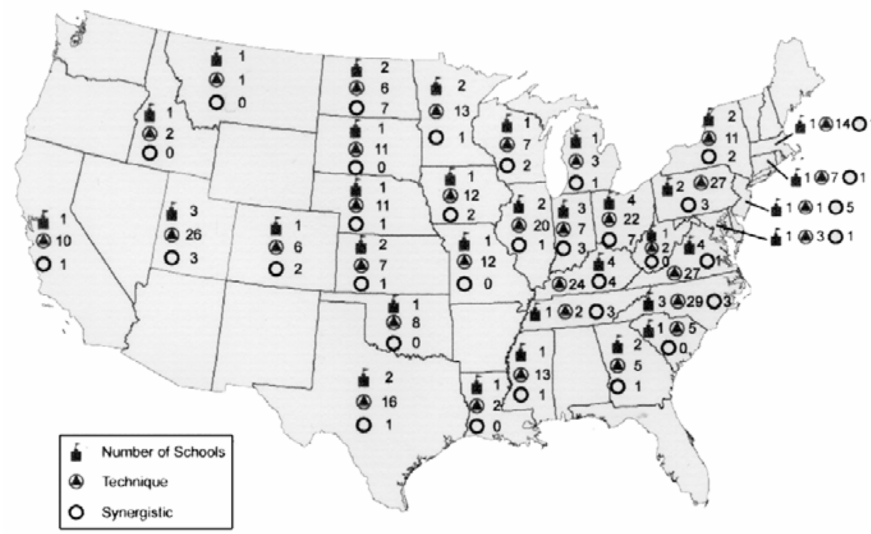

Figure 5. Geographic distribution, by state, of design courses among teacher education programs.

Conclusions

Since this was only an observational study, there was no determination of the benefits or the drawbacks of either type of class, and there was no determination of an ideal ratio between the two types of courses. However, the current status of the study of design in the curriculum content experienced by pre-service technology teachers during their undergraduate studies indicates a profession that is deeply rooted in the technical aspects of the design process. With the release and the subsequent acceptance of the *Standards* as a professional yardstick by which technological literacy can be measured, it could be expected that the content and organization of the courses for the study of design during the undergraduate experience will evolve to reflect a broader understanding of the influence of design toward the study of technology.

Recommendations

The lack of similar data in the literature prevented a comparison between the past and the present. However, future research could be done to measure the type and amount of change that has occurred since these data were collected. This information will be helpful in tracking the changes made by the undergraduate technology teacher education programs as they make adjustments in their curricula to reflect the technological literacy goals and objectives of the *Standards*. In-depth research could also be done on the specific content of both types of courses to determine how they relate to the goals and objectives of the *Standards.* Finally, research could also be done to identify an ideal ratio of technique-based and synergistic courses in an undergraduate curriculum. As stated previously, this study was intended to be the first in a series of investigations into the nature and status of the study of design in technology teacher education. During the next several years, the researchers will be initiating studies into these and other questions on this subject using this study as a foundation upon which to build.

University administrators and faculty have a responsibility to provide their students with an educational experience that prepares them for long and successful careers as technology educators. The findings of this research should serve as one piece of the puzzle in determining how they can meet that responsibility.

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