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A survey of elementary teachers' knowledge of manufacturing

Stephen Joe Sarver
Iowa State University

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A survey of elementary teachers' knowledge of manufacturing

by

Stephen Joe Sarver

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Industrial Education and Technology
(Industrial Vocational Technical Education)

Major Professor: John C. Dugger

Iowa State University
Ames, Iowa
1996
This is to certify that the Master's thesis of

Stephen Joe Sarver

has met the thesis requirements of Iowa State University

Signatures have been redacted for privacy
# TABLE OF CONTENTS

LIST OF TABLES v

CHAPTER I. INTRODUCTION 1
   Background of the Study 6
   Purpose of the Study 6
   Research Questions 7
   Assumptions of the Study 8
   Procedures of the Study 8

CHAPTER II. REVIEW OF LITERATURE 10

CHAPTER III. METHODOLOGY 17
   Population and Sample 17
   Survey Instrument 18
   Data Collection 19
   Data Analysis Methods 19

CHAPTER IV. RESEARCH RESULTS AND FINDINGS 21
   Introduction 21
   Demographic Variables 21
   Response Rates 26
   Research Questions 26
   Summary of Research Results 30

CHAPTER V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 32
   Summary 32
   Conclusions 37
   Recommendations 39

APPENDIX A. PANEL OF EXPERTS 40

APPENDIX B. PILOT TEST SURVEY 41

APPENDIX C. HUMAN SUBJECTS APPROVAL FORM 50

APPENDIX D. FINAL TEST SURVEY 51

APPENDIX E. COVER LETTER TO RESPONDENTS 59
LIST OF TABLES

Table 1. Respondents of the study by gender 22
Table 2. Respondents by grade level taught 23
Table 3. Experience level of respondents 24
Table 4. Respondents' area of expertise 24
Table 5. Education level of the respondents 25
Table 6. Type of institution from which respondents graduated 26
Table 7. Test questions answered correctly by all respondents 28
CHAPTER I. INTRODUCTION

Our lives today are becoming more and more influenced and controlled by the applications of technology at every level of society. Technology has created significantly and often times monumental advancements in improving our quality of life. Many of these advancements were created from the need to improve the quality of the living conditions for humankind and, indirectly, the need for many of these advancements sustained a parallel manner of improving industrial processes. The lack of sufficient and substantial food supplies spurred technological developments and mechanization of the agricultural area. These technological advances in the agricultural area have virtually eliminated or at least substantially reduced famine in many parts of the world.

Likewise, industry has used technology to replace tedious, time intensive, and hazardous jobs. The need to replace the tedious job of preparing cotton for the textile mill, gave birth to the cotton gin. This mechanical invention alone sparked the development of many power tools, machines, and industrial processes. The internal combustion engine and electricity were great advancements in providing cheap dependable power.

These developments freed industry from the bondage of being located near a water source for power and relieved man from being a slave to the less productive tools. These tools paved the way for mass production facilities that provided goods that were affordable by the general public. This raised the
standard of living and at the same time increased the time for leisure and recreational activities.

Many fields of industry have changed drastically over the past hundred years. Today's manufacturing processes have catapulted the individual craftsman shops of the colonial era into massive production facilities. These facilities with miles and miles of conveyors, carry the product from start to finish in a very orderly and systematic fashion. Many of these processes are so sophisticated that human contact with the product is very limited and often times used only for intervention. New production materials, processes, and high volume output have almost entirely eliminated the small craftsman shops, except for a few specialty shops.

Today manufacturing is the foundation of the United States economy. According to Parnell (1990):

Technology will be the driving force in the 1990s. It is creating millions of jobs, revitalizing older industries, and spawning entirely new fields. In the process many jobs will be eliminated, others will be radically altered, and new kinds of occupations will be born. The technology age will force decision makers to consider hard new policy choices. (p. 40)

Manufacturing sustains tens-of-millions of people in a continuous and stable work environment. In terms of monetary assets for the United States economy, “Twenty-five percent of U.S. GNP originates in services used as inputs by goods-producing industries” (Annual report of the President, 1983, p. 25).

Manufacturing also creates a massive “ripple effect” throughout the economy.
This spin off from manufacturing creates new entities for research and development, legal services and regulatory agencies, in addition to the underpinning of investment and banking institutions (Teegarden & Dugger, in press). The value of these adjuncts to manufacturing confirms the importance of manufacturing to the U.S. economy.

To move raw materials and manufactured goods to desired locations in a timely manner, the technological upgrading of manufacturing systems and procedures has forced the transportation industry to revolutionize its day-to-day business practices, procedures, and equipment. During the same time that technology improved manufacturing by leaps and bounds, transportation transcended from animal power, rail travel, automobiles, airplanes, through space travel and exploration. Technology has played a primary role in the development of these systems and technology has a continuing role in providing daily improvements in the speed, efficiency, and the safety of these production systems.

Similarly, technology has revolutionalized the communications system. Volumes of information can be analyzed and transmitted worldwide with the aid of computers, satellite communications, fiber-optics, and facsimiles. Complicated systems have been redesigned and redefined to provide easy operation by the average individual. This everyday exposure to technology has created a commonplace or nonchalant attitude about these technologies. An attitude which fosters little respect or appreciation for the history, development,
or the impact technology has made on society. According to the National Science Board Commission (1984), "A technologically literate person understands the historical role of technology in human development, the relationship between technological decisions and human values, the benefits and risks of choosing technologies, the changes occurring in current technology, and technology assessments as a method of influencing the choice of future technology" (p.22).

Children of today will soon be operating as adults in a society which is even more technologically-oriented than at the present. The single most distinctive characteristic that sets current and anticipated futures apart from previous eras of development is technology (Idaho State Dept. of Ed., Workforce, 1989). The thrust of technology has created many new challenges within our society.

Overcoming the complacency of just using technology with little regard for how or why technology functions is a challenge that is becoming more evident every day. In addition to improving man's station in life, the degree of sophistication, the rate of development, and the relative ease of access to these technologies has created many global concerns. The same technology that places a space craft in orbit or fuels a nuclear power plant can within moments completely obliterate vast areas of the earth's surface of all forms of life. Another such concern is the need for a universal attitude to insure the common good of mankind. Also there is the need to develop understanding and respect, which must be generated to insure appreciation of the benefits and
responsibilities of technology. Children are the hope of the future. Therefore, children must acquire an awareness of how different technologies impact one another and ultimately how they impact the survival of society. Where do people develop the understanding, skills, and attitudes to deal with forces such as technology? Clearly our society uses formal schooling as a principal method to this end—for children, and currently for an increasing number of adults. "Public education in a democratic society is responsible for providing all citizens the opportunity to become and remain occupationally competent" (Wenrich & Galloway, 1988, p. 7). This translates into a society that must be technologically literate, skilled, and appreciative of technology.

Over the past hundred years or so, industrial arts and its predecessor, manual arts, have done much to broaden and to clarify the understanding of industrial concepts through hands-on experiences at the secondary level. These experiences were an integral part of developing improved psychomotor skills and proper tool manipulation, promoting practical application of skills, and developing an appreciation for quality craftsmanship. Many general concepts were expanded by visits to manufacturing plants. However, with the increased sophistication of technology, more knowledge and awareness of these systems must be formally developed and presented at an earlier age. This development should extend from early childhood through post-secondary school (Wenrich & Galloway, 1988).
Some elementary schools have addressed technology by incorporating activities or packets of information into existing curriculum in areas of social studies, math, and science (Oregon State Dept. of Ed., 1986). Due to the lack of manufacturing technology curriculum at the elementary level, a situation has been created that may provide a piecemeal, disjointed, and fragmented presentation of information concerning technology.

**Background of the Study**

No research has been reported which describes the level of knowledge possessed by elementary teachers regarding industrial manufacturing concepts. Such a study could help determine the potential information about manufacturing concepts that may be taught in elementary classrooms.

