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ABSTRACT

This monograph addresses the essential elements for high quality technology education programs at the graduate level. It discusses the issues in eight chapters written by individual authors: (1) "The 'Why' of Graduate Study" (Paul W. DeVore); (2) "Curriculum Development" (Ronald E. Jones); (3) "Instructional Strategies at the Graduate Level" (Donald Maley); (4) "Tests and Measurements" (Paul E. Brauchle); (5) "Graduate School Regulations, Requirements and Resources" (William Paige); (6) "Graduate Faculty" (Paul E. Post, William D. Umstattd); (7) "Research and Scholarly Activity" (Daniel L. Householder); and (8) "Program Development and Implementation" (Thomas L. Erekson). (KC)

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The Essential Elements of a Quality Graduate Technology Education Program

John R. Wright
Editor

Graduate Studies Committee

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Introduction

We live in a dynamic, changing world. Each day is different from the last; each day we progress one step further into an unknown future. Nothing remains as it was. Even our history changes. As new evidence emerges about our past, our perceptions of that past change.

Our disciplin, is no exception as it, too, is constantly changing. Small day to day changes build into major philosophical and operational changes. In the past, we have transitioned from an emphasis on the study of skill development for crafts, to the study of skill development for the manual arts and then to their relationship to the industrial arts. Currently, we are again in the midst of a major philosophical shift, this time to the study of technology as the major discipline focus. This slowly changing evolution was given its first major boost at the Jackson's Mill conference, where the philosophical base for the new discipline focus was formally articulated.

The Council on Technology Teacher Education (at the time still known as ACIATE), in conjunction with the leadership of ITEA, developed a Professional Improvement Plan (PIP) in 1984-85. Entitles "Providing Leadership in Teacher Education," this document outlined a five year plan of action to support the development of quality teacher education programs. Among the plan's goals were to "identify and operationalize the components and criteria for quality technology teacher education programs" and to "develop and promote an awareness of and support for implementing quality technology teacher education programs." Mandated in the PIP document, this monograph is one step toward accomplishing the first goal and should be a major contributor toward accomplishing the second goal.

Those of us involved in graduate studies have an especially important role in our changing discipline. We are responsible for disseminating the new philosophical base; it is our responsibility to enlighten college teachers who, in turn, will provide future public school teachers with the basic philosophical foundations for their classroom activities. Whether or not technologically literate students leave those public school classrooms ultimately depends upon how well we do our job. We, the authors of this monograph, sincerely hope that this document will aid all of us in becoming better trainers of tomorrow's technology education teachers.

Edward C. Pytlik, Chairperson
Graduate Studies Committee
CTTE

Chapter 1

The "Why" of Graduate Study

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The field of education currently known as technology education has emerged from a lineage that has paralleled closely the industrialization of the United States and the Western World. Various descriptors have been used to describe the progression of the field of study--manual training, manual arts, industrial arts, industrial technology, and technology education. As the field of education evolved and the preparation of teachers changed from two year normal school requirements to four year programs and master's degrees, so too did the requirements for the preparation of teacher educators. Today the minimal requirement for employment in a graduate institution, with few exceptions, is a doctoral degree.

Graduate Education

Faculty responsible for graduate degree programs in technology education at the master and doctoral levels have been attempting to meet the demands of graduate level study brought about by the many content and social changes taking place in the technologies and society. The impact of technological and social change has been significant in all fields of education but particularly so in the field of technology education. There are two reasons for this. One is the high rate of technological change which has altered significantly the content base of the field of study. The other reason is the impact of the technological changes on people, the social order, and the life-giving and life-sustaining environment. The entire context and rationale for the field of study has been changed forcing a reassessment of not only the field of study as offered in the schools of the Nation but also the preparation of faculty for these programs.

The professional technology educator of today is involved in a complex multifaceted field of endeavor. The issues in society have become more and more intertwined with technological issues. The effect of individual collective decisions in the use of technical means has culminated many times in aggregate effects that have been detrimental to human beings and destructive to society and the environment. The preparation of citizens who can act intelligently and responsibly in the complex technological world that has been collectively created is a primary order of business in a democratic society. It is thus a primary order of business for graduate programs of technology education to prepare intelligent knowledgeable faculty capable of designing, developing, implementing and operating quality teacher education programs for the preparation of competent teachers for the public schools of our democratic republic.

Graduate programs in technology education have an important and critical role in the system of technology education. In the past, for the most part, the focus of graduate programs in industrial arts has been on courses in education with little attention to the content base in the technologies. The assumption was that the undergraduate program had prepared the teacher in the content and the graduate program was for "professional" preparation. This raised the question of the purpose of graduate study. In most disciplines the primary purpose is to prepare researchers and to generate and transfer new knowledge. In most fields of educationthe reason given most often is that graduate study is to prepare a better teacher. Often a better teacher is described as one who has taken a number of specified courses in education beyond the baccalaureate degree. There is little evidence that these programs contribute to better teaching.

There is evidence that supports the position that true curricular change involves significant improvement in the "what to teach?" and "how to teach it?" equation. The primary question focuses on what the learner will know and be able to do. The secondary question, which derives direction for answers from the content of the answer to the first question, focuses on pedagogical issues related to the delivery of instruction. Unfortunately, educators have, for the most part, limited their inquiry concerning the critical question of "what to teach?"

For the most part teachers and faculty in teacher education institutions are not required to prove current competency in the discipline they are certified to teach. Competency is often assumed or not considered a truly critical issue. In the field of technology education, where the content base is always changing, the field of study, the students, and the nation are poorly served by graduate programs that focus on methodology and professional development rather than the content and intellectual processes of the discipline.

Content and Structure

Determining the content and structure for a graduate program in technology education involves the same process and the same questions as would be used to determine the content and structure of other graduate programs. It is critical that a paradigm of the program be developed. A paradigm is grounded in one's world view, one's philosophy of life or philosophical position. Only after the philosophical position is clearly delineated is it possible to develop and offer a graduate study and research program that is appropriate and has internal consistency and integrity.

Dominant Paradigms

There are two dominant paradigms that have influenced our social order and national policy debates. These paradigms have also influenced the content and structure in recent years of graduate study and research in technology education. One is the technocratic philosophy which focuses on the control of nature for human ends. The focus is anthropocentric. The other is the organic planetary philosophy which focuses on the control of technical means by knowledgeable and socially sensitive human beings. The focus is ecocentric. The latter is an emerging paradigm which gives priority to community and ecosystem integrity. These concerns have emerged and become dominant issues during the last several decades because of the realization that the technical means that were being created and the way the new and powerful technical means were being used portended serious consequences for human beings and other life on earth. As a consequence a search for new direction has emerged guided by a new set of questions.

1. What is our purpose?
2. Who are we and why are we here?
3. What kind of technical means is most appropriate for attaining agreed upon social purposes given the limits of our natural world and system entropy?
4. How can we design, redesign and implement a technological and social system that, as a minimum, provides basic needs for each citizen, including the provision of a meaningful role in society for each citizen?

The content, structure, and research of graduate programs of technology education implied by this world view would be different from the technocratic anthropocentric world view. The emerging organic planetary view directs study, inquiry, and action toward transcending the more narrow instrumental view of using technical means to control nature to a more complex cultural view that focuses on the design of technical systems that are compatible with the social order and the natural environment. The goal is the understanding of the behavior of socio/technical/natural systems. The direction is toward the biotechnologies which require understanding of the natural environment, the aggregate of the technical means that form a part of and provide a definition of the society and culture in which one lives, and the relations and connectedness between these elements, including human beings. Curricula and programs emerging from this world view would emphasize the design of environmentally and community specific and appropriate technical means and recognize the need to design with nature rather than to control nature. This position is based on the realization that there are many bioregions throughout the world. Each bioregion requires of humans knowledge and understanding of the natural order if the technical means selected and/or designed and used are to be compatible with the life-giving and life-sustaining environment and not destructive of it. This is a different order of knowledge and know-how than is required by the technocratic world view. And the nature and characteristics of a technologically literate person would be different.

The shift in the paradigm that has been taking place has brought about not only the realization of the essential role that the study of technology has in the education of the youth of a democratic society but also an awareness of the fact that the creation, development, and assessment of technical means is of the intellect. Technical means of today are more intellectual not less intellectual, more conceptual not less conceptual. The technical means of today, composed of a wide array of sophisticated tools and knowledge, require disciplined and systematic study not only from a technical perspective but also from a social, cultural and environmental perspective as well.

