

Chapter 3

Methods

Introduction

To address the research questions proposed in chapter 1 of this dissertation, a survey instrument was developed. The process of developing a useful survey instrument involved identifying the target population and selecting a sample, and determining appropriate statistical methods for analyzing the data. Once these were accomplished, a pilot study was conducted to assess the adequacy of the instrument. Subsequent to completing the pilot study, minor modifications were made to the survey instrument, after which, the full study was conducted. After receiving the responses and entering the data, the complete data set was analyzed. The essential components of these processes, the intentions and methods of achieving those intentions, are examined in this chapter.

Theoretical Underpinnings of the Survey Instrument

The development of the survey instrument began with the assumption that primary and secondary public school teachers of technology education ultimately define the technology education curriculum. A corollary to this was the premise that public school technology teachers' philosophical approach to technology education curriculum development is, in part, derived from the philosophical approach espoused or exhibited by the technology education

professors whose classes they took when pursuing their undergraduate or graduate degree. Therefore, faculty members of technology teacher education programs throughout the United States were surveyed.

Because various members of the technology education and industrial arts communities have expressed differing opinions with respect to a general education or preparation for industry focus, and because college and university departments have exemplified these differences, two fundamental steps were undertaken in attempting to differentiate one approach from the other. First, after a review of literature, general education was operationally defined as “the full development of the human personality”. Second, the Spheres of Influence model which allows technology to be reviewed in the context of the whole person was developed. By operationally defining general education and devising a model which encompasses all human interaction with technology it became possible to investigate a systematic approach to the allocation of the technology education curriculum content in a way that was responsive to general education constraints.

Selection of the Sample

The sample was drawn from the *Industrial Teacher Education Directory* (ITED) 1996-97 35th Edition. The following steps were used to identify the pool of respondents. Each university or college listing in the ITED was examined to ascertain whether they met the following criteria: 1) Degrees were granted to undergraduates in a teacher education program during the fiscal year July 1,

1995 to June 30, 1996. 2) The teacher education programs were identified by the following titles: Industrial Arts, Technology Education, Technology, Industrial Education, or Industrial Technology. Using these criteria 106 programs were identified.

Once the programs were identified, respondents were selected using the following methods. 1) If one or more of the faculty members was identified as specializing in construction, the name of that person or those persons were not included during the next step in the selection process. 2) The names of faculty who were not listed as specializing in construction were assigned a number starting with 1 at the top of the list and then counting down (see Table 3).

Table 4. Example of the First Stage of Participant Selection

1		Jones, F.		Manufacturing
		Smith, J.		Construction
2		Miller, A		Communication
3		Johnson, M.		Transportation

After completing the process of assigning numbers, Lotus 123 was used to randomly select the participant. The Lotus computer spreadsheet *@Rand* function generates a random number from 0 to 1. The randomly generated number was multiplied times the number of possible respondents and then .5 was added in order to avoid the possibility of the result being 0. To demonstrate, there are 3 possible candidates shown in Table 4. If, for example,

Lotus @Rand presented the number .573, the calculation would look like, $(.573 \times 3) + .5 = 2.219$. By rounding to 0 decimal points, #2 Professor Miller would be selected.

In cases where more than one faculty member was identified as specializing in construction, the process described above was applied to the list of construction specialists. If the department had only one faculty member who specialized in construction then that person was selected. If no faculty member was identified in the Industrial Teacher Education Directory it was necessary to call the department and inquire. The purpose of separating the faculty who specialized in construction from the non-construction oriented faculty was, whenever possible, to survey one faculty member from each department who specialized in construction, and one who specialized in some other area. This was done in order to collect data about the status of construction in technology teacher education programs throughout the United States. In those departments where no one specializing in construction could be identified, one survey was mailed to the randomly selected faculty member.

The initial plan involved soliciting respondent participation via e-mail. This process was carried out during the pilot study and for a short time during the first stages of the full study. While using e-mail worked fairly well with the pilot study respondents, the response at the beginning of the full study was often slow and in many cases nonexistent.