**Purpose of the Study**

The purpose of this study was to measure Iowa elementary teacher knowledge in the area of manufacturing technology. This study provided a data base in an area where no research has been available.

Awareness of manufacturing technology by the general public has been through “news worthy” stories presented by the mass media. Formal study or schooling of manufacturing technology usually begins at the secondary level for a small percentage of students who take industrial education classes. Even a
smaller percentage of students pursues technology at the post-secondary level.

Due to the need for greater knowledge of manufacturing technology at an earlier age, a need existed for manufacturing technology curriculum at the elementary level, with teachers who are knowledgeable in this area.

This study attempts to identify the level of knowledge possessed by elementary teachers regarding manufacturing technology. The results of this study can be used to guide planners of elementary teacher pre-service and inservice programs.

**Research Questions**

The questions of concern were:

1. What is the elementary teacher’s level of knowledge concerning basic manufacturing technology terms and concepts?

2. How does the upper elementary, (fifth and sixth grade level), teacher’s knowledge concerning manufacturing technology terms and concepts compare with the lower elementary, (third and fourth grade level), teacher’s knowledge?

3. How does the level of teaching experience affect the knowledge level?

4. How does the level of education, Bachelor of Science versus Master of Science, affect the teacher’s knowledge of manufacturing technology terms and concepts?
5. Does gender affect the teacher's knowledge of manufacturing technology terms and concepts?

6. How do teachers graduating from small colleges compare to teachers graduating from major universities concerning knowledge level of manufacturing terms and concepts?

Assumptions of the Study

1. Measuring instrumentation was accurate, after calibration, and did in fact measure the characteristics for which it was designed.

2. South-central Iowa area elementary school teachers are representative of teachers in Iowa elementary schools.

3. Elementary teachers would accurately and honestly respond to the questionnaire.

Procedures of the Study

The study procedures consisted of the following procedures:

1. Formulation of the problem.

2. Review the related literature pertaining to elementary teachers' knowledge of manufacturing terms and concepts.

3. Identify the population/sample for the study.

4. Prepare a research proposal for the study.
5. Develop a list of terms and concepts pertaining to manufacturing technology.

6. Convene a panel of experts to validate manufacturing terms and concepts.

7. Use a pilot instrument to survey an Iowa State industrial technology class to refine the survey instrument.

8. Gather data via the instrument and survey a minimum of 50 Iowa elementary third through sixth grade teachers.

9. Analyze the data in descriptive terms through inferential statistics using the Statistical Package for the Social Sciences (SPSS-X) at Iowa State University.

10. Interpret findings.

11. Write the summary, conclusions, and recommendations.
CHAPTER II: REVIEW OF LITERATURE

In conducting this study, resources were sought through the ERIC System, thesis and doctoral dissertations, journals, other publications, and videotapes for information that was directly related to this subject. At the time of this study, no evidence could be found that indicated the existence of appreciable knowledge related to the knowledge level of elementary teachers concerning manufacturing. However there are related studies that deal with the effects of technology in industry.

It is human nature that leads people to continually improve their present situation. Consequently, technology is at the front of change to the point that technology cannot be separated from the day-to-day existence of people. Furthermore, nowhere is technology more evident than in industry. The technological changes in manufacturing processes and procedures are developing at an explosive rate. This creates the need for a more technologically literate and skilled work force. According to Daggett (1991), America is no longer "in the ballgame" when it comes to doing what is needed to prepare American youth for the jobs and lives of today and the future.

In addition, according to Daggett (1991), it requires more academic skills to enter the work force than it does to enter most colleges or universities. Kerr (1991) stated:
... the type of thinking encouraged by technology emphasizes a variety and a certain divergence in intellectual effort. It is a type of thought and action seldom fostered in schools, yet it may have more to do with economic well-being than the subjects that currently dominate the curriculum. (p. 6)

Thus, technology is dynamic, progressive, and seems to take on a life of its own. There is no turning the clock back to a less technological time. As a world culture, we will only become more technological and, at an increased rate that here-to-date has been unprecedented.

An increasingly technological society will create a class system, a stratum, or at the very least, a division between those of society who understand and can use the new technologies and those who are frustrated and intimidated by the new technologies. There must be a common ground from which to build a technologically functional society.

Let's begin by defining technology? Jackson's Mill Industrial Arts Curriculum (1981) defined technology as “the knowledge and study of human endeavors in creating and using tools, techniques, resources, and systems to manage human potential and the relationship of these to individual, society, and the civilization process” (p. 20). Savage and Sterry (1990), as quoted in the January 1993 issue of The Technology Teacher, interpreted technology as “a body of knowledge and actions used by people to apply resources in designing, producing, and using products, structures, and systems to extend human potential for controlling and modifying the natural and human made modified environment.”
Similarly, the United Nations Education, Scientific and Cultural Organization (1986) defined technology as “the know how and creative processes that may assist people to utilize tools, resources, and systems to solve problems and to enhance control over the natural and made environment in an endeavor to improve the human condition” (p. 1). Thus, technology is a process of creating and using tools and resources to improve man's control over his environment. Or technology is the sum of all human knowledge, used to transform resources for purposes of modifying the natural environment.

Technology in itself is not a new idea, process or paradigm. Technology started more than two million years ago when man first started making tools to improve his way of life. The rate and sophistication at which technology is being developed are the major obstacles that man faces today. Traditionally, technology was taught by master craftsmen to a few would be artisans. As processes were developed that increased man’s station in life, there became a need for educating the mass populace. This became particularly evident during the Industrial Revolution of the 1700s. Technology was taught by industry itself until “manual training” became a part of the educational system in the mid 1800s.

Due to the Industrial Revolution which continued into the 1900s, an almost meteoric development of industrial practices brought about by the “mass production” system created a need or void of worker entry level skills. To counter this need, Richards (1904) was one many who aligned manual training
practices with industrial practices and procedures. Hence, Richards coined the term "industrial arts" to describe the educational system's approach to filling the void of entry level worker skills.

As early as 1947, Dr. William E. Warner directed a conference entitled "A Curriculum to Reflect Technology" in an effort to recognize the need for technology to become an integral part of education, instead of an add-on. The generic "shop" curriculum no longer met the needs of industry. The nature of the workplace had changed. Thus, clearly, the nature of the workforce needed to change.

Parnell (1985), in The neglected majority, depicted an obligation for a major change in the educational system to address technological illiteracy. The American Association for the Advancement of Science's Project 2061 publication stated that an educated citizenry must make important decisions in a democratic society. Schools traditionally have been the method of choice to educate the people. According to Daiber, Littlesland, and Thode (1991), students must learn from technology, about technology, and with technology whenever appropriate.

Daggett (1991) noted: We in education, have traditionally been the slowest to react to change, but now are faced with the responsibility of educating students about the fastest changing aspect of our society, i.e., technology. While curriculum guides and course outlines identify problem solving as a teaching technique, relatively few teachers know how to use it.
Problem solving is highly effective when technology is used as a catalyst. There must be some place in the school where the student can put all the parts (academic disciplines) together in the context of reality and the world beyond the school. Technology education offers the best place to accomplish a coordinated curriculum, one that crosses all disciplines. The mere presence of a computer in the classroom is not a guarantee that it will be used effectively. The teacher plays the central role in the effectiveness of teaching technology. Many teachers will not tackle technology education if they lack the expertise. Leaving the comfort zone of having the knowledge in a certain content area for the zone of technology education, which has almost no clearly defined boundaries, is not very appealing to most teachers. Many teachers do not understand the hows and the whys of teaching technology. Personal fear about teaching technology increases with the lack of instructional support, lack of time, and the lack of any standardized system to measure the effectiveness of technology. Kerr (1991) asserted that there is little research available relating to how technology is conceived in teachers’ thoughts about their work, planning instructional activities, and classroom organization. In addition, there is always the question: At what level do we introduce technology?