Implications for Graduate Study

The implications of the paradigm shift for technology education graduate programs is considerable. Not only has the philosophical base of the field been evolving but the nature of the content base of the discipline has been evolving as well. One might ask the question, "What should be the nature of a graduate program for the preparation of professional educators for technology education?" The answer is found in the analysis of one's philosophical paradigm and the nature of the content of the discipline or field of study.

Technology education is grounded in the discipline of technology. The discipline is concerned with the study of the creation and utilization of adaptive systems--tools, techniques, machines, resources, energy, information, human organizations---and the relation of the behavior of these systems and elements to human beings, society and the environment.

Those preparing to enter the field of technology education would, therefore, by implication, be grounded thoroughly in the philosophy of technology, the structure of the discipline, the central themes, and the concepts and principles that give insight into the behavior of the technical means and their impact upon and relation to the social, cultural, and environmental context in which they exist. By implication, graduate programs in technology education would include study and rese arch in and about:

1. The philosophy of technology,
2. The history and evolution of macro and micro technical systems,
3. The human and social variables related to the creation of technological devices and systems,
4. Assessing potential and alternative technical developments and projecting future impacts and directions,
5. The relation of technological change to environmental, human, and social impacts,
6. The evolution of the significant developments of major adaptive systems of society; communication and information systems, production systems, and transportation systems and the interrelated components of each, and
7. The concepts and variables related to the behavior of technical systems.

There are no single discipline problems in the world. Thus, graduate programs in technology education, committed to the study of technology, require that students be thoroughly grounded in other sciences and the humanities as well.

Research

There is the need for those who guide and direct graduate programs in technology education to recognize the importance of research in the continual renewal and improvement of the discipline. A research agenda focused on the behavior of technical systems and their elements and the relation of technical means to human beings, society and the environment would provide graduate programs with a dynamic and meaningful research direction. Such an agenda would provide the field with a cumulative research effort where the knowledge base is created and added to systematically. These are necessary factors of a quality research effort.

The Transfer of Knowledge

The diffusion of knowledge and know-how are central to the mission of technology education. Problems and issues related to the transfer of knowledge and know-how to others involve instruction, research, and field or clinical work with human subjects in schools and community settings. Some of the most difficult and rewarding research is carried out in these settings. Diffusion and adoption efforts are necessary components of graduate programs. It is through these efforts that students have the opportunity to assess their knowledge and know-how and learn of the complex environment in which change takes place. It is in these programs that the future leaders learn about the design, development, and evaluation of change models, curricular designs and instructional delivery systems. The testing of theory in real situations on a continual basis and the reporting of the results to other practitioners in the field will ensure the continued evolution and growth of technology eduction.

The field of technology education is a complex and difficult field to master. It is a field of education that has major contributions to make in the preparation of intelligent and knowledgeable citizens for a democratic technological society. Meeting these responsibilities will require quality individuals who are committed to a career in a discipline that requires disciplined inquiry of the highest order.

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Chapter 2

Curriculum Development

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With the shift in the philosophical base taking place during the previous decade and the accompanying change in the content base to focus on technology, curriculum development efforts at the graduate level are critical if programs are to survive. Much emphasis has been placed on undergraduate curriculum change, and with success. However, there seems to be little effort or emphasis on graduate level curriculum development. The time to start is now.

Curriculum Development Approaches

Developing a curriculum for graduate level technology education programs could take one of three approaches:

1. A simple upgrading of an existing good quality program.
2. A significant "makeover" of an existing program.
3. Starting over by virtually eliminating an existing program and developing a totally new one to replace it.

Each approach has both positive and negative factors to be considered by curriculum developers. Included in these factors are such things as time to devote to the developmental work, cost of upgrading (if facilities and equipment are considered), and potential enrollments.

A simple upgrade includes reviewing all existing courses, maintaining those that are of high quality and that meet the objectives of the new graduate program, and upgrading others to ensure that high quality is continued. If the program has decreased in quality during previous years for whatever reason, it may be rather difficult to upgrade existing courses to the level of quality needed in a new technology education program.

A significant makeover of an existing program has many of the same positive and negative factors associated with upgrades. However, one major positive factor is that the degree "exists," i.e., an approved degree program is in place. Therefore, curriculum developers will not need to seek approval for a new degree, a sometime lengthy task. The makeover approach allows them to complete significant curriculum changes within an existing degree program.

Starting over may be the easiest approach of accomplishing the overall objectives of the new curriculum. While starting over seems like such a radical decision and option, this may be the simplest method in terms of the number of hours devoted to the overall project and may also help increase the quality of the ultimate product: the courses. The major negative factor, again, may be the effort needed to obtain new degree program approval at the institution or state level. Also, by starting over curriculum developers are not hampered by having to maintain selected portions of existing courses for whatever typically good reasons may be presented. Whatever the approach, curriculum developers should be prepared to defend their decision as to which direction they have decided upon.

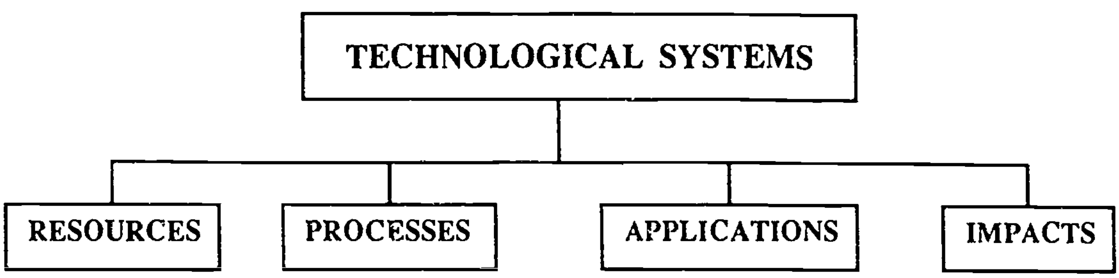

Figure 1. The Technological Systems Model was developed as a logical approach for developing technology-based curriculum.

A Suggested Scope and Sequence Model

The most readily adaptable curriculum model for developing technology education curriculum on any level is the Technological Systems Model. The model (Figure 1) was originally developed by the author and adopted for use in the curriculum project known as Illinois Plan. Since that time the model has been adopted by a variety of schools, districts, and states due to ease of implementation, time savings, simplicity in in-servicing teachers, overall simplicity of the approach, and the effectiveness of the model in meeting the goal of helping students gain a level of technological literacy.

The Technological Systems Model was patterned after the Universal Systems Model (Figure 2). Using the systems approach for developing curriculum has been successful and is applicable to graduate level curriculum development. While the conceptual features of the Universal Systems Model remain the same as with the undergraduate program, the content areas and the taxonomic structures are changed for graduate curriculum.

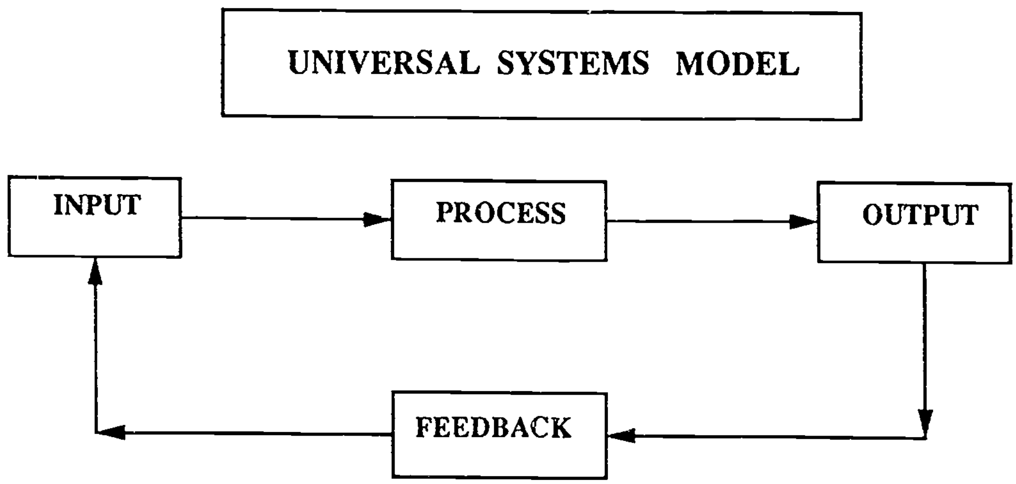

Figure 2. Using the systems approach for developing curriculum has been successful at the undergraduate level.

For purposes of this chapter, a content area is defined as that specific information that falls under each of the four major headings: inputs, processes, outputs, feedback, in the Graduate Curriculum Systems Model (Figure 3). It should be noted that content areas will contain suggestions for what may be individual courses, plus concentrations or areas of study that may include two or more courses. The following includes a general description and rationale for each of the content areas in the Graduate Curriculum Systems Model. Appropriate examples are presented for clarification.