When this method was employed, e-mail addresses for the respondents were obtained in from the ITED list, or by calling the department and requesting

the e-mail address. During the phone call to the department, the following information was also requested: 1) Verification that the faculty members selected were currently active members of the department. 2) Verification of the published area of specialization. 3) If a respondent would not be available to receive a survey, information was requested about the person whose name appeared next on the list. 4) If no person was listed as specializing in construction, department personnel were asked if construction was offered and if so who was the faculty member teaching the course. If a faculty member was teaching construction, his/her name and e-mail address was requested.

Request for Participation and Mailing Procedure

When a respondent's e-mail address was obtained, a letter requesting their participation was sent to them via e-mail. After receiving a reply affirming their willingness to participate, a survey was mailed to them.

Non-Response Follow-up to E-Mail Request to Participate

If no response to the initial request was received within a week, a follow-up request was sent by e-mail. The follow-up e-mail requested participation or an indication that participation would not be possible. Those who replied and expressed a willingness to participate were sent a survey. Those who replied and expressed either an inability or unwillingness to participate were considered to be non-responses.

As was mentioned previously, initial contact by e-mail worked only to a limited degree. Since time was limited, and the level of response was unacceptable, all surveys were mailed out after pursuing this approach for approximately two weeks.

Section 1 of the Instrument

Section 1 of the survey asked the respondents to evaluate their own qualification to teach any of 10 listed study areas. The areas were obtained from the November 8, 1995 draft of the *Technology For All Americans: A Rational and Structure for the Study of Technology*, made available on the Internet in December of 1995. These study areas were designated as “technological utilization systems” (p. 22) and were listed as follows: manufacturing, construction, transportation, communication, health & medicine, agriculture, energy, recreation & entertainment, education, and military (p. 22). In the survey they were listed alphabetically to minimize the possibility of introducing bias. Respondents were asked to rank their qualification to teach each study area using a 3 point Likert-type scale which offered the following classifications: 1 = highly qualified, 2 = qualified, 3 = not qualified. This information was collected as a possible control measure in the event that extreme variances in scores might be the result of an overabundance of construction respondents.

Section 2 of the Instrument

Section 2 consisted of 13 statements which the respondents were asked to rate in terms of their importance as educational objectives for kindergarten through 12th grade (K-12) technology education programs. A 4 point Likert-type scale was used and the scale extended from 1 which represented Very Important to 4 which represented Not Important. The statements were selected with the intent of devising a range with a general education emphasis on one end of the spectrum and a preparation for industry emphasis at the other extreme. The statements were, to a large extent, taken from existing sources and paraphrased to a limited degree. For example, the first word in each statement was the verb *develop*. This was done in order to minimize bias that might occur related to sentence structure or semantic emphasis.

The operational definition of general education, “the full development of the human personality,” (Piaget, 1973, p. 41) was selected for its broad non-disciplinary explanation of the concept. Next, a list of characteristics which defined “technological competence” (p. 9) or technological literacy, were derived from the November 8, 1995 draft of the *Technology For All Americans: A Rational and Structure for the Study of Technology*, made available on the Internet in December of 1995. They were as follows:

- Understand and appreciate the importance of fundamental technological developments
- Understand and assess the issues and outcomes of technological activities.

- Appreciate the interrelationships among technology, cultures, the environment, and other human endeavors.
- Know and appreciate how human ingenuity and resources combine to meet human needs and wants.
- Apply practical problem-solving/design techniques through a creative process.
- Understand the necessity of lifelong technological learning in order to adapt to changing technological careers and environments.
- Use and understand technological devices, processes, and systems. (p. 9)

The “Purposes of Industrial Arts” (p. 15) used in the Standards Project as reported by Bame and Miller (1980) was reviewed as a possible source of additional goal statements. A comparison of these purposes with the “characteristics of technological competence” (Technology for All Americans Project (TAAP), 1995, p. 9) identified in the preceding paragraph revealed similarities and differences. For example, “Use and understand technological devices, processes, and systems” (TAAP, 1995, p. 9) seemed to address some of the same issues as the “Skills in tools and machines” (Bame & Miller, 1980, p. 15) which was derived from the Standards Project. Although certain differences existed, because of the potential for overlap both were not used in Section 2 of this survey. Further, because the Standards Project survey collected much the same information as the study done by Schmidt and Pelly in

1966, and because both research efforts found that the respondents “placed the greater degree of emphasis on ‘developing in each student a measure of skill in the use of common tools and machines’” (p. 17), a statement more closely resembling the one found in the Standards Project survey was used.