The Mission 21 Kids and Technology Program, funded by NASA and developed by the technology education program at Virginia Polytechnic Institute and State University proposes that technology education begin at the elementary school level and extend as a well designed and articulated program
throughout the schooling experience. An extension of this approach is the science, technology, and society (STS) proponents that place technology at the core of the liberal arts curriculum. The STS movement places the study of technology squarely in the middle of the science and social studies combined curriculum to create a more “fully educated” student, more so than the disciplines would provide if taught separately. Harrington (1991) noted that education should prepare students to be full participants for life in a rapidly changing society in which technology will play a more prominent role in what and how they learn.

Technology has touched every aspect of human endeavor. The diversified mass production techniques of the manufacturing system have provided affordable technology to virtually every household in America. Ironically, the wealthiest nation in the world, the nation that has prospered for decades from manufacturing technology, this same nation has provided only a piecemeal approach to educating the next generation about the history, benefits, and societal values of technology. The educational community is only beginning to come to terms with necessary curriculum development that must underpin the future worker of America—technology. “Technology education is a comprehensive, experienced based educational process designed to develop a population that is knowledgeable about technology, its evolution, systems, techniques, its utilization in industry and other fields, and its social and cultural significance” (Maley, 1995, p. v).
Technology use and technology curriculum will not succeed unless teachers adopt it as their own. One must examine the role of the teacher in the implementation of any curricular innovation. If teachers lack knowledge concerning technology, or if teachers lack experience concerning technology, then possibly this void in instruction might transmit to a void in learning technology for the student.
CHAPTER III. METHODOLOGY

This study was designed to ascertain the knowledge elementary teachers have concerning manufacturing technology terms and concepts. A survey instrument was developed and used to gather the necessary data.

After the research problem was defined, a review of literature was conducted and a research proposal was developed and approved. The following procedures were used to investigate the problem.

1. The population for the study was identified and described.
2. A survey instrument was developed, approved, and administered.
3. The data were collected.
4. Data analysis methods were applied.

Population and Sample

The participants of this study were Iowa elementary teachers, who taught at the third, fourth, fifth, or sixth grade level. Participating school districts were Knoxville Community School District, Pleasantville Community School District, and Ottumwa Community School District. Sixty-four elementary teachers from these districts were surveyed. There were 12 males, 51 females, and one participant who chose not to disclose his or her gender. Twenty-seven of the teachers reported that they taught third or fourth grade, 30 teachers taught fifth and sixth grade, five teachers were “floaters” (taught at all four class levels), and
two teachers failed to report at which grade level they taught. The majority of the teachers reported that they taught general education (n = 49) while the remainder reported teaching either math (n = 4), science (n = 2), social science (n = 7), art/music (n = 1), or no report (n = 1).

The sample range for the total number of years taught ranged from zero (meaning several months, but not yet a full year) to thirty-five years. The teachers were almost evenly distributed where level of education was concerned. Thirty-five of the teachers held a bachelor's degree, twenty-six of the teachers held master's degrees, two teachers reported "other" degrees (but did not specify what those degrees were), and one teacher failed to report the type of degree he or she held. However all the teachers reported the type of institution from which they had received their degrees. Thirty-seven of the teachers received degrees from liberal arts colleges and 27 received degrees from universities.

Survey Instrument

A panel of experts (see Appendix A) validated the manufacturing test items from a list provided by the researcher. A pilot survey of 45 questions (see Appendix B) was constructed and submitted to the Human Subjects Review Committee at Iowa State University for approval (see Appendix C) prior to administration to a class of Iowa State University elementary education teachers. Information from the pilot test of these prospective teachers was
analyzed and used to revise and improve the test instrument and procedures. A copy of the final test survey is presented in Appendix D.

Data Collection

These data were collected from three elementary schools located in South-central Iowa. A cover letter stating the purpose, parameters, and possible outcomes of the study were prepared and included in each survey instrumentation packet (see Appendix E). In addition, demographic information was collected, such as gender, years of teaching experience, grade level taught, education level of the teacher, and type of institution from which the teacher graduated.

Data Analysis Methods

After the data were collected, an analysis was conducted to answer the research questions and fulfill the objectives of the study. The t-test was used in the analysis for independent samples, to test whether or not observed differences in group means could be reasonable attributed to chance or whether a statistical difference existed between groups. Homogeneity of variances was examined to determine whether or not they were equal; if equal, the pooled estimate of the variances was used to determine the test statistic (t-value). In cases which were not equal, a separate variance value was used to determine the test statistic (t-
value). Analysis was conducted using the SPSS-X mainframe computer software program. All tests were conducted using alpha (p) < .05 as the criterion for statistical significance. The statistical analyses were undertaken to answer seven specific study questions.
CHAPTER IV. RESEARCH RESULTS AND FINDINGS

Introduction

The central purpose of this study was to identify the knowledge level of elementary teachers concerning manufacturing technology terms and concepts and to determine the relationships between the knowledge level of the teachers and selected demographic characteristics (gender, grade level taught, level of experience, area of expertise, education level, and type of institution attended).

A survey instrument was constructed and used to collect the demographic information. An achievement test was also developed to measure the knowledge level of elementary teachers regarding manufacturing terminology and concepts.

Chapter 4 presents the results of the analysis of the data gathered by the instrument. The demographic variables are described in the first section and the six research questions are addressed in Section two. The final section summarizes the results of the research questions.

Demographic Variables

The respondent demographics provide an overview as well as a more defined range of characteristics of the population surveyed. The sample consisted of 64 elementary teachers sampled from three south-central Iowa school districts. The demographic results are displayed in Table 1 through Table 6.
As shown in Table 1, the survey results show a breakdown according to gender as 18.8 percent (n = 12) males, 79.7 percent (n = 51) females, and one participant who chose not to disclose his or her gender. The female teachers represented approximately a four to one ratio over the number of male teachers.

Table 1. Respondents of the study by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>12</td>
<td>18.8</td>
</tr>
<tr>
<td>female</td>
<td>51</td>
<td>79.7</td>
</tr>
<tr>
<td>no response</td>
<td>1</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Table 2 shows the frequency comparison of lower elementary teachers (3rd and 4th grade) to upper elementary teachers (5th and 6th grade). Twenty-seven of the 64 teachers surveyed taught at the third or fourth grade level. That translates to 42.2 percent of the respondents teaching at the lower elementary grade level. Thirty teachers had teaching responsibilities at the upper elementary level (fifth and sixth grade). This represents 46.9 percent of the teachers. This is a comparatively equal frequency distribution, with a difference of 4.7 percent between the two groups. In addition, five (7.8 percent) teachers were "floaters", that is, teachers with responsibilities at all four grade levels. Two teachers (3.1 percent) did not respond to this question.
Table 2. Respondents by grade level taught

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd &amp; 4th (lower elementary)</td>
<td>27</td>
<td>42.2</td>
</tr>
<tr>
<td>5th &amp; 6th (upper elementary)</td>
<td>30</td>
<td>46.9</td>
</tr>
<tr>
<td>floaters</td>
<td>5</td>
<td>7.8</td>
</tr>
<tr>
<td>no response</td>
<td>2</td>
<td>3.1</td>
</tr>
</tbody>
</table>

The level of experience of the respondents ranged from zero (meaning from several months, but not yet a full year) to 35 years (see Table 3). A group of twenty-two teachers with a teaching experience form 16 to 20 years accounted for the largest percentage (34.3 percent) of the sampled population. Forty of the 64 teachers had more than 16 years of experience, for a total of 62.5 percent of the teachers surveyed. Thus, well over 60 percent of the teachers had completed at least half of their teaching career. While the zero experience level (not yet a full year) accounted for the smallest percentage of the sample (3.1 percent).