Inputs

In this case inputs are the initial resources in the system with the "system" being any level of graduate program. Inputs include that series of courses or areas of study that establishes a content base from which students will pursue a specialized interest, that will provide them with a stronger knowledge base, or that may provide them with an initial philosophical "footing" or knowledge base from which to work and study.

This content area is where students are introduced to and concentrate on the study of technology. Through formal types of courses the content area may include studies dealing with the history of technology, research into what is happening today, and projections into the potential future of technology. Other formal, structured courses such as Statistics, Introduction to Research, or Curriculum Devel ment would also fall within this content area.

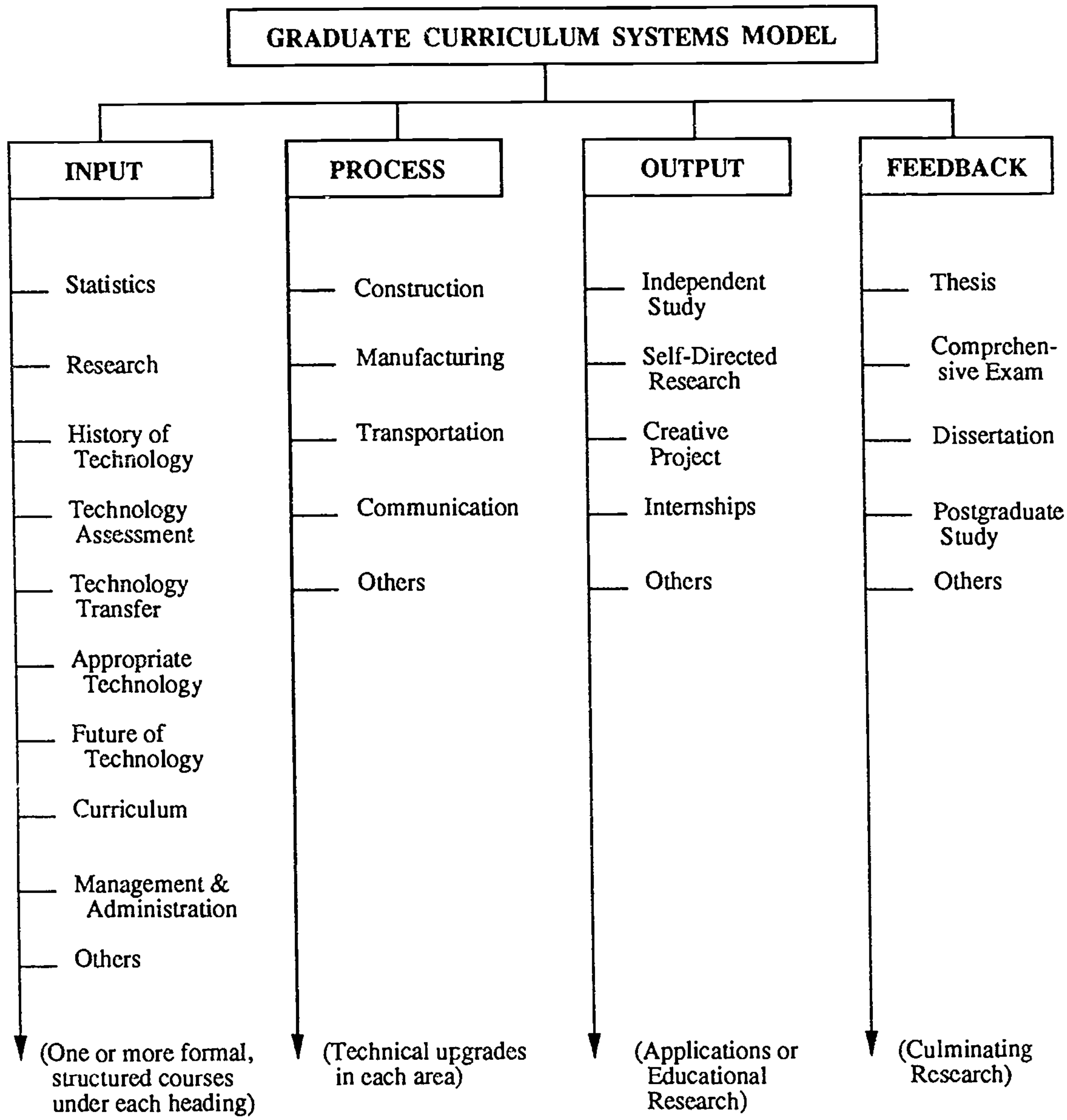

Figure 3. A model and suggested content for developing graduate programs.

A convenient way to view the inputs content area is to think in terms of having students learn "about technology." Students are typically not able to do this to any degree of sophistication as part of their undergraduate program. Undergraduate programs often focus on the development of technical skills and may include some initial "technology" information such as found in a lower division technology core. However, there is usually not time to delve into and develop a strong, philosophical base. The inputs content area can and should provide that base.

Processes

Graduate students at any level need the opportunity to continually upgrade selected technical skills or to develop new technical skills based on potential changes in "state-of-the-art" equipment in a given field. The processes content area provides opportunities for graduate students to approach selected technical courses to gain that increased level of understanding in a particular technical area.

Certainly, high quality applied research in a technical field should provide graduate students with the opportunity to further their technical skills, their technical knowledge, and their understanding of the areas of construction, manufacturing, transportation, and communication. This is obviously an alternative approach to research when compared to the usual "questionnaire" method or "review of literature" method in educational research that has been the primary technique of graduate students and encouraged in the past by faculty. Applied research in the technological systems would neither eliminate nor replace educational-type research but would enhance it and provide students with an additional support area of study.

It could be argued that students should have obtained necessary technical skills in an undergraduate program and should, through some intrinsic, self-motivation act of professionalism, keep themselves technically up-to-date. That argument is typically invalid in the study of technology due to the rapidly changing tools, technical processes, and materials that comprise the field. No single individual can handle the massive change in information alone and therefore, opportunity to keep up should be provided in the educational system.

To truly understand the technical means of today and to develop a conceptual framework and knowledge base for continuing to understand future technical apparatus and effects, students must be directed to experience "hands-on." This hands-on experience should be sophisticated, be intellectual in nature, and be legitimate cognate in the process of disciplined inquiry.

Outputs

The outputs content area of the model provides graduate students with opportunities to synthesize previous information. Synthesis may be handled in selected individual courses or again, areas of study that may take on several unique components. The first component is a traditional one: the independent study or self-directed research. The independent study approach should provide students with the focus to identify the topic and to utilize information from previous courses and the results of their initial research from the content areas of resources and processes.

The following two examples are presented to illustrate how the synthesizing of information may take place:

1. A student interested in studying communication has been involved in research with a major objective of establishing criteria for judging color for the printing industry. This student also (as part of a previous group project in the content area of resources) helped complete a Delphi study into the future use of color in the printing industry. For the outputs content area, our student may combine those two segmented pieces of research. As a result of synthesizing the information, if criteria has been established for judging color and if there is going to be a potential future change in the color printing industry, there may be valid projections that could be developed in a self-directed research project.

2. A second brief example is of a graduate student focusing on the area of construction. Assume his/her processes research was focused on energy efficient construction techniques for the housing industry and related course work concentrated on the history of technology. The results of those two research areas may be combined to allow the student to synthesize heretofore unrelated information (in their individual program). An independent study project could be developed to research what preventative measures should have taken place to alleviate the energy shortage in the 1970's, given a change in construction techniques by the housing industry at that time.

An alternative method of study in the outputs content area includes cooperative educational experiences, commonly termed as internships. Students could move into an industry under a typical internship, i.e., a full-time working situation for one or two semesters. The internship responsibilities should be monitored by faculty and should enhance the student's concentration area. It should not simply be a "fill-in" job to help the industry alleviate a temporary personnel shortage, or simply to support the graduate student.

In addition, the same student should have the opportunity to move into an educational situation (e.g., a school district) in an internship capacity. During the educational internship the student might help a school district implement change or be involved in curriculum work. This could include writing curriculum, helping implement curriculum change, developing new activities, helping to in-service and transition teachers, helping plan to upgrade facilities, or developing a public relations campaign to promote programs in periods of change.

Outputs experiences provide graduate students with opportunities to "put their knowledge to work" in a controlled situation. The internship at an educational system or with an industrial system is an excellent means of accomplishing this.