Other aspects of the Standards Project survey also contributed to the creation of this instrument. Several “purposes” were linked to industrial preparation or vocational training. Such statements as: “Make informed educational-occupational choices”, “Provide pre-vocational experiences”, and “Provide pre-vocational training”, and to a lesser degree, “Provide technical knowledge and skill”, (p. 15) were considered when developing the statements which were slanted toward preparation for industry. Starting from the top of Section 2 and working towards the bottom of the page, items 5, 6, 9, and 11 incorporated Standards Project vocational or preparation for industry concepts.

Although, “Understand and appreciate the importance of fundamental technological developments” and “Know and appreciate how human ingenuity and resources combine to meet human needs and wants” (TAAP, 1995, p. 9) seemed to include some consumer related aspects, the first suggests appreciation of the history of technology and the second seems to point more towards appreciation of the functional aspect of technology. On the other hand, “Develop consumer knowledge and appreciation”, and “Develop worthy leisure time activities” (Bame & Miller, 1980, p. 15), taken from the Standards Project, link the knowledge about technology and the benefits of using it more directly to

people. Even so, some areas of commonality seemed to exist, and since the two statements from the Technology for All Americans Project were included in the instrument, another statement was devised with the idea of incorporating both consumer and leisure aspects through aesthetics. This newly developed statement is found fourth from the top of Section 2 and reads “Develop an appreciation for product design and quality” (see Appendix A).

Section 3 of the Instrument

This section asked the respondents to evaluate the relative importance of 10 “technological utilization systems” which, for this research, were considered to be possible study areas or curriculum organizers. This assignment of the relative importance was to be done while considering the organizers in relation to each of the three spheres of interaction which were described in chapter 2 (see Figure 2). These were the same organizers that were listed in Section 1 of the survey instrument. In this section they were listed in alphabetical order. The organizers were arranged in rows. The Civic Life Sphere, the Personal-Life Sphere, and the Work-Life Sphere were each assigned to a column. The respondents were asked to fill in each column completely with a digital number from 0 to 4. A rating of not important or non-essential was represented by a 0, and on the other end of the continuum 4 represented very important or essential. The respondents were asked to consider the importance of these organizers in the context of a broad based K-12 technology curriculum. In the paragraph which explained how to fill out this portion of the instrument, the

phrase “ ‘use of technology’ study areas” was used. These words were selected to minimize the potential for bias since some of the listed technological systems such as, manufacturing, construction, communication, and transportation have traditionally been linked to the word “organizers”

This rating system was designed to accomplish several objectives. First, a rank ordering within each column was desired. Second, it was desirable to learn whether the rank order changed across the three columns. Third because a ratio scale of measurement was used it was possible to convert the values provided by the respondents to percentages. This made it possible to compare the percentage attributed to construction in this section of the instrument with the actual percentage of the curriculum required of teacher education majors as identified in section 7 of this instrument.

Prior to conducting the pilot study of this instrument, a pre-pilot study was conducted in a graduate seminar at Virginia Polytechnic Institute and State University. The students and the professor were asked to complete an earlier draft of this instrument and comment on it. In that draft of this instrument the appearance of Section 3 was quite similar to the final draft, but the respondents were asked to provide percentages instead of numbers ranging from 0 to 4. Feedback from the pre-pilot study group indicated that filling in the percentages was too time consuming due to the need to total each column to 100%. In addition, there was a tendency for the respondents to add across columns which provided data that was not requested and, therefore, was meaningless for this research. Other comments made by the pre pilot study group regarding

graphic presentation were also considered in the redesign of the instrument.

Because the intention of the pre-pilot study was to improve the instrument and because the respondents were not from the same population as the actual study, the results of the pre-pilot study were not used in this research.