As shown in Table 4, the respondent's area of expertise was predominately general education (n = 49, or 76.6 percent). Thus, at the elementary level general education majors consisted of better than three-fourths of the sampled population, followed by social science at 10.9 percent (n = 7), math at 6.3 percent (n = 4), science at 3.1 percent (n = 2), with art/music
Table 3. Experience level of respondents

<table>
<thead>
<tr>
<th>Experience level (years)</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>3.1</td>
</tr>
<tr>
<td>1 - 5</td>
<td>6</td>
<td>9.4</td>
</tr>
<tr>
<td>6 - 10</td>
<td>10</td>
<td>15.6</td>
</tr>
<tr>
<td>11 - 15</td>
<td>6</td>
<td>9.4</td>
</tr>
<tr>
<td>16 - 20</td>
<td>22</td>
<td>34.4</td>
</tr>
<tr>
<td>21 - 25</td>
<td>9</td>
<td>14.1</td>
</tr>
<tr>
<td>26 - 30</td>
<td>4</td>
<td>6.3</td>
</tr>
<tr>
<td>31 - 35</td>
<td>5</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Table 4. Respondents' area of expertise

<table>
<thead>
<tr>
<th>Area</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>General education</td>
<td>49</td>
<td>76.6</td>
</tr>
<tr>
<td>Math</td>
<td>4</td>
<td>6.3</td>
</tr>
<tr>
<td>Science</td>
<td>2</td>
<td>3.1</td>
</tr>
<tr>
<td>Social science</td>
<td>7</td>
<td>10.9</td>
</tr>
<tr>
<td>Art / Music</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>1.6</td>
</tr>
</tbody>
</table>
and "no response" finishing at 1.6 percent (n = 1). The majority of the elementary education teaching responsibilities fell to the general education majors.

As depicted in Table 5, the level of education of the respondents was fairly even, with 54.7 percent (n = 35) having obtained a Baccalaureate degree and 40.6 percent (n = 26) of the sampled population having obtained a Master's degree. Two teachers reported "other" for degree, but did not specify what those degrees were and one teacher failed to report the type of degree he or she held.

Table 5. Education level of the respondents

<table>
<thead>
<tr>
<th>Education level</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baccalaureate degree</td>
<td>35</td>
<td>54.7</td>
</tr>
<tr>
<td>Master's degree</td>
<td>26</td>
<td>40.6</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>3.1</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>1.6</td>
</tr>
</tbody>
</table>

The data regarding the type of institution from which the respondents graduated are presented in Table 6. Almost 58 percent (n = 37) graduated from a liberal arts college with the remaining 42 percent (n = 27) having graduated from a university. This represents a difference of approximately 15 percent.
Table 6. Type of institution from which respondents graduated

<table>
<thead>
<tr>
<th>Institution</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liberal arts college</td>
<td>37</td>
<td>57.8</td>
</tr>
<tr>
<td>University</td>
<td>27</td>
<td>42.2</td>
</tr>
</tbody>
</table>

Response Rates

A face-to-face interview was conducted with the superintendent of each of the three school districts and then with the principals of each of the schools in this study. Permission was granted for the survey to be conducted, and the building principal distributed the survey instruments to the appropriate teachers. This was a totally voluntary response on the part of the teachers. Eighty survey instruments were delivered with a return of sixty-four (80 percent) usable instruments.

Research Questions

Research question one was: "What is the elementary teacher's level of knowledge concerning basic manufacturing technology terms and concepts?" This question was addressed by obtaining the mean percent of correct answers for the sample. That mean was 76.25%, with a standard deviation of 8.72 and a range from 53 percent to 93 percent. Test questions 9, 10, 11, 26, and 29 were
answered correctly by all respondents (see Table 7). However, these five questions may not have been as technologically specific and more generic in nature. This may partially explain the perfect scores (see Appendix D for the complete test survey).

Research question two was: "How does the upper elementary teachers' (those teaching fifth or sixth grade) level of knowledge concerning manufacturing technology terms and concepts compare with the lower elementary teachers (those teaching third or fourth grade) teacher's knowledge?" This question was addressed by conducting a t-test between the two groups and their mean test scores. The mean test score for grades 3 and 4 was 75.59 with a standard deviation of 8.78, and for grades 5 and 6 the mean score was 78.46 with a standard deviation of 8.88. The results (t = -1.65, p = .10, df = 55) indicate that there are no statistically significant differences between the upper and lower elementary teachers' knowledge of manufacturing technology. This could be a reflection of teacher training practices that may not differentiate between upper and lower elementary levels regarding manufacturing content.

Research question three was: "How does the level of teaching experience affect the knowledge level?" A simple correlation procedure was used to compare the number of years of teaching experience—the independent variable, and the percent of correct answers—the dependent variable. The correlation for the two variables used in the regression was equal to P = -.18 which was not significant.
Table 7. Test questions answered correctly by all respondents

<table>
<thead>
<tr>
<th>No.</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>Pilot runs are:</td>
</tr>
<tr>
<td></td>
<td>a. assembly line mass production runs.</td>
</tr>
<tr>
<td></td>
<td>b. production runs of a specialty item.</td>
</tr>
<tr>
<td></td>
<td>c. test runs to make evaluations and corrections.</td>
</tr>
<tr>
<td></td>
<td>d. production rejects.</td>
</tr>
<tr>
<td>10.</td>
<td>Profit is:</td>
</tr>
<tr>
<td></td>
<td>a. the cost of production.</td>
</tr>
<tr>
<td></td>
<td>b. income beyond total cost.</td>
</tr>
<tr>
<td></td>
<td>c. income before cost.</td>
</tr>
<tr>
<td></td>
<td>d. production inventory.</td>
</tr>
<tr>
<td>11.</td>
<td>Private enterprise is:</td>
</tr>
<tr>
<td></td>
<td>a. freedom to own and manage a business.</td>
</tr>
<tr>
<td></td>
<td>b. government control of private business.</td>
</tr>
<tr>
<td></td>
<td>c. freedom of all government control.</td>
</tr>
<tr>
<td></td>
<td>d. the financial structure of an organization.</td>
</tr>
<tr>
<td>26.</td>
<td>Chain of command is:</td>
</tr>
<tr>
<td></td>
<td>a. mechanical links of production.</td>
</tr>
<tr>
<td></td>
<td>b. mass production facilities.</td>
</tr>
<tr>
<td></td>
<td>c. a level of authority communication system.</td>
</tr>
<tr>
<td></td>
<td>d. a way of networking piece work.</td>
</tr>
<tr>
<td>29.</td>
<td>Discovers and develops new products:</td>
</tr>
<tr>
<td></td>
<td>a. management</td>
</tr>
<tr>
<td></td>
<td>b. research and development</td>
</tr>
<tr>
<td></td>
<td>c. marketing</td>
</tr>
<tr>
<td></td>
<td>d. industrial relations</td>
</tr>
</tbody>
</table>
Research question four was: "How does the level of education, Bachelor of Science versus Master of Science, affect the teacher's knowledge of manufacturing technology terms and concepts?" A t-test was used to assess the degree of difference between the teachers with a bachelor's degree and those with a master's degree. The mean score for teachers with a bachelor's degree was 75.45 with a standard deviation of 9.67, and for those with a master's degree the mean score was 78.42 with a standard deviation of 6.65. The results ($t = -1.34$, $p = .18$, $df = 59$) indicate there are no statistically significant differences between the teachers due to their educational degree.

Research question five was: "Does gender affect the teacher's knowledge of manufacturing technology terms and concepts?" A t-test was again used to make this comparison. The results ($t = 1.0$, $p = .32$, $df = 61$) revealed that gender had no significant impact on knowledge of manufacturing technology terms and concepts. This result could have been influenced by the number of female teachers (51) as compared to the much smaller number of male teachers (12).