Feedback

The feedback content area provides students with the opportunity for the highest level of research for their particular degree program. This segment of the model is where students have the opportunity to complete the cycle, to close the loop, to embark on and complete research to bring closure to their total degree program. At the master's degree level the primary emphasis should be the completion of a thesis.

The thesis provides the opportunity to conduct high level research and should be the culminating experience in the master's graduate program. While there has been some emphasis in graduate programs in allowing students to do the "creative project" as an alternative to the thesis, using the Graduate Curriculum Systems Model this alternative is not necessary. That creative project option actually falls within the outputs area of the model. Students may have already completed a type of "creative project" as an ongoing part of the graduate program. The creative project is an excellent type of option in a content area, but it is not suggested as an alternative for the thesis.

Finally, the comprehensive examination may be a legitimate alternative in selected cases for particular graduate students. Primary among these options are individuals who wish to upgrade their credentials and who could utilize the information in the degree program but have no ambition to continue with their education past the master's degree. For this type of individual, "practice" at higher level research such as the thesis may actually be of little value.

The culminating research effort will help close the loop and should address the "feedback" segment of the curriculum model. Therefore, not only will those research projects conclude, wrap up, and help the future degree recipient to pull together a total program, it will also add to the knowledge base as all legitimate research must do. These efforts will serve to provide the researcher with the evaluation component of his/her education. Completion of the feedback segment should provide opportunity for the researcher to make viable evaluative statements and value judgements in his/her area of expertise.

The "Professionalization" of Future Professionals

The development of curriculum in technology education graduate programs must, of course, include blatant aspects such as establishing a strong philosophical base, a research component, and technical upgrading. But, in addition, the same curriculum development effort should contain a subliminal but concentrated effort on developing professionalism. Graduate students must be provided with the opportunity for professional activities. These activities include attendance at and presentations to local, state, and national conferences. Graduate programs should have a built-in component that ensures students will be involved in various professional activities. Students should be encouraged to present and publish research findings that may develop during their program. Presentations and articles may be coauthored with a faculty member to provide a mentoring environment.

The practice for this type of "professionalization" can certainly take place as an ongoing part of graduate classes. Professional quality presentations should be encouraged and required as a part of all graduate classes. It is at this point in the professional's budding career that he/she has the opportunity to practice these skills, develop them, and to become a more highly skilled teacher through constructive evaluation, criticism, and feedback as an ongoing part of classes.

This particular subliminal component is of enormous benefit to the profession as a whole. This type of activity, when nurtured at the graduate level, has manifested itself later in many former graduate students continuing to serve the profession in various capacities. These positive results include, but are not limited to continuing to work with the professional associations at the local, state, and national level; presentations at various conferences and continuing to write and publish whether required to or not.

This critically important component of helping our profession to grow, maintain itself, better itself, and to continue to attract young new members is a serious factor to be considered in curriculum development efforts for technology education graduate programs. Again, this emphasis must be subliminal. Graduate programs cannot establish courses such as "How To Be A Professional." Most importantly is the fact that perhaps all students should not be forced into the "Active Professional" type of situation. If handled as part of normal graduate class involvement on the part of the students, then those individuals that surface as the high quality researchers should be encouraged to continue. On the other hand, some individuals simply cannot or prefer not to function at presentations or writing for publication. However, they are able to complete the requirements of a graduate program and should be able to make better informed career decisions from the experiences in the program.

Essential Elements

The Universal Systems Model provides a logical, applicable, and easy-to-use method for planning graduate curriculum in technology education. The essential elements for the model are inputs, processes, outputs, and feedback. Curriculum developers should ensure that all four elements are used in their planning of technology education graduate programs.

Additional, but equally important, essential elements unique to technology education graduate programs are the commonalties that tie the program together and make it truly a "program," not just a collection of course/experiences that may or may not be related. These are as follows:

1. The history and philosophy of technology education - An area of study concentrating on the development and growth of technical, "hands-on" education through current national trends (e.g., Principles of Technology, OM, Invent America, Gifted and Talented, and Technology Camps). The historical base should provide for the establishment of a justification for the philosophy.
2. Understanding the systems - An area focusing on the social, economic and environmental variables as they are related to technological developments.
3. The behavior of technical systems - An area devoted to the upgrading of technical skills and information.
4. Understanding change - An area specifically related to understanding the dynamics of change, that change may be both positive and negative, that change is taking place at an exponential rate, and that the only "constant" in technology is change.

Chapter 3

Instructional Strategies at the Graduate Level

Donald Maley
University of Maryland

It is significant that the Council and the editorial directors of this monograph have singled out "instructional strategies" for a place in this writing. It is significant because of its importance in the learning process. It is also significant because of its apparent lack of importance in the reward systems of too many of the major universities and their graduate programs. It is no secret among the major universities that instructional strategies and teaching as such are not of considerable weight in the reward systems in that area of great importance to the faculty, and that is promotions and tenure.

However, the presence of that schema, and regardless of the ingrained attitudes that tend to perpetuate present practices in the reward system, the importance of teaching and the quality of instruction must be recognized and ever present. The institutions are still institutions of learning in the public's eyes -- which implies learning for students as well as the faculty.

Graduate work implies a certain level of performance on the part of the student as well as the faculty. Although the graduate schools of most institutions have established entrance requirements related to grade point averages in undergraduate work, this criteria does not guarantee any substantial amount of capability for advanced study at the graduate level. The reasons for this are related to the fact that there are so many differences in undergraduate programs in such elements as grading practices and course requirements, as well as student and faculty expectations. It is also important to note that graduate programs leading to the doctorate generally have higher admission standards, but here again, there are important variations in the backgrounds of students coming out of programs at the master's degree level.

All of this points to difficulty of making any solid generalizations related to the capabilities of students entering graduate programs at either the master's or the doctoral levels. Yet, if the work is to be graduate caliber and of an advanced level, there needs to be some assumptions that one can make with respect to both content and methodology. The underlying assumptions upon which this presentation of instructional strategies is made are that the students in graduate programs are mature scholars capable of advanced study and that the content of such programs is of an advanced level.

Strategies and Purposes

Any discussion of strategies for graduate instruction must be tied to the broad purposes behind the program. This is to say that different strategies are used to accomplish different purposes. It also is fair to say that purposes of graduate work vary considerably among institutions of higher education. The following are some of the purposes that one may find in graduate programs.

1. Professional development in theory and practice. This purpose is commonly found in those instances where certification for administration and certain staff positions require the advanced degrees or certificates.
2. Penetrating and indepth study. Penetrating and indepth study is a purpose of many dimensions of the graduate program. The maturity level of the student in many instances dictates such a purpose. The nature of the topics as well as the anticipated outcomes of certain courses will require a depth of study.
3. Pushing back the frontiers of knowledge. This is a common purpose for major universities and those emphasizing research. The generation of knowledge is a fundamental purpose subscribed to by many graduate programs.
4. Pushing back the frontiers of program development and implementation. This can be an exciting and challenging purpose to pursue. It is a kind of graduate program function eminently suited to a professional education graduate school effort.
5. Research base for knowledge or discussion. The achievement of stature for professional development in education requires a commitment to the establishment of knowledge and practice on the findings and conclusions from research.

Selected Strategies

It is recognized from the beginning that instructional strategies at the graduate level have no bounds and few limitations. The ensuing discussion will center around ten instructional strategies that have been used and found useful in a number of graduate programs associated with technology education. These ten instructional strategies are:

1. Lecture - discussion.
2. Seminar.
3. Independent study.
4. Internship.
5. Research project participation.
6. Practicum.
7. Teleconferences/lectures (audio).
8. Computer assisted instruction.
9. Demonstrations.
10. Faculty - student informal interaction.

Each of the above will be discussed briefly regarding appropriateness of the particular strategy for graduate study.

Lecture - Discussion

This is perhaps the oldest form of advanced instruction. It is also the most frequently used strategy and particularly in those instances where the classes are of considerable size. The lecture-discussion strategy can vary considerably in its effectiveness dependent on a number of factors.

1. The lecturer must be well prepared for the session.
2. The lecturer must be capable of inspiring the audience and stimulating interest in the topic.
3. The students should have done their homework and background study prior to the lecture.
4. The discussion that follows must be carried out in a manner that will clarify and amplify the content as well as stimulate the student to pursue the topic further.
5. The discussion portion must also be conducted by persons knowledgeable about the topic and capable of keeping the discussion focused on the topic.

The lecture- discussion may be the strategy used when a prominent authority or leader is available to make such an event possible. This is an excellent opportunity for the students to experience contact and interaction with such people. It is also an excellent opportunity for the student to get another point of view on the topic or issue. The lecture-discussion session may also be supplemented with a variety of approaches including the computer, video presentation, overhead transparencies, slides, and graphics.