Section 4 of the Instrument

Section 4 asked the respondents to indicate what percentage of a broad-based K-12 technology program should be allocated to each of the three spheres of human/technology interaction. In Section 4, the respondents assigned percentages of the curriculum to each sphere. By integrating this data with the information gathered in Section 3, the 3 spheres and organizers could be viewed as a comprehensive whole.

Section 5 of the Instrument

Section 5 asked the respondents to indicate the number of undergraduates in a formalized teacher preparation program and the number participating in a non-teacher preparation program. This information was collected in order to provide descriptive information about the status of technology teacher education programs.

Section 6 of the Instrument

Section 6 asked the respondents to choose one of three statements which best described their viewpoint with regard to the general education vs.

preparation for industry approaches to technology education. The first statement represented a broad-based technological literacy point of view which de-emphasized. The second statement represented an approach which could be identified with industrial technology education in that it favored a balance of employment and technological literacy. The third statement represented a vocational point of view in that employment was clearly emphasized. This section was created as a cross check in the event that the responses given in Section 2 appeared to be reversed.

Differences in the Instruments Sent to Construction Specialists Versus Non-Construction Specialists

Those respondents who were not specialists in the area of construction were sent surveys that included sections 1 through 6 (see Appendix A). The respondents who specialized in construction were sent surveys that contained section 1 through 6 plus sections 7 through 11, or the entire instrument. Construction specialists were asked to complete these additional sections which addressed issues specific to construction course work. The respondents were asked to consider their answers for these sections as they related to teacher education majors.

Section 7 of the Instrument

Section 7 asked the respondents to estimate the percentage of formal instructional contact hours devoted to course work in construction when

considering the total number of required formal instructional contact hours in technical subjects. This information was gathered to allow for a comparison of the percentage reported against the percentage suggested by the relative importance attributed to construction in Section 3.

Section 8 of the Instrument

Section 8 asked the respondents to indicate whether construction was offered as an individual course, part of another course, offered both of the ways just mentioned, or not offered. If it was offered, the respondent was asked to indicate whether it was a required subject, an elective, or both.

Section 9 of the Instrument

Section 9 asked the respondent to identify the instructional methods employed in construction classes and estimate the percentage of the instruction devoted to each method. The categories listed were: classroom lecture/discussion, model fabrication - lab experience, computer simulation - lab experience, full-scale fabrication - lab experience, actual site experience, and other.

Section 10 of the Instrument

Section 10 asked the respondent to identify the approximate percentage of the construction curriculum focused on residential construction, commercial/industrial construction, and infrastructure related instruction.

Section 11 of the Instrument

Section 11 asked the respondents to identify the degree of content orientation versus process orientation by indicating a point on a continuum from 1 to 10. The scale was structured such that 1 represented a complete content orientation focus, while a 10 represented a complete process orientation focus. This question was intended to reveal whether construction specialists in technology education tend to seek a balanced approach, a compromise between content and process as LaPorte (1994) suggested was possible, or do they tend towards the content approach “because of its [construction’s] narrow, trade-based heritage” (p. 203).

The Pilot Study

A pilot study was undertaken to determine the adequacy of the survey instrument. The steps outlined earlier in this chapter under the heading “Selection of the Sample” were adhered to with the following exceptions:

- The *Industrial Teacher Education Directory*, 1995-1996 34th Edition was used because the 1996-1997 35th Edition was not available.
- One Hundred and thirty three universities or colleges were identified as members of the research population, but some *trade and industry* programs were inadvertently included.
- Thirty three programs, or approximately 25% of the 133 were randomly selected.

- An effort was made to obtain e-mail addresses all of the potential respondents. Some were available from a pre publication list produced by the editor of the *Industrial Teacher Education Directory* 1996-97. This list, however, was not comprehensive. Therefore, the Internet was used to search the directories of university and college home pages. Many of these searches were successful but not all. In cases where the above approaches proved unsuccessful, the addresses were requested over the telephone. However, on occasion the person answering the phone did not know the e-mail address or have access to it, and some voice-mail messages were not returned. Combined, these efforts provided e-mail access to faculty members in 25 of the 33 randomly selected programs. Due to the length of time involved in searching for e-mail addresses, telephone calls to each department were used as the first step rather than the last resort for the remainder of the study.