Research question six was: "How do teachers graduating from small colleges compare to teachers graduating from major universities concerning knowledge level of manufacturing terms and concepts?" The results of a t-test ($t = 3.01$, $p = .01$, $df = 61$) revealed there is a statistically significant difference between the two groups and their total percent correct answer means. The teachers who graduated from liberal arts colleges had a mean percent correct equal to 73.76, whereas the teachers who graduated from universities had a
mean percent of 79.67. With standard deviations of 9.52 and 6.16, respectively, this difference was statistically significant.

**Summary of Research Results**

The results of data analysis from the teacher survey were presented in this chapter. The demographic data concerning the gender ratio of elementary teachers was found to be indicative of most elementary schools. Approximately three-fourths of the staff included women, with approximately one-fourth of the elementary teachers being male. The results showed that this gender composition did not affect the teachers' knowledge level of manufacturing technology terms and concepts.

There was less than 5 percent difference between the number of teachers (N = 30) who taught at upper elementary levels (5th and 6th grade) and the number of teachers (N = 27) who taught at the lower elementary levels. With the groups being about equal in size, testing the knowledge level of elementary teachers concerning manufacturing technology terms and concepts should provide more balanced results. The results in the present study showed no statistical difference between the manufacturing technology test scores of the upper elementary teachers and the lower elementary teachers.

When the number of years of teaching experience was compared to the knowledge level of manufacturing, a slightly negative correlation (p = -.18) was observed. There was no significant difference between teachers with Bachelor's
degrees and those with Master's degrees. Respondents who graduated from universities did score higher than those who graduated from small liberal arts colleges. Further review of this difference may indicate a curriculum difference or student achievement difference at the entry level.

Overall, the elementary teachers scored about 76 percent on the test. On a normal curve, this would group the teachers in the “C” range on their level of knowledge concerning manufacturing technology terms and concepts.
CHAPTER V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter 1 through 4 of this study provided an introduction, a review of related literature, a description of the methodology utilized, and a section containing the results. This chapter provides a summary of the previous chapters, lists and discusses the conclusions of the study, and states recommendations based on this study for possible future research.

Summary

The central purpose of this study was to determine the knowledge level of elementary teachers concerning manufacturing technology terms and concepts and to determine the relationships between knowledge level and selected demographic characteristics (gender, grade level taught, level of experience, area of expertise, education level, and type of institution graduated from).

According to Henry (1993), if schools are to prepare students for the real world then technology must have a place in the classroom. Teachers must possess technological knowledge and expertise or they cannot adequately pass that information on to students. In today’s classrooms, technology aimed at improving education is present in most and abundant in others. However, its infusion into the curriculum has not solved all of the problems of the educational system.
This study was designed to investigate and answer the following questions:

1. What is the elementary teacher's level of knowledge concerning basic manufacturing terms and concepts?

2. How does the upper elementary, (fifth and sixth grade level), teacher's knowledge concerning manufacturing technology terms and concepts compare with the lower elementary, (third and fourth grade level), teacher's knowledge?

3. How does the number of years of teaching experience affect the knowledge level?

4. How does the level of education, Bachelor of Science versus Master of Science, affect the teacher's knowledge of manufacturing technology terms and concepts?

5. Does gender affect the teacher's knowledge of manufacturing technology terms and concepts?

6. How do teachers graduating from small colleges compare to teachers graduating from major universities concerning the level of knowledge about manufacturing terms and concepts?

A survey instrument was used to measure the knowledge level of elementary teachers concerning manufacturing terms and concepts. Data were collected from 64 elementary teachers teaching in grades three, four, five, and
six in three South-Central Iowa school districts. Descriptive and inferential statistics were used to analyze the data.

Chapter four of this study provided results of the analysis of each of the six research questions. Additional explanations and a summary of the research questions follow.

1. **What is the elementary teacher's level of knowledge concerning basic manufacturing technology terms and concepts?**

   The statistical analysis of this question was addressed by obtaining the mean percent of correct answers from the sample population. That mean was equal to 76.25 with a standard deviation of 8.72 and a range from 53 percent to 93 percent. In a graph form this would show an approximate normal curve with just a slight skew. On a typical grading scale, the teachers as a whole would rank at about a “C to C+” level of performance concerning their knowledge level of manufacturing technology terms and concepts. There were several questions (9, 10, 11, 26, & 29) that the entire sample answered correctly. However, these five questions were not necessarily manufacturing technology specific and crossed the boundaries of general organizational structure. This may partially explain the perfect scores (see Appendix D for examples of the questions).

2. **How does the upper elementary, (fifth and sixth grade level), teacher’s knowledge concerning manufacturing technology terms and concepts compare with the lower elementary, (third and fourth grade level), teacher’s knowledge?**

   The performance on the test indicates that the teachers who taught at the third and fourth grade level and those teachers who taught at the fifth and sixth
grade level was similar. Twenty-seven (42.2%) of the teachers taught at the lower elementary levels (third and fourth grade) and thirty teachers (46.9%) taught at the upper elementary levels (fifth and sixth grade level). Five teachers (7.8%) were "floaters" (teachers who crossed the boundaries of upper and lower elementary grade levels). Two teachers (3.1%) failed to report the grade level they taught. Statistically, this question was addressed by conducting a t-test between the two groups and their percent of correct average answers. The results ($t = -1.65$, $p = .10$, $df = 55$) indicate that there are no statistically significant differences between the upper and lower elementary teachers concerning their knowledge level of manufacturing technology terms and concepts.

3. *How does the level of teaching experience affect the knowledge level?*

The number of years teaching was the independent variable and the percent of correct answers was the dependent variable. The results ($t = -1.62$, $p = .09$, $df = 76$) indicate the number of years spent as an elementary school teacher has very little effect on the knowledge level of teachers concerning manufacturing technology terms and concepts. The correlation between the two variables used in the regression was equal to -.18 which was not significant.

4. *How does the level of education, Bachelor of Science versus Master of Science, affect the teacher's knowledge of manufacturing technology terms and concepts?*
Again, a t-test was used to assess the degree of difference between the teachers with bachelor's degrees and those teachers with master's degrees. The results (t = -1.34, p = .18, df = 59) indicate that there are no statistically significant differences between the teachers due to their educational degree.

5. Does gender affect the teacher's knowledge of manufacturing technology terms and concepts?

A t-test revealed (t = 1.0, p = .32, df = 61) that the gender had no significant impact on the teachers' knowledge level of manufacturing technology terms and concepts.

6. How do teachers graduating from small liberal arts colleges compare to teachers graduating from major universities concerning knowledge level of manufacturing terms and concepts?

The results of a t-test (t = -3.01, p = .01, df = 61) reveal a statistically significant difference between the two groups and their total percent correct answer means. The teachers who graduated from small liberal arts colleges had a mean percent correct of 73.76, whereas, the teachers who graduated from major universities had a mean of 79.67. With standard deviations of 9.52 and 6.16 respectively, the difference is statistically significant. The teachers graduating from universities scored somewhat better than their counterparts graduating from small liberal arts colleges.
Conclusions

In order to prevent any misleading assumptions in the interpretation of this material and to preserve the integrity of the work involved in developing this document, the reader should be aware that Chapters 1 - 3 of this thesis were completed in the fall of 1990 and Chapters 4 and 5 were completed in the fall of 1996. In addition, some of the material in the literature review of Chapter 1 was updated to reflect more contemporary ideas on the significant impact manufacturing has on society.

The primary objectives of this study were achieved. The knowledge level of elementary teachers concerning manufacturing technology terms and concepts was tested. Then, those results were compared to specific demographic criteria. Also, if others and future researchers find the results of this study useful, then this objective too, will have been met.

This researcher draws the following conclusions from this study.

1. A mean score of 76% indicates that elementary teachers do have a significant level of knowledge concerning manufacturing terms and concepts.