Seminar

The seminar represents one of the fine instructional strategies in the graduate repertoire of practices. It is basically a structured opportunity for informed individuals (students) to explore indepth a selected issue or topic. The seminar is at its best when the student participants have done their homework on the selected topic. The ideal seminar is one in which the respective students approach the topic from a variety of points and directions of focus. The prior preparation by the student on his/her approach to the topic is important. If there is not this prior preparation the seminar may well end up as opinion and defeat the purpose of the event.

Some qualities and characteristics of a seminar would include the following:

1. The number of students may range from five to fifteen.
2. There is a seminar leader who may be either a faculty member, an authority on the related topic, or a capable student.
3. There is a specific topic or area of concern that has been identified.
4. The students have had prior knowledge of the topic in sufficient time to be prepared to discuss it.
5. There may be one or two presentations by participants to set the stage for the ensuing discussion and exchange of informed perspectives.
6. The seminar leader is responsible for keeping the discussion on track and also to see that all get a chance to participate.
7. The seminar leader will also bring the discussion to a close with some form of summary.

The seminar setting should be around a large conference table where the participants may exchange information and communicate on a face-to-face basis. The traditional classroom rows of seating or theater seating is not appropriate for such seminar settings.

Independent Study

No discussion of instructional strategies for graduate study would be complete without some mention of what may be termed "independent study." It is the student's opportunity under faculty guidance to pursue topics or problems of a personal and an intense interest. Such an experience is at its best when the topic under study demands a form of self-discipline to pursue the depth of penetration from which satisfaction and accomplishment are possible. It is to pursue the elusive and to search for the infinite in a seemingly endless search for knowledge.

Such a process is greatly aided by knowing and practicing the means of good scholarship. The technique of discovery and synthesis must be learned and applied. The process of pursuing knowledge takes on different forms as one conducts a library search, a museum investigation, an interview with an expert, or the calculations and observations of an experiment.

The secret of independent study and its effectiveness is in many respects related to the tools, skills, and processes that the student has in his/her command. This is where faculty guidance and assistance can play an important role. It is a role, if played well, that can provide much satisfaction for both student and faculty.

Internships

The internship is, in many respects, a field experience with some form of contractual agreement between the student, the institution (or faculty advisor) and the individual or group to which the student is assigned. The internship may serve to provide the student with experiences directly related to a career goal, or it may be aimed at broadening the individual's perspective with respect to the functions and operations of a particular school, industry, business, governmental agency or educational professional association.

The key to a good internship experience is integrally tied to the kind and quality of prior planning and agreements that the three entities have consummated prior to the student's starting the internship experience. Such prior planning and agreement would include the following:

1. Purposes of the internships and what is to be accomplished.
2. Responsibilities of the intern.
3. Responsibilities of the individual or organization where the internship will be served.
4. Graduate program requirements that the student must fulfill.
5. Concerns related to security, priority, safety, and ethics.
6. Logistical matters, such as time or location, parking, hours of presence, limitations of involvement, lunch, liability and special requirements.
7. Compensation of the intern at the place of the internship, if any.
8. Approval at all levels as necessary at the school, as well as the internship place (organization or person).

As a final comment on the internship, it should not be a form of cheap labor for the internship group or individual. Nor, should it be an occasion for the internship group or individual to take advantage of the intern in getting him/her to do tasks or work that others are reluctant to perform in the organization.

Research Project Participation

One of the valuable kinds of graduate school instructional strategies is to have the students participate as research assistants (paid or unpaid) along with a senior faculty member on an on-going research project. The purpose behind such participation is to enable the student to experience the realities and the processes involved in conducting research. Each of the phases of research project development, as well as its conduct, should provide the student with concrete experiences that would enable the individual to put into practice much of the theory and concepts learned in research and statistics classes in other parts of his/her program.

The opportunity to have such a working relationship with a senior faculty member should go beyond the involvement in the conduct of the research project. A further, and perhaps equally valuable, part of such a research assistant role is the continuous interaction and dialogue between the professor and the student -- usually on a one-to-one basis.

The key to the richness of such an experience is dependent upon the attitudes that the mentoring professor and the research assistant have with respect to the experience. The faculty member must start with the frame of mind that the student is there to learn all that he/she can in the process of developing capability in the research procedures and practices.

Practicum

The practicum strategy provides an entirely different experience in graduate student instruction. The practicum may take two different forms of student experience. The first is a simulation format where the graduate student participants execute certain roles germaine to the purposes of the class or course. The role-playing experience is structured and designed to provide the students with a simulated involvement that may deal with such professional tasks as teacher evaluations, supervisory practices, counseling situations, parent conferences, IEP development, board of education presentations, staff meetings, and conference leadership.

The more realistic form of practicum experience is to provide the student/s with the opportunity to carry out selected tasks or assignments under direct supervision of the faculty or an appropriate administrator in the education setting.

The nature of the practicum experience should be designed and related to the nature of the goals of the students or the specific objectives of the class or course.

Teleconferences/Lectures (Audio)

The telephone conferences represent one of the excellent techniques by which the graduate students can experience contacts and exposure to leaders in almost any field of study. A typical application of this strategy might involve an educator (administrator, practitioner, college faculty or other expert) from some distance away from the campus of the program. The presenter would speak from his/her home or office. Another version of this audio teleconference procedure may involve a panel of experts from three of four different institutions or school systems, all feeding into the arranged graduate classroom or auditorium.

The receiving classroom or auditorium would have an amplifying unit supplied by the telephone company. This system would permit the graduate audience to hear as well as to talk back to the speaker in what is a two-way communication system. Visuals may also be used in such presentations with the speaker providing a numbered set of slides or overhead transparencies that can be projected on a screen at the request of the speaker.

Computer Assisted Instruction

The pursuit of graduate level programs in the present and future will in many ways involve computers. Such equipment and its accompanying software will be a vital tool in the processing of data and information retrieved through inter-library and inter-institutional networks, as well as networks between professional associations. A classic example of such a network is the Technology Link sponsored by the International Technology Education Association. Some states have their own networks for their schools.

Computers also may serve in the process of simulation, direct instruction, and interactive modes of instruction. Advanced courses in the use of robots, CAD-CAM operations, and a variety of control functions with different kinds of technology may also be a part of the program at the graduate level. The computer as a tool for research and statistical processes will continue to enhance the student's performance in these areas.

Demonstrations

The demonstration has been the workhorse of a great deal of the operational and technical dimensions of industrial arts/technology education at the undergraduate level. It is still an important strategy for instruction at the advanced technical level as well as in those classes devoted to translating theory into practice.

The demonstration of technical equipment and processes or theories into practice requires considerable skill, practice, and prior experience. The prior preparation of facilities as well as students or other personnel is critical. One of the critical dimensions of the demonstration strategy is the form of involvement in which the students take part. If the student is to be an observer that is one level of involvement. However, a more productive demonstration can take place if the student takes an active role in the conduct of the experience in addition to being an observer. The student may be involved in role playing, evaluating, analyzing, and synthesizing.

Faculty - Student Informal Interaction

One of the most valuable experiences of a continuing nature can be the informal interaction sessions between faculty member/s and student/s. This may be one-on-one sessions in the faculty member's office, in the faculty lounge, over a cup of coffee in the cafeteria, or in an automobile on the way to a conference.

These informal sessions are opportunities for greater understanding of issues and concerns that are rarely treated with such freedom in the classroom. It is also an opportunity for faculty and student to pursue topics of personal interest that may not be appropriate for taking up class time. It is an opportunity to explore ideas and test one's perceptions in an environment that is not as threatening as may be in the case of a formal class.

The informal sessions may also involve small numbers of faculty and students and may happen at "brown bag" luncheon programs, picnics, breakfasts, and lawn or beach parties. Each is an opportunity to broaden and deepen one's understanding in an atmosphere that is not restrained by the usual classroom atmosphere.