Pilot Study Response

Surveys were only mailed to respondents who responded affirmatively to the e-mail request to participate. Nevertheless, of the 23 surveys mailed 18 were returned. One of the 18 was incomplete and therefore was not used.

Pilot Study Data Entry

The data collected through the pilot study was coded and entered into *Lotus 123 Spreadsheet for Windows Release 5.0* (Lotus 123). The data was then imported into *Number Cruncher Version 5.03*.

Pilot Study Summary

No significant defects in the instrument were identified as a result of the pilot study. Three comments were received regarding Section 3. One respondent did not complete the section and wrote “I disagree with these as areas of study. They are too regional, etc., too limited. Some or all of them could provide contexts for the study of materials & processes, energy, information, historical impacts issues, systems, design processes, etc.” Another respondent wrote, “not too easy” with an arrow pointing towards the portion that needed to be filled in. The third respondent wrote “confusing” to the right of the instructions for this section.

In response to these comments, the following observations were made. Materials and processes, energy, information, issues related to historical impacts, systems, and design processes could also be considered aspects of each of the study areas offered as choices in this survey. This is not to say that the comment was meaningless but rather that there are a number of valid ways to organize the technology education curriculum. With regard to the other two comments which indicated some difficulty in comprehending and completing the task, the fact is the respondents did successfully complete the section.

Unfortunately, the comments “not too easy” and “confusing” did not point to any specific weaknesses or ways for making improvements. Although no alterations were made in response to these comments, three potential reasons for the difficulty or confusion were acknowledged. First, although the civic, personal, and work related aspects of technology are not uncommon in the literature of the industrial arts and technology education, the Spheres of Influence model was created during the process of developing this dissertation, and therefore, may have seemed unfamiliar to the respondents. Second, if conscientiously undertaken, the task of evaluating the relative importance of curriculum organizers is not one that can be performed in a few seconds. Third, the 10 study areas or organizers found in Section 3 included at least six more areas than Manufacturing, Construction, Transportation and Communication which received widespread acceptance following the publication of the *Jackson's Mill Industrial Arts Curriculum Theory* in 1981.

Overall Response Rate

The response rate for the entire study was 77.03%. One hundred forty eight surveys were mailed and one hundred and fourteen were returned prior to beginning the data analysis. Of the 148 surveys, 98 went to non-construction faculty and 50 went to faculty who teach construction. Respondents from the pilot study were included. Non-respondents from the pilot study were re-contacted and their participation was requested again. If they could not be

reached, a new respondent was randomly selected. More information related to the response rate is presented in Chapter 4.

Follow-up on Non Respondents

Approximately two weeks after the full study was implemented, an effort was made to contact those persons who had not responded. The first step in this process involved sending a fax requesting that the surveys be completed and returned. If that failed to produce results, a series of phone calls was made. If the person was not available by the phone or if they did not return calls, the department chair was contacted in order to determine if the person was on campus, or if they were the appropriate person to have sent the survey to. In a number of cases, particularly in large programs with a strong industrial focus, the random selection process resulted in faculty being selected who had little or no connection with technology teacher education. In those cases, the department chair was asked to recommend faculty who might be appropriate and available to complete the survey. Those faculty were called and their participation requested. The same procedure was followed for faculty who were not on campus.

Software Used in the Data Analysis

Three software packages were used for the data analysis of this dissertation. *Lotus 123 Spreadsheet for Windows Release 5.0* was used as the initial system for data entry. Conversion of the raw data in Section 3 to

percentages was also performed in Lotus 123 using simple spreadsheet functions.

Both descriptive and inferential statistical operations were performed with *Number Cruncher Statistical System Version 5.03*, the add-in package titled *Number Cruncher Statistical System Product 5.3 Advanced Statistics*.

Medoid Cluster Analysis

Everitt (1974) wrote that cluster analysis is the term most commonly used “for techniques which seek to separate data into constituent groups. Such techniques are generally used for the grouping of objects or individuals under investigation.” (p. 1). According to Hintze (1992) “Medoid clustering is a partitioning technique which seeks to find clusters with high similarity between objects within a cluster and high dissimilarity between objects in different clusters” (p. 237).