2. There is no significant difference between test scores of upper elementary teachers when compared to lower elementary teachers. This is expected since there is no difference in elementary teacher certification between grade levels and, as demonstrated by the “floaters”, teachers who cross grade level boundaries.
3. The number of years spent as an elementary teacher has very little effect on the amount of manufacturing technology knowledge one possesses.

4. The results of this study indicate that gender had no significant impact on the knowledge level of elementary teachers concerning manufacturing technology terms and concepts. This is expected since elementary teacher education training programs are not gender specific.

5. The results of this study indicate that university graduates scored significantly higher than their counterparts who graduated from liberal arts colleges. This researcher concludes there is not enough information or evidence to speculate about reasons for the difference.

This exploratory study may be expanded and improved upon as a direct result of new materials and methodologies that have been generated during the time frame of this study. Some possible changes could be:

1. Utilize a more structured test design process that would address specific categories of manufacturing such as materials, design techniques, production practices, quality control, or organizational structure, to name a few.

2. Research the batteries of employment tests for up-to-date technologically explicit terms and concepts to create test items covering manufacturing terms and concepts.

3. Incorporate new and improved methodologies for data collection and data analysis to detect differences based on the independent variables.
Recommendations

As a result of this study, the following recommendations are made by the researcher:

1. Further study is recommended to compare the elementary teachers' knowledge of manufacturing technology terms and concepts with the knowledge level of other groups (i.e., general public, technology teachers, high school technology students, etc.).

2. It is recommended that future research efforts compare the knowledge level of teachers exiting a teacher training program in the last ten years with those who have been in the profession more than ten years.

3. It is recommended that future researchers study a more gender-balanced sample of elementary teachers. An expanded study may also be conducted to determine if gender is indeed a factor in the mean scores or if societal and educational background is a more likely determining factor.

4. It is recommended that further research be conducted concerning the possible variables that had a significant impact on the test scores of graduates of a major university versus small college graduates (i.e., high school grade point average, entrance requirements, curriculum differences, professors' level of expertise, etc.)
APPENDIX A. PANEL OF EXPERTS

1. Brent Ewell
   Knoxville High School
   Knoxville, Iowa

2. John O'Hara
   Urbandale Middle School
   Urbandale, Iowa

3. Ned Rasmussen
   East High School
   Des Moines, Iowa

4. Gene Tychsen
   Hoover High School
   Des Moines, Iowa
APPENDIX B. PILOT TEST SURVEY

INDUSTRIAL
TECHNOLOGICAL
KNOWLEDGE

PLEASE DO NOT OPEN UNTIL YOU ARE TOLD TO DO SO
TEST INSTRUCTIONS

This test is being administered as part of a research project. The aim of the research is to investigate ways of measuring knowledge of industrial technology. Please remember the following instructions.

1. Do NOT begin or write on any of the forms until you are told to do so.

2. First you will be completing a personal data sheet. It should be attached to the facing page. Complete the top half only. Write your name in the correct blank - last name first. Then answer the two questions. Your name will be removed from this sheet after your records are examined. This will guarantee confidentiality.

3. You will be taking this test anonymously, do NOT put your name on the answer sheet.

4. Please indicate your grade level by darkening in the appropriate circle in the long vertical box near the center of the page.

5. Darken in the appropriate oval for sex.

6. This test contains 45 questions about industrial technology. You should try your best to answer every question. However, do not spend too much time on a hard question. For difficult questions, it is a good strategy to try to eliminate a couple of the choices and then make your best guess from among those remaining. You may skip items and come back to them later. If you do this, remember to mark the next item in the correct spot.

7. Indicate the correct answer by darkening in the appropriate space on the answer sheet.

8. Use only a No. 2 lead pencil to mark your answer.

9. If you want to change your answer, completely erase your previous answer.

10. You may not use a calculator or notes to help answer a question.

11. Please do not write in the test booklet.

12. When you are finished, place your answer sheet inside the test booklet, do NOT fold the answer sheet.
INDUSTRIAL TECHNOLOGICAL KNOWLEDGE

1 Industrial technology:
A is not related to other technical areas such as bio-technology.
B only functions in a free enterprise system.
C is likely to become more important in the future.
D exists only in advanced countries.
E like agricultural technology, is becoming less important.

2 Which of the following is the first step in the problem solving process?
A Selecting the best solution
B Develop alternative solutions
C Set goals
D Define the problem
E Implement the solution

3 Which of the following is NOT true of government and technology?
A The government can influence the availability of technology.
B The government can influence the cost of technology.
C The government can stop technology.
D The government can influence the growth of technology.
E The government funds technical research.

4 A compact disk can be used to store:
A numbers.
B music.
C pictures.
D language.
E all of the above

5 The importance of new technology:
A depends solely upon its economic impact.
B is determined by human values.
C is less for Communist countries.
D is greater for industrial nations.
E is determined by government and industry experts.

6 Speech synthesis:
A restores the use of a person's voice that was lost in an accident.
B allows surgeons to perform surgery on a person's larynx.
C allows computers to make sounds like human speech.
D allows people to talk to computers.
E is the art of breaking apart sentences into the parts of speech.

7 The biggest increase in jobs in the future is most likely to be in the areas of:
A technicians and health care workers.
B laborers and machine operators.
C managers and retail clerks.
D computer operators and clerical workers.
E mining and agricultural workers.

8 A superconductor is:
A a material that has very little electrical resistance at a certain temperature.
B a type of elevated train.
C a machine that accelerates nuclear material.
D the electronic component that makes compact discs possible.
E a type of metal used in cookware.
INDUSTRIAL TECHNOLOGICAL KNOWLEDGE

9. Which of the following pairs of energy resources are both renewable and cause little air pollution.
   A. Nuclear and wind
   B. Solar and hydro electric
   C. Wood and geothermal
   D. Solar and gas
   E. Gas and electric

10. Which of the following is/are true about solar energy? It:
    A. Is a renewable resource.
    B. Produces usable energy from light.
    C. Produces usable energy from heat.
    D. Uses photovoltaics.
    E. All of the above

11. Which of the following systems is LEAST dependent upon advanced technology?
    A. The FBI
    B. The Internal Revenue Service
    C. Social Security
    D. The Supreme Court
    E. The United States Postal Service

12. Technology currently has the greatest effect on:
    A. History.
    B. Philosophy.
    C. Economics.
    D. Religion.
    E. Education.

13. The introduction of new technology should be controlled by:
    A. A knowledgeable public which weighs the new technology's benefits and hazards.
    B. Special government boards who are economic experts.
    C. Scientists and engineers who have developed the technology.
    D. Corporation managers because they run the companies.
    E. Company stockholders because they own the company.

14. Passive solar houses in America have the majority of windows on the south side of the house. The location of windows is reversed in Argentina because:
    A. Argentine customs and traditions are different.
    B. Summer breezes in America come from the south; in Argentina, this is reversed.
    C. In the winter, north facing windows in the southern hemisphere receive more light.
    D. Argentina is not as advanced as America.
    E. Argentina is more mountainous.

15. One of the most promising uses of microbes is for:
    A. Cleaning the environment.
    B. Miniaturizing computer circuits.
    C. Measuring small industrial parts.
    D. Looking into the human body.
    E. Fiber optic surgery.
16 Air bags would probably be more effective in saving lives than seat belts because:
   A they are an automatic safety devise.
   B air bags keep you from hitting the dashboard.
   C seat belts can break.
   D air bags cost more.
   E they are filled with air.

17 Health hazards have been linked to microwave ovens, living near high power lines and viewing computer terminals. These hazards will probably be addressed by:
   A restricting the use of radio waves.
   B abandoning unsafe technologies.
   C having robots deal with hazardous technologies.
   D the application of additional technology.
   E strict voluntary compliance to government regulations.