Concluding Comment

The matter of instructional strategies is integrally tied in with the factors of content, goals, students, faculty, and facilities. A good teacher is one who has many strategies in his/her instructional repertoire. The items discussed represent some of the tools of the craft of teaching and student development at the graduate level. Their effectiveness is a factor of teacher function in proper selection and use and they represent the essential instructional strategies of a quality technology education graduate program

Chapter 4

Tests and Measurements

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This chapter will briefly examine the kinds of tests and measurement experiences that a graduate student should encounter in master's and doctoral programs at high quality colleges and universities. However, before turning our attention to specifics, it is important to note that there are great differences in the tests and measurements preparation that students receive before they enter the graduate ranks. These differences are usually due to requirements of undergraduate teacher education programs, and they pose some problems for graduate education. Many states require at least one basic tests and measurements course for an undergraduate teacher education degree, some states have no such course work available, and some states provide a rich menu of available, but elective, courses. The graduate program that receives the students may have to take up the slack and provide some needed exposure to testing and measurement concepts. As a result, master's programs often try to "homogenize" the general level of test and measurement knowledge before students enter a terminal degree program such as the Ph.D. or Ed.D.

A working knowledge of tests and measurements is essential for every graduate student in technology education. Most will work in an instructional capacity, whether in a traditional educational setting (teaching technology in K-12 school systems, technical or community colleges), or in business and industry (providing technical skills training and industrial training). In each case, the instructor (or trainer) will be faced with the challenge of assessing the degree to which the students or trainees have learned the technical or cognitive skills that were taught. The practitioner will quickly discover that he or she needs some essential test and measurement skills. Some of the most important ones are:

1. Designing tests.
2. Conducting formative, summative, and ultimate testing.
3. Evaluating cognitive, psychomotor, perceptual, and affective performance.
4. Measuring the reliability of tests and quizzes.
5. Establishing validity of tests and quizzes.
6. Using norms, curves, and statistics.
7. Using alternative methods of evaluation.

Let us examine each of these at the master's and doctoral levels.

Designing Tests

The design of reliable and valid tests is both an art and a science. At the master's level, the student needs to gain a working knowledge of how to put together a viable test instrument that accurately measures the material that was taught. He or she must be able to use a table of specifications to develop a test that will provide the needed information about the learning and must be able to properly assemble the test instrument. This skill includes such tasks as writing directions and working with answer sheets, which are important for testing in all domains. For cognitive skills, at least three types of tests can be used: (1) multiple choice, (2) fixed answer, and (3) extended response. Each has its unique set of advantages and disadvantages, and indications for best use. For psychomotor skills, actual performance tests are often used, although it is often more cost-effective to test enroute behaviors or simulations of the actual performance. These general skills in test design should be included in the master's program and they should be reintroduced and reinforced at the doctoral level. Other topics of importance are dealing with observation, recording results with a rating scale or other instruments, and evaluating group activity.

Conducting Formative, Summative, and Ultimate Evaluation

Testing may be viewed in terms of the purpose for which the test is intended. If the testing is conducted during an education or training project for the purpose of assessing strengths and weaknesses and helping the student grow, it is called formative testing (a midterm examination). If the test assesses the total amount of learning that has occurred, it is summative testing (the final exam). If the test has job and career implications, summative testing would be an airline pilot's flight test and ultimate measurements would be the long-term flight record. Practitioners must understand these distinctions and correctly use assessments for the appropriate purposes.

Evaluating Cognitive, Psychomotor, Perceptual, and Affective Performance

Researchers as well as practitioners need to be adept at the art of evaluating activities. They may be faced with a wide range of job or task performance which must in some way be assessed. The tasks can range from laying a weld bead to flying an aircraft and may require various degrees and complexities of psychomotor, cognitive, and affective activity. This kind of evaluation is often referred to as the evaluation of performance. The continuing emphasis on competency-based instruction and the use of performance objectives in a wide range of instructional settings have made it important for graduate programs in technology education to provide instruction in how to assess performance, whether it is cognitive, affective, or psychomotor.

There are various performance evaluation techniques available that should be made a part of the graduate program. The simplest and easiest to manage are the measurement of enroute behaviors--subskills that must be mastered on the way to accomplishing the total performance (e.g., the proper method of "puddling" a weld is a necessary subskill). Next in line are job simulation activities, where sample job related behaviors are assessed. For example, a welding sample might be prepared in the laboratory and evaluated in terms of desired characteristics of welding. The final level is observation and evaluation of actual work activities, a much more expensive proposition, but one possessing significant advantages over less comprehensive measures because of the accuracy with which it predicts the performance of complex tasks. Graduates of master's programs should be capable of utilizing appropriate performance evaluation in all of these settings. Later on, the student's evaluation skills can be enhanced in doctoral programs where he or she learns to devise, validate, and manage the use of a wide range of activity or performance assessments.

Measuring the Reliability of Tests and Quizzes

The first requirement of tests and quizzes is reliability. All evaluation instruments must accurately and consistently measure the tested behavior or knowledge. There are several methods the individual teacher or trainer can use to obtain reliability, and these methods should be included in every graduate program. A good tests and measurements background should include training in how to establish and improve reliability through testing, how to use retest and split-half methods, and how to improve the reliability of instruments that have already been developed. Graduate programs with a focus on the future needs of the graduate student should stress the use of reliability techniques that can improve locally developed tests. Specialist and doctoral programs need to focus on the development and improvement of more sophisticated instruments that might have larger scale or commercial use.

Establishing Validity of Tests and Quizzes

After a test is found to be reliable, its validity becomes important. At the master's level, students should learn how to establish evidence for content (face) validity. This can usually be adequately done with the tools available to the classroom teacher, and so the master's program frequently aims to prepare graduates who can validate locally made tests. Doctoral programs should afford the opportunity to treat the subject at a greater depth and explore methods of establishing construct (factorial), concurrent, and predictive validity. Graduates should be able to clearly express the degree of validity that they measure and to defend their methodology. In addition, doctoral students should learn to use more sophisticated methods by which validity may be enhanced and improved. In our litigious society, it seems especially important to have the leaders in educational and private sector testing capable of assuring that all testing with which they are associated does in fact reliably measure the trait (or traits) that it was intended to measure.

Using Norms, Curves, and Statistics

One of the most difficult problems in the management of a graduate program is that of time. Typically a master's student is in residence for about one calendar year, perhaps a bit more. The doctoral student may be around for three years. In the available time, the students must build just the right mix of technical, methodological, and skill-building courses. After all is said and done, there is seldom time at the master's level for additional coursework, especially in statistics, but there is a minimum standard of performance that will be expected of holders of a postgraduate degree. This unwritten standard exists as a general set of assumptions that the master's degree holder can handle norm referenced measurements, descriptive statistics, and basic tests for differences, regression, and the like. What this adds up to is the need for at least one good course in basic tests and measurements or basic statistics. For a practitioner in education or industry, this level of preparation should be acceptable.

As one ascends the career ladder, additional and more sophisticated skills are necessary. Doctoral graduates should have sufficient test and measurement and statistical expertise to enable them to be critical and sophisticated users of research and practitioners in the art of student and program evaluation. Since most large scale measures are norm referenced, it is important to develop a sound background in the meaning and value of norms and norm groups, normal and abnormal distributions and their effects upon instrument reliability, classical test development, and the basics of latent trait testing.

Using Alternative Methods of Evaluation

Not all evaluation is linear and quantitative. Often, we are faced with an evaluation problem that lends itself to a different (qualitative) approach. Such methods are extremely powerful and have their uses, but they are not new.

One example of an alternative evaluation data that has been around for years is the graffiti (or graffitus, if there is only one). For thousands of years, people have been writing on the walls, reading what was written by someone else, or trying to understand just what was meant by the writer. This process continues more or less unchanged today. It is one method of indirectly ascertaining what is on the mind of the writer.

A more up-to-date example might be the problem of assessing the effect a safety training program has had on industrial workers. Are there fewer accidents? If so, direct evidence may exist. But, in the absence of direct evidence which sometimes takes months or years to assess, what indirect indications are there? Do the workers organize their work areas? Is the general level of housecleaning better? Are the work activities occurring in what appears to be a safe manner? These observations of enroute behaviors can shed light on questions that for practical reasons cannot be answered directly. Here is a happy example of the synergism that should exist in a good graduate program: the skills learned in research methodology, statistics, and tests and measurements courses form a coherent whole and enable the student to conduct a defensible evaluation based upon observation and measurement.

Conclusion

The truly outstanding graduate program should contain elements at the master's level that enable students to construct affective, psychomotor, and cognitive measures of achievement or performance; plan, construct, and administer valid and reliable teacher-made tests; evaluate teacher-made tests from a local perspective; evaluate commercially-prepared tests and inventories; and accurately interpret the results of teacher-made tests and commercial instruments. Moreover, students should be able to use subjective and objective evaluation techniques in appropriate situations. With an adequate statistical background, students will have powerful skills that may be used in educational or private sector settings to increase the accuracy with which they evaluate learners and systems. For example, this important skill can be used to critique and improve one's own examination and evaluation techniques.