The intent of Section 2 of the instrument was to determine the respondents' tendency toward a general education focus or toward a preparation for industry focus. As was discussed previously, the 13 statements included in that section were written so as to make that possible. However, until the data was collected and evaluated, the idea that the statements represented two ends of a continuum and that variance in the population would result in two distinct groups was only a theory. Medoid cluster analysis was used to statistically sort respondents into clusters and to determine the number of clusters.

Using this method, groups or clusters are defined by “a partitioning algorithm which minimizes an objective function using exchange operations. That is, at each step in the iteration process, rows are switched from one cluster to another in such a way that the objective function is decreased” (p.238). This process continues until the objective function cannot be reduced further by exchanging rows. Number Cruncher allows the user to input a range of clusters in order to evaluate what number of clusters provides the optimal fit for the data. This evaluation is performed by reviewing the *Iteration Status Report* which shows the various iterations of the objective function for each variation in the number of clusters. In addition this report provides a summary section, wherein the optimal objective function value for each variation in the number of clusters is reported. The suggested method for selecting the number of clusters is “to choose the number after which the objective function seems to quit decreasing at a rapid rate” (p. 247). A two cluster model was selected for the pilot study. However, when the data from all 114 surveys was used, a three cluster model offered the best fit. Figure 3, found in Chapter 4 provides a sample graph that shows the decrease in the objective function.

Number Cruncher produces a Cluster Report which identifies the case or respondent associated with a certain cluster. This information provided the means for creating the dummy variables that were used with discriminant analysis which was recommended for analyzing “the appropriateness of the cluster configuration” (p. 237). Table 5 is an example of the cluster report taken from the pilot study.

Table 5. Pilot Study Cluster Report

Cluster Report For - 2 Clusters		
Cluster	1:	5,9,11,12,13,15,16,17
Cluster	2:	1,2,3,4,6,7,8,10,14

Creating Dummy Variables to Represent Respondent Assignment to a Cluster

Using the information obtained from the Cluster Report, respondents were assigned to a cluster through the use of dummy variables. This was accomplished by creating an additional variable column alongside the existing data in the Lotus 123 spreadsheet. Within this column a 1 was entered in the cells corresponding to the respondents who were defined as members of cluster 1 and a 2 was entered in the cells corresponding to the respondents who were defined as members of cluster 2. When this process was complete, the spreadsheet was saved and the data were uploaded to Number Cruncher.

Discriminant Analysis

“Discriminant analysis begins with the desire to statistically distinguish between two or more groups of cases” (Klecka, 1975, p. 435). “To distinguish between the groups the researcher selects a collection of discriminating variables that measure characteristics on which the groups are expected to differ” (p. 435). For this research, the groups that were to be statistically distinguished were previously identified using medoid cluster analysis. The

dummy variables which represented assignment to one cluster or another became the dependent variable for the purpose of discriminant analysis. The statements in Section 2 of the survey instrument were the independent variables. Through discriminant analysis, the accuracy of the assignment to these groups or clusters and the characteristics or variables that were most “important for distinguishing among the groups” (Norusis, 1988, p. 73) were assessed. To enable the user to arrive at these conclusions, *Number Cruncher* produces several reports. Those found to be most informative for this study were the *Variable Influence Report* (Hintze, 1992, p. 91) and the *Canonical Variate Analysis Report* (pp. 97-98).

Interpreting the Variable Influence Report

The Variable Influence Report analyzes the influence of each of the independent variables on the discriminant analysis. The F-Probability (F-Prob) located under the “If Removed” heading was of primary interest. This statistic indicated the impact on the overall discriminant analysis if a variable were to be removed. Using this information, variables with the least probability of contributing to the explanatory power of the discriminant analysis were removed and then the discriminant analysis was repeated. This operation was continued until only those variables remaining were significant at the .05 level. Examples from the pilot study are presented in Tables 6 and 7.