18 Why can computers lead to greater productivity in industry?
   A Reduction of human error
   B Reduction of cost
   C Greater speed
   D Increased accuracy
   E All of the above

19 If you had to communicate technical information to a technician who spoke a different language, you would probably be most successful if you:
   A spoke slowly and clearly.
   B used drafting.
   C used sign language.
   D wrote down the information.
   E used a computer.

20 The automatic price scanners in a grocery store work by:
   A electromagnets reading a magnetic code on the package.
   B a video camera comparing the price on the sticker with a data bank.
   C a flying spot scanner reading the price.
   D reading laser beams bounced off a bar code.
   E microwaves reflected from the price sticker reading the price.

21 Technology was first used by the people of:
   A America.
   B the Roman Empire.
   C prehistoric times.
   D ancient China.
   E the British Empire.

22 The relationship between where a product is produced and its quality is such that:
   A all products are of varying quality and should be evaluated.
   B foreign produced products are seldom as good as American made products.
   C foreign produced products are usually better than American made products.
   D both foreign and American products are of high quality.
   E both foreign and American products are of low quality.

23 Triple pane windows are most useful:
   A in large rooms.
   B on the south side of the house.
   C in very hot or cold climates.
   D when a house does not have an air conditioner.
   E for small window openings.
24 What is the most likely result of the space shuttle program?
A Developments connected with the project will be applied to other areas and products.
B People will live on the moon within 50 years.
C There will be a colony on Mars within 50 years.
D Space travel will become much cheaper.
E The amount of space travel will increase greatly.

25 Which of the following statements is correct?
A Technology has had little impact on our lives.
B Technology can create negative social outcomes.
C Technological knowledge is not related to knowledge of the humanities.
D Technology has had little effect on the environment.
E Technical systems have little to do with social systems.

26 CAD/CAM is used for:
A automotive engine tuning.
B the application of technology to military defense.
C the manufacture of cadmium/carborundum compounds.
D digital to analog conversion.
E the design and manufacture of products.

27 Which of the following can be done with a class I laser?
A cut through steel
B be aimed at a human eye without damage
C burn away blood clots
D cut through plastic
E shoot down enemy missiles

28 Geothermal energy comes from:
A burning coal.
B hot water in the earth.
C gasses produced during the decomposition of garbage.
D uranium.
E sunlight.

29 The average worker has to be retrained because:
A they were promoted.
B they have had poor training in school.
C they quit their old job.
D their job was shifted overseas.
E new methods of doing things have been developed.

30 Drafting, photography, and printing:
A all are ways that people communicate ideas.
B are necessary skills for all people.
C are types of classes primarily for non-college bound students.
D are high paid professions.
E have very little in common.
INDUSTRIAL TECHNOLOGICAL KNOWLEDGE

Answer question 38 based on this table

<table>
<thead>
<tr>
<th>ATOMS</th>
<th>TYPICAL EXAMPLES</th>
<th>MOISTURE ABSORPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C,H</td>
<td>Polyethylene, polypropylene</td>
<td>Very low, 0.1%</td>
</tr>
<tr>
<td>C,F</td>
<td>Polytetrafluoroethylene</td>
<td>Very low, 0.01%</td>
</tr>
<tr>
<td>C,O,H</td>
<td>Acetal, acrylic, polycarbonate,</td>
<td>Low, 0.5%</td>
</tr>
<tr>
<td></td>
<td>linear polyester</td>
<td></td>
</tr>
<tr>
<td>C,N,O,H</td>
<td>Nylon</td>
<td>High, up to 8%</td>
</tr>
<tr>
<td>C,Cl,H</td>
<td>Polyvinyl chloride</td>
<td>Low, 0.5%</td>
</tr>
<tr>
<td>Si,O,C,H</td>
<td>Silicone</td>
<td>Low, 0.5%</td>
</tr>
</tbody>
</table>

38 According to the data provided, molecular absorption is directly related to the atoms making up the plastic. Which atom increases moisture absorption significantly?
A Hydrogen  B Fluoride  C Oxygen  D Nitrogen  E Chloride

39 Which line on the following graph best describes the growth rate of technology?

![Graph Image]

A  B  C  D
INDUSTRIAL TECHNOLOGICAL KNOWLEDGE

Answer questions 40 and 41 based on the following graph.

40 In areas where the degree days are over 9,000, it would be best if:
   A expensive insulation was used.
   B houses were not built there.
   C a combination of super insulated and conventional techniques was used.
   D houses were smaller.
   E houses cost less.

41 The graph contains insufficient information to make a decision about what type of temperature control to use because it does NOT take into account:
   A how cold it gets.
   B degree days over 10,000.
   C the cost of the house.
   D costs less than 50 per square foot.
   E the cost of energy.

Read this paragraph then answer questions 42, 43, and 44.

One of the fastest growing "high tech" firms is RBI Incorporated. During each of the past 5 years it has added another 50 R&D specialists to its staff. These and other technologists have consistently kept RBI at the leading edge of computer innovation. On the average, the speed and capacity of RBI's CPU's has doubled every year. Their X1000 micro computer can perform a calculation in a nanosecond. The chip that allows this speed stores a megabyte of information.
INDUSTRIAL TECHNOLOGICAL KNOWLEDGE

42 Which of the following BEST describes a technologist?

A A ram and dynamic memory specialist
B A person whose job involves creating and/or applying technology
C A person whose main skill is in using computers
D An expert in electronics
E none of the above

43 How many calculations can an X1000 computer perform in 1 second.

A $10^2$
B $10^3$
C $10^4$
D $10^5$
E $10^6$

44 The growth of RBI's staff would best be labeled as:

A logarithmic.
B exponential.
C geometric.
D trigonometric.
E linear.

45 Consider this situation. The design, manufacturing, marketing, and management of product XX was performed by hundreds of individuals. After using product XX, many consumers were injured. In a latter court case, injured person John Doe testified that he thought product XX was unsafe even before he used it. Several employees that helped make and sell the product also testified that they had always thought XX was dangerous. The Judge asked the injured person why he went ahead and used the product. He also asked the employees why they went ahead and made and sold the product even though they thought it was unsafe. The situation presented above could be accounted for because:

A individuals, when given directions by people in authority, often do things without thinking about the possible outcomes.
B technology has grown too powerful.
C the legal system is not technically advanced.
D doctors are not prepared to deal with technologically caused medical problems.
E hospitals and courts are not part of the technological process.

THIS IS THE END
APPENDIX C. HUMAN SUBJECTS APPROVAL FORM

INFORMATION ON THE USE OF HUMAN SUBJECTS IN RESEARCH
IOWA STATE UNIVERSITY

(Please follow the accompanying instructions for completing this form.)

1. Title of project (please type): SURVEY OF ELEMENTARY TEACHERS

2. Knowledge of Manufacturing

I agree to provide the proper surveillance of this project to insure that the rights
and welfare of the human subjects are properly protected. Additions to or changes
in procedures affecting the subjects after the project has been approved will be
submitted to the committee for review.

Stephen J. Sarver 5/5/89
Typed Name of Principal Investigator Date Signature of Principal Investigator
3156 Buchanan Hall 294-3922
Campus Address Campus Telephone

3. Signatures of others (if any) Date Relationship to Principal Investigator

Major Advisor

4. Attach an additional page(s) (A) describing your proposed research and (B) the
subjects to be used, (C) indicating any risks or discomforts to the subjects, and
(D) covering any topics checked below. CHECK all boxes applicable.

☐ Medical clearance necessary before subjects can participate
☐ Samples (blood, tissue, etc.) from subjects
☐ Administration of substances (foods, drugs, etc.) to subjects
☐ Physical exercise or conditioning for subjects
☐ Deception of subjects
☐ Subjects under 14 years of age and/or Subjects 14-17 years of age
☐ Subjects in Institutions
☐ Research must be approved by another institution or agency

5. Attach an example of the material to be used to obtain informed consent and CHECK
which type will be used.

☐ Signed informed consent will be obtained.
☐ Modified informed consent will be obtained.