At the doctoral level, the best programs will enhance these skills by providing experiences that focus on classical and latent trait test construction with a richer statistical background that enables students to perform state-of-the-art analysis and investigation. The proper use of powerful and sophisticated techniques of analysis will move the potential of the graduate from being merely a consumer and user of testing and research to a producer of useful evaluation techniques in research and education. Such an individual will be self-confident and secure in the knowledge that the results of testing and evaluation are accurate and that decisions based upon them will be well founded.

Chapter 5

Graduate School Regulations, Requirements, and Resources

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Quality graduate programs in technology education are influenced by many factors. Important components which contribute to this quality depend on several considerations: admission standards, credit requirements, residence, examination requirements, computer support, laboratories, and library resources. Obviously this list is incomplete and there are many other factors that help make quality graduate programs. Several of these other factors will be discussed in the subsequent chapters of this monograph.

This chapter is divided into four sections which cover the following major topical headings: admissions standards; length of program; residency and examination requirements; and library, computer and laboratory resources.

Admission Standards

Standards for admission into technology education graduate programs should be listed in three general categories: scholarship, work experience, and personal qualifications. Most master's degree programs require a 3.0 out of 4.0 or better undergraduate grade point average for full admission to a graduate program. An undergraduate point average shows a relationship between all the grades earned compared to the total number of credits in all courses attempted at or upon receiving a bachelors degree. Many schools use a scale of quality points per credit for determining GPA. For example: one point may be earned for a D, two points for a C, three points for a B, and four points for an A. Some schools have divided this even further by having plus (+) and minus (-) being given some fractional point value.

The practice of requiring evidence of scholarly ability for admission into technology education graduate programs should be continued. However, prospective students with less than this standard GPA may be admitted at one of several other possible categories of admission such as provisional, restricted, or non degree admit, if they show promise or potential for excellence in one or both of the other areas for consideration. It must be noted at this point that the undergraduate GPA is also evaluated for admission at the doctorate level. The master's degree GPA, although examined and taken into account, is usually not recognized as the sole criteria of scholarship for admission for the doctoral degree.

Since "the master's degree . . . was intended to provide opportunities for individual scholarship and research in a specialized subject area, thus enabling a person to develop a mastery within an academic discipline," (Buffer, 1979, p. 296) it is recognized that any candidate should have had at least two years of full-time teaching experience within the discipline prior to graduate study. Without this practical experience, the master's degree--although quite attainable--may not be as beneficial in terms of identifying important problems for research and making scholarly contributions.

Personal qualifications such as effective oral and written communication abilities, evidence of professional leadership, and an acceptable level of maturity are all considered essential attributes for any potential graduate student. The academic and intellectual demands placed upon graduate students are tremendous. Failure to consider these aspects as part of the total list of requirements would be negligent.

Other considerations in this area may include the evidence of successfully conducting scholarly research. This may be demonstrated by publications in professional and trade journals and other professional activities such as reporting curriculum development activities at professional conferences and participation in grantsmanship.

Departments of technology education may require potential graduate students to score above a national norm score on graduate level entrance/placement exams. Specifically, some departments require the Graduate Record Examination for all prospective graduate students and the TOEFL exam for foreign students. In most cases these departments have established minimum acceptable scores for each subsection of these examinations. All of these test results serve as one more source of information for admission purposes. Such test scores can also serve as indicators of the student's strengths and weaknesses. Furthermore, identification and clarification of the prospective student's educational goals would also help to plan the implementation of a meaningful program of study and research.

Length of Program

The credit weight of the master's degree program should be somewhere between 30 to 36 semester hours. This may vary somewhat depending on the strength of the technology education undergraduate program of the student. Ultimately there would be a core of courses dealing with statistics, research methodology, testing, and evaluation. This may be approximately 12 semester credit hours and would include several hours (3-6) for a thesis.

Another area of coursework may include curriculum development, administration and supervision, history, and development of technology education courses. This area would also consist of 12 semester hours.

The final area of the program must be the technology education core. This is the area that may vary in length according to the candidate's undergraduate program. This area must include coursework in the implementation of computer into technology education courses, and advanced technology laboratory coursework specifically geared towards upgrading knowledge and skills within several of the areas of technology. This area must also include coursework on the philosophical basis for technology education, current and future issues and trends in technology education, and methods of implementing technology education content into existing courses should the student's undergraduate degree coursework lack such in-depth experiences.

The maximum time allowed for attaining a master's degree once the coursework is begun may vary from three to five years.

The primary intent of graduate study is to improve philosophical insights, teaching capabilities, and research competence, even though many simply have a strong motivation to gain another step on the salary schedule. Important as this may be, salary increase alone must not be the primary reason in pursuing a graduate degree.

The length of the program for a doctoral degree varies from 72 to 84 semester credit hours. These credits will generally include coursework completed for the master's degree if the coursework is current. As with the master's degree, the requirements for the doctoral degree should vary slightly according to the educational background and work experiences of the student in question. Generally the doctoral degree should take between three and four years of additional full time study beyond the master's. As a general rule, at least 24 of those hours should be within the major area of technology education. Another 18 hours should be required to be taken in some relevant cognate area outside of technology education.

The same categories of coursework as found in the master's degree should also be used for the doctoral degree. Further study of philosophy, administration, curriculum development, and evaluation is essential along with statistics and research courses. The time allowed for completion of the doctorate should be no more than seven years following the first coursework.

Residency and Examination Requirements

While basic admission standards and time limits for degree completion are desirable, the expectations in terms of full-time study and residency are critical to quality graduate programs.

Ideally residency requirements should be in effect for both the master's degree and the doctoral degree. It is most important for a quality graduate experience that a student be where he/she can study a discipline in depth as well as have significant interactions with other graduate students, professors and other members of the academic community. This interaction also includes being near and having immediate access to the scholars and research facilities of a university. However, given the fact that many states require the completion of a master's degree within three to five years for continuing certification, the residency requirement at the master's level is impractical.

To help overcome this constraint, master's degree students need to be encouraged to become involved in local, regional and national professional organizations. These associations will provide some of the benefits that would normally be gained through the requirements of residency. Those who can spend two or more consecutive semesters on campus should be encouraged to do so whenever possible. The benefits accrue to the student from the constant interaction with other graduate students and faculty.

At the doctoral level, residence requirements are generally maintained. With the emphasis at this level being placed on such areas as research, evaluation, philosophy and curriculum development, the significant interactions with others in the academic community become essential. Each student must build a firm foundation of educational theory, research, methodology, statistics, and knowledge of technology education to be able to execute sound research and further the discipline.

Periodically, it is essential to assess the graduate student's growth and readiness to conduct research. A variety of examinations can be administered for these purposes.

All master's degree students should satisfactorily pass a written exam before becoming a degree candidate. This exam would be given for the purpose of ascertaining the student's mastery of a specified core of material relating to technology education. Depending on the results of this exam, the student may (1) be required to take additional courses to bolster an area that may be deficient or (2) move on to the next phase of the degree program which should be the completion of all coursework followed by the writing of a thesis or creative project. A master's thesis in technology education must be a scholarly work, demonstrating the author's ability to accomplish independent and creative work. It is essential that the thesis be precise and logical and augment the knowledge within the area of technology education. The completion and oral defense of this thesis should be the final phase of the master's degree program in technology education.

For doctoral degree programs in technology education, there should be a written preliminary examination given at a time that is close to the completion of all formal coursework. This written examination is given to comprehensively test the student's grasp of the subject matter and determine one's readiness to conduct independent research. The written examination should be followed in short order by an oral examination to determine if the student possesses the prescribed minimum standards of knowledge within the general major, research methodology, statistics, and any other supporting subject areas. This procedure should be successfully completed before a doctoral student is admitted to candidacy. The doctoral dissertation affords the candidate the opportunity to demonstrate the ability to formulate, design, conduct, and interpret research. This research effort must attempt to significantly contribute to the advancement of the knowledge of technology education.

After the dissertation is completed, the candidate should orally defend the research effort. This allows the committee to determine if the candidate's efforts have been successful and that the candidate possesses the qualities necessary for a scholarly career.

Library, Computer, and Laboratory Resources

Quality graduate programs are facilitated when adequate institutional resources are available to provide support in terms of computers, extensive library holdings, and research laboratories.

To adequately prepare graduate students, computing resources must be available. Adequate computing resources not only include the usual hardware (terminals, cpu, disc drives, printers) and software (word processors, spelling checkers, statistical packages) but also the specialty peripherals, control software and consulting services to support the research and instructional needs. The graduate experiences cannot be limited to using microcomputers only since certain computer-based analyses and simulation can only be accomplished on mainframe computers and some minicomputers.