Table 6. Variable Influence Report from the Pilot Study: All Variables

Variable	If Removed				If Alone				
	Lambda	F-Value	F-Prob		Lambda	F-Value	F-Prob	R2-X's	Mean
1	0.089	3.410	0.374		0.770	1.300	0.318	0.531	1.529
2	0.015	22.500	0.154		0.444	5.430	0.012	0.743	2.353
3	0.035	9.280	0.236		0.654	2.290	0.126	0.742	1.235
4	0.017	19.750	0.164		0.817	0.970	0.436	0.833	1.706
5	0.032	10.070	0.227		0.356	7.840	0.003	0.924	2.118
6	0.046	6.980	0.270		0.782	1.210	0.345	0.912	1.706
7	0.048	6.600	0.277		0.567	3.310	0.054	0.861	1.765
8	0.880	0.050	0.982		0.908	0.440	0.728	0.915	1.941
9	0.554	0.270	0.851		0.850	0.760	0.534	0.905	2.588
10	0.067	4.640	0.326		0.754	1.410	0.283	0.699	1.647
11	0.062	5.060	0.313		0.778	1.240	0.336	0.640	2.824
12	0.036	8.960	0.240		0.797	1.100	0.383	0.929	1.059
13	0.570	0.250	0.860		0.660	2.240	0.133	0.725	1.353

Table 7. Variable Influence Report from the Pilot Study: After Removal of Variables 4, 5, 6, 8, & 13

Variable	If Removed				If Alone				
	Lambda	F-Value	F-Prob		Lambda	F-Value	F-Prob	R2-X's	Mean
1	0.494	9.220	0.014		0.711	6.110	0.026	0.342	1.529
2	0.576	6.640	0.030		0.980	0.310	0.585	0.452	2.353
3	0.629	5.310	0.047		0.654	7.940	0.013	0.520	1.235
7	0.543	7.590	0.022		0.813	3.440	0.083	0.560	1.765
9	0.415	12.660	0.006		0.730	5.550	0.033	0.357	2.588
11	0.591	6.230	0.034		0.993	0.100	0.758	0.318	2.824
12	0.570	6.780	0.029		0.930	1.130	0.304	0.463	1.059

A comparison of these two tables revealed that the elimination of variables 4, 5, 6, 8, and 13, which were not significant at a .05 level. By eliminating the non significant variables and concentrating on those that were discriminating at a .05 significance level, a more precise interpretation of the groups became possible.

Interpreting the Canonical Variate Analysis Report

“This report provides a canonical correlation analysis of the discriminant problem” (Hinze, 1992, p. 97). “The canonical correlation is a measure of the degree of association between the discriminant scores and the groups” (Norusis, 1988, p. 89). The portions of this report to which close attention was paid were the canonical correlation² (Canon Corr²), the significance of the F-test (Prob>F), and Wilks’ Lambda. Regarding the canonical correlation² Hintze (1992) wrote that “this is similar to R² in multiple regression” (p. 97). In other words, it is an expression of the proportion of variance in the dependent variable accounted for by the independent variables (Pedhazur, 1982, p. 46). Tables 8 and 9, are samples of the Canonical Variate Analysis Reports that were generated for the pilot study along with the previously presented Variable Influence Reports. As the extraneous variables were removed, limited change occurred in the in the canonical correlation². At the same time, the likelihood of identifying truly discriminating variables and meaningful relationships between them increased.

In this example the null hypothesis was: the mean of group 1 equaled the mean of group 2 with respect to the variables under investigation. Considering the information presented in Tables 7 and 9, the null hypothesis would be rejected and the variables identified in Table 7 would be considered significantly discriminating at a .05 level. Wilks’ Lambda as shown in the following tables represents the proportion of the total variance not accounted for by differences among groups (Norusis, 1988, p. 90).