6. Anticipated date on which subjects will be first contacted: Month Day Year

Anticipated date for last contact with subjects: Month Day Year

7. If Applicable: Anticipated date on which audio or visual tapes will be erased and/or
identifiers will be removed from completed survey instruments:

8. Signatures of

Date Department or Administrative Unit

9. Decision of the university committee on the use of human subjects in research:

☐ Project Approved ☐ Project not
☐ No action required

Name of Committee Chairperson Date

Received by

MAY 23 1989
GRADUATE COLLEGE

5/3/89 E& 4 Ed. Technology

Patricia M. Keith 5/3/89
Name of Committee Chairperson Date
APPENDIX D. FINAL TEST SURVEY

SURVEY DIRECTIONS

The purpose of this survey is to identify the level of knowledge of third through sixth grade elementary teachers, concerning manufacturing technology terms and concepts.

You are expected to be honest and spontaneous in your responses and use no reference books to answer these questions.

Part one of the survey has seven demographic questions.

Part two of the survey has thirty questions relating to various aspects of manufacturing.

Please use the answer sheet that has been provided with the survey. The answer sheet is graded electronically, so use a no. 2 pencil and fill the appropriate ovals neatly.

ON SIDE ONE OF THE ANSWER SHEET

1. For purposes of confidentiality, DO NOT put your name on the answer sheet.
2. In the box labeled “sex”, indicate your gender by marking “M” for male or “F” for female.
3. In the box labeled “GRADE OR EDUC.”, indicate grade currently teaching: 3 for third grade, 4 for fourth grade, 5 for fifth grade, or 6 for sixth grade.

UNDER THE SECTION “SPECIAL CODES”

1. Under the letters “K” (tens column) and “L” (ones column”), indicate your years of teaching elementary school. Example (if less than 10 years, the “K” is zero) or (if 24 years then “K” would be 2 and “L” would be 4).
2. Under the letter “M”, indicate your area of concentration. (0-general education), (1-math), (2-science), (3-social science), or (4-art or music).
3. Under the letter “N”, indicate your level of education. (0-Bachelor’s degree), or (2-other).
4. Under the letter “O”, indicate the type of institution graduated from with Bachelor's degree. (0-liberal arts college) or (1-university).
5. Under the letter “P”, indicate if you have taken at least one course in industrial arts, industrial technology, or manufacturing technology. (0-yes) or (1-no).

6. You may start the survey. Use numbers (1 through 30) on side one of the answer sheet, that correspond to the questions numbered one through thirty.
1. Industrial technology:
   a. is not related to other technical areas
   b. only functions in a free enterprise system
   c. is likely to become more important in the future
   d. exists only in advanced countries
   e. all of the above

2. Which of the following pairs of energy resources are both renewable and cause little air pollution?
   a. nuclear and wind
   b. solar and hydroelectric
   c. coal and geothermal
   d. gas and electricity

3. Technology currently has the greatest effect on:
   a. history
   b. philosophy
   c. economics
   d. education

4. The introduction of new technology should be controlled by:
   a. a knowledgeable public which weighs the benefits and hazards
   b. governmental boards who are economic experts
   c. scientists and managers of large companies
   d. company stockholders who own the companies

5. CAD/CAM is used for:
   a. product repair
   b. transmitting mail electronically
   c. the manufacture of cadmium/carborundum
   d. digital to analog conversion
   e. the design and manufacture of products
6. The average worker has to be retrained because:
   a. new methods of production have been created
   b. they were promoted
   c. they quit their old job
   d. their job shifted overseas
   e. they received poor training in school

7. Robots:
   a. can make judgments independent of their programs
   b. are best suited to perform piece work
   c. cannot work as skillfully as humans
   d. are best suited to perform repetitious tasks

8. Technology can best be defined as:
   a. a collection of sophisticated control systems
   b. people using tools, resources, and processes to solve problems
   c. skill at various job levels
   d. consultation and technical assistance

9. Pilot runs are:
   a. assembly line mass production runs
   b. production runs of a specialty item
   c. test runs to make evaluations and corrections
   d. are production rejects

10. Profit is:
    a. the cost of production
    b. income beyond total cost
    c. income before cost
    d. production inventory

11. Private enterprise is:
    a. freedom to own and manage a business
    b. government control of private business
    c. freedom of all government control
    d. the financial structure of an organization
12. R & D is:
   a. concerned with developing ideas, methods, and products
   b. transportation of manufactured products
   c. raising and distributing investment capital
   d. quality control

13. Casting, forming, and separating are forms of:
   a. industrial management techniques
   b. line production styles of operation
   c. material processing
   d. functions of organizational control

14. Quality control:
   a. physical checking of product against standards
   b. production inspection
   c. making production adjustments to meet specifications
   d. all of the above

15. Lead time:
   a. extra time for materials to arrive
   b. time needed to manufacture parts
   c. time needed to assemble product
   d. all of the above

16. A flow chart:
   a. gages fluid flow
   b. a list of systematic tasks
   c. lists viscosity for all liquids
   d. charting factory rejects

17. Plant layout:
   a. the arrangement of equipment within the plant
   b. the blueprints of production machines
   c. the scheduling of line tasks
   d. all of the above
18. Determining where each operation is to be performed:
   a. tooling
   b. diversifying
   c. channeling
   d. routing

19. Formal financial records of the company:
   a. general accounting
   b. budgeting
   c. financial control
   d. marketing

20. An enterprise owned by stockholders:
   a. single proprietorship
   b. partnership
   c. corporation
   d. all of the above

21. Daily planning, directing, and controlling are functions of:
   a. stockholders
   b. management
   c. workers
   d. union

22. Which of the following has ultimate control over the enterprise?
   a. stockholders
   b. board of directors
   c. president
   d. plant manager

23. Span of control:
   a. the number of people reporting to one person
   b. the number of tasks performed on one line
   c. the policy and guidelines of the organization
   d. testing for product quality
24. Line activities are:
   a. secretarial and accounting controls
   b. unionization of workers
   c. levels of authority
   d. essential operations for production and sales

25. Diversifying means:
   a. production unrelated to original product line
   b. research and development of new products
   c. production quality control systems
   d. changing the way a product is produced

26. Chain of command is:
   a. mechanical links of production
   b. mass production facilities
   c. a level of authority communication system
   d. a way of networking piece work

27. Major areas of manufacturing activities are:
   a. research and development
   b. production and marketing
   c. industrial relations and financial affairs
   d. All of the above

28. Industrial relations:
   a. recruits, selects, and trains needed workers
   b. promotes positive relations between company and employees
   c. facilitates human relations training
   d. all of the above

29. Discovers and develops new products
   a. management
   b. research and development
   c. marketing
   d. industrial relations
30. Prototypes are:

   a. detailed drawings
   b. mock-ups
   c. working models
   d. factory rejects
APPENDIX E. COVER LETTER TO RESPONDENTS

Dear Brent,

This folder contains a test over manufacturing terms and concepts. The purpose of this test is to identify the knowledge level of, third through sixth grade, elementary teachers concerning these concepts.

Please use your professional judgment to improve this instrument. Evaluate these test questions according to (1) whether they address manufacturing and (2) whether students leaving elementary school should be acquainted with these concepts. Write all comments directly on the instrument. Also, two blank pages at the end of the test have been provided for additional comments, such as, other terms and concepts that should be included on the test.

Please be liberal with your comments and suggestions. Your input is valuable for improvement of this instrument.

Please call me at (515) 294-3922 or (515) 947-6209 if you have any questions. Please use the stamped, self-addressed envelop and return by May 5, 1989.

Thanks for your help and support.

Sincerely,

Steve Sarver
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