Table 8. Canonical Variate Analysis Report from the Pilot Study: All Variables

	Inv(W)B	Indvl	Total	Canon	Canon		Num	Den		Wilks'
Fn	Eigenvalue	Prcnt	Prcnt	Corr	Corr2	F-Value	DF	DF	Prob>F	Lambda
1	43.85339	100	100	0.98879	0.97771	10.1	13	3	0.0407	0.022295

Table 9. Canonical Variate Analysis Report from the Pilot Study: After Removal of Variables 4, 5, 6, 8, &13

	Inv(W)B	Indvl	Total	Canon	Canon		Num	Den		Wilks'
Fn	Eigenvalue	Prcnt	Prcnt	Corr	Corr2	F-Value	DF	DF	Prob>F	Lambda
1	11.49219	100	100	0.95914	0.91995	14.8	7	9	0.0003	0.08005

Through the process of identifying clusters using cluster analysis, and then discriminant analysis to determine which variables significantly discriminated between the clusters provided the means for addressing research problem 2 of this dissertation.

Calculating the Relative Importance of Construction

In response to research problem 1 the following steps were taken. First, the scores provided by the respondents in Section 3 of the survey were converted to percentages. This was accomplished by totaling their scores for the various curriculum organizers in the civic-life, personal-life and work-life columns. Using Lotus 123, the score for each cell was divided by the column total. This resulted in the scores being converted to percentages. Once the percentages were obtained, a mean percentage was calculated for each of the

human/technology spheres of interaction. In addition, an overall mean was obtained by summing the means of each sphere and then dividing by three. With this information it was possible to determine the relative rank of construction.

Testing for Differences Between the Clusters with Respect to the Relative Importance of Construction.

Since multiple t-tests were required in order to determine whether significant differences existed between the clusters with respect to the relative importance of construction, the critical values found in the Bonferroni tables were used to control the familywise error rate (Howell, 1992, p. 349). In the case of the pilot study, one cluster was identified as the general education cluster and the other cluster was identified as the preparation for industry cluster. Different clusters were identified in the final analysis. However, for the pilot study, the null hypotheses were as follows: 1) The mean of the general education group and the mean of the preparation for industry group were equal with respect to the relative importance they placed on construction in a civic-life context. 2) The mean of the general education group and the mean of the preparation for industry group were equal with respect to the relative importance they placed on construction in a personal-life. 3) The mean of the general education group and the mean of the preparation for industry group were equal with respect to the relative importance they placed on construction in a work-life contexts. 4) The mean of the general education group and the mean of the

preparation for industry group were equal with respect to the relative importance they placed on construction overall. The overall evaluation of construction was established by determining the mean of civic, personal, and work-life for each respondent. The information provided by testing these hypotheses provide the information necessary to respond to research question 4.

Testing for Differences Between the Clusters with Respect to the Relative Importance Attributed to Each of the Three Spheres of Human/Technology Interaction

Multiple t-tests were used to make comparisons between the clusters related to their allocation of curricular emphasis among the civic-life sphere, the personal-life sphere, and the work-life sphere. The Bonferonni tables were used to account for family-wise error. In the case of the pilot study, the null hypotheses were as follows: 1) The mean of the general education group and the preparation for industry group were equal with respect to the percentage of the curriculum they allocated to the civic-life sphere. 2) The mean of the general education group and the preparation for industry group were equal with respect to the percentage of the curriculum they allocated to the personal-life sphere. 3) The mean of the general education group and the preparation for industry group were equal with respect to the percentage of the curriculum they allocated to the work-life sphere. These tests were performed in response to research problem 3 of this dissertation.

Comparing Practice and Theory

In response to problem 5 of this dissertation, a t-test was conducted which compared the percentage of the technology education curriculum allocated by the respondents to construction with the percentage of required technical courses in a technology teacher education program accounted for by course work in construction. The null hypothesis was: the mean of percentage of construction allocated in an ideal K-12 curriculum equals the mean percentage of required technical course work accounted for by construction.

Descriptive Statistics

Descriptive statistics were generated with Number Cruncher for the purpose of determining various educational aspects of construction . The following statistics were calculated.

- The means percentage of technical subject formal instructional contact hours devoted to course work in construction.
- Frequencies and means related to the ways that construction course work is offered.
- The mean percentages of various instructional methods used in construction courses.
- The mean percentages of the construction curriculum centered around residential, commercial/industrial, and infrastructure aspects of construction.

- The maximum, minimum and mean score indicative of a content orientation versus process orientation in construction-related courses.

The information provided by these statistics addressed research question 6.