Since the use of computers in technology education is relatively new, especially the use of microcomputers, there is a tendency to make the computer itself the focus of the classroom instruction. How a computer is built and how it functions electronically and how to program computers are important content areas, but they should be only a small part of the total graduate curriculum. More emphasis must be placed on the use of the computer as a tool in the classroom rather than studying the computer as being the subject of instruction itself. The use of the computer must be integrated into the curriculum in order to go beyond the traditional curriculum content base.

Several specific examples of computer usage within the classroom are in the areas of simulation, modeling, monitoring and control of experiments as well as data organization. The technology education graduate student must also have the opportunity to learn to use the computer for word processing, spelling check, thesaurus, spread sheet analysis, development of data bases, CAD/CAM/CIM, and graphics, to mention a few applications. The computer is a fact of life today and will become more so in the future. Therefore, it is imperative that its use becomes almost second nature to all in the field of technology education.

One of the most important considerations with regard to graduate program quality is the availability of and access to adequate resource materials. The library is central to providing these resources and services that support teaching, research, and the independent study usually required for graduate work. Library resources must include the various computerized research support and information systems for accessing the accumulated knowledge such as ERIC, LARS, and MASUA, as well as subject matter specialists to assist the student. The library holdings must include special collections for research along with current periodicals and textbooks relating to technology education. For example, these holdings should include materials on such topics as societal and environmental impacts of technology, selecting appropriate technology, research and problem solving, understanding the process and principles of innovation, and technological forecasting as well as the history and philosophy of technology education. The primary difference between these holdings and those usually found for industrial arts courses is in the breadth of the topics within the field of technology education. The absence of these more comprehensive materials would hinder any graduate student by not enabling the consideration of all aspects of the past, present, and future technological developments plus the impacts of these changes. Without this quantitative and qualitative support from the library, a graduate program in technology education would be lacking in strength and direction.

Laboratory resources for a graduate program in technology education must be flexible enough to provide the learning environment which allows a broad, conceptual approach to the understanding of technology. This can not be accomplished by unit laboratories organized around a specific material or activity. The materials, equipment, and walls of this facility must all be movable to accommodate the process to be used or the problem to be solved.

The resources found within these laboratories must be among the latest that technology has to offer. It is important to facilitate both the updating of skills and knowledge as well as the creative, problem solving, and research activities on the part of the student.

Summary

The task of building and maintaining quality graduate programs is complex, costly, and time and energy consuming. It is also rewarding, critical, and essential if technology education as a discipline is to provide for its own growth and renewal.

What is apparent is that wherever quality graduate programs exist, generally able students are attracted, quality standards are retained, a quality faculty is maintained, vital research is conducted, institutional support is garnered, and the respect of leaders in technology education is obvious.

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Chapter 6

Graduate Faculty

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Expectations for faculty members who teach graduate courses and advise graduate students vary greatly among colleges and universities across the nation. There is a distinct difference in academia between those institutions where the master's degree is the highest degree offered and those where terminal degrees are available.

Achieving Graduate Faculty Status

Professors with a doctoral degree are typically eligible to achieve graduate faculty status through an evaluation process. This can be anything from a subjective review of a resume by an administrator to consensus approval by a graduate studies committee or the actual voting of a peer into membership by faculty colleagues with graduate status.

Peer review with committee consensus seems to be the predominant method for approving graduate faculty status. The process does not vary nearly as much as the difference in criteria upon which judgements are made.

Criteria for acceptance usually are expressed by expectations in the areas of research/grantsmanship, service, and teaching. The relative importance of each category depends on the institutional demands made of the faculty members seeking status. This is especially true among the large research oriented colleges and universities where faculty members are expected to conduct historical, experimental and/or descriptive research. There, the researcher is almost compelled to collect data and publish findings as a contribution to a body of knowledge within the field of expertise. These should benefit the professions and/or provide a form of individual and institutional visibility. Further recognition for both comes from presenting papers on research results before diverse audiences.

Associated with the need to engage in research is the necessity to become competent in grantsmanship. There is increasing pressure to seek project funding from external (to the university) sources. These funds are expended to enable the faculty member to continue to pursue topics of self-interest and/or in conjunction with helping to meet the needs of outsiders. Therefore, a great amount of the faculty member's time is spent in preparing proposals or responding to the RFP's (request for proposals) from agencies to continue ongoing projects.

Few rewards are forthcoming unless there is a sharing of knowledge gained through research and grantsmanship. As a result of professional activities within the field, publications, and presentations, both the faculty member and the representative institution are acknowledged. This may serve as a method for achieving individual visibility as well as a catalyst for recruiting efforts which often make it desirable for graduate students to enroll and study under the person where interests are common. Thus personal recognition, institutional visibility, and student recruitment become essential criteria for quality graduate programs. A college or university dedicated to graduate education should provide travel money for promotional purposes.

Service within the educational institution and the profession are additional expectations for graduate faculty members. There is an obligation to participate in inter- as well as intra-disciplinary activities. The growing support for Science-Technology-Society programs provides an excellent opportunity to strengthen technology education's ties with other disciplines in the university. Many endeavors seem to succeed or fail due to the interest and enthusiasm displayed by participants. Thus, committee contributions and consultancies appear as more subtle means for professional and program recognition.

Exemplary and innovative teaching is also essential to quality graduate faculty members. Keeping abreast of advancements within the field through conferences, seminars and other learning opportunities keeps the faculty member and the students up-to-date. This has to be translated by a contemporary faculty into revising and increasing course offerings.

Advising Graduate Students

Graduate faculty members find themselves advising students in many areas. In addition to advising students on their advanced educational program development, there are matters of compliance with university or college policies, departmental practices, financial assistance, funding resources, professional matters, and often counseling of personal problems. Lack of expertise in any of these areas can cause undue delay in providing students with appropriate information.

The advisement process usually begins after student admission and acceptance. Once enrolled in a graduate studies program, the student has need for guidance toward two different goals. One goal relates to the selecting and completing of coursework, both a core of major courses in technology education and often one or more support areas of interest such as administration, curriculum and instruction development, evaluation, and human resources development. The second goal deals with satisfying exit requirements, such as a comprehensive examination and/or research in the field.

There is the necessary assignment of a qualified graduate faculty member to the student. This may be done on a temporary or permanent basis. Having a tentative advisor who gets the student started properly in the necessary sequence of courses is the most beneficial. It allows the student to become acquainted with the faculty and then exercise the option of choosing an advisor with mutual interests, especially in the area of research if the student pursues a thesis or dissertation as a requirement or comprehensive examination option.

The most desirable relationship is that the advisor and student develop a rapport conducive to learning on the part of both people. This process of open communications should exist until the student graduates but may continue for many years thereafter. If there is a disagreement that cannot be resolved, there should be the opportunity for the two to part company without animosity, and for the student to find another advisor.

Master's Degree Students

After a collegiate advisor-student relationship is established, meetings and discussions are held periodically as the student proceeds through the coursework. This keeps the advisor informed of progress, especially at the master's level. The advisor also assumes responsibility for directing the requirements. There likely will be one or more additional graduate faculty members involved in the exit process. These additional people reduce the influence of advisor bias in the final decision to grant the degree.

Specialist or Doctoral Degree Students

A more complicated procedure is involved for the specialist or doctoral degrees. There must be a graduate advisory committee actively involved in approving the program of study. The committee is composed of the advisor, one or two members of the program in which the student is studying and a graduate status professor from another department or organization within the college or university. They meet with the student and approve the program of study. Within certain parameters, the advisor and student may alter the plan of work as goals may change. Upon completion of the majority of course work the committee will conduct a general examination. The same or a different committee may be formed for conducting the dissertation defense and approval.

Selecting the advisory committee is critical for the student. The members should have a professional desire to assist the student during the program. It is recommended that the student and major advisor consider a list of names of people who the student might interview. Thus, rapport can be established with a broader group of faculty members who can suggest program changes as time passes.

Graduate Faculty Professional Expertise

Graduate faculty members should display positive leadership traits to students by assuming a mentor role. Faculty must possess the knowledge, skill, attitudes, and values related to quality education. These would likely include philosophy, curriculum, instruction, evaluation, facilities, administration, and supervision. Members should also be involved with conducting and reporting research in which advisees may participate as time and interest allows. Opportunities to work as co-authors and co-presenters with graduate students to disseminate results of scholarly works should be pursued. Periodically there could be committee assignments, within the educational institution and at local, state, and national levels where the student (future leader) observes the mentor (current leader) in professional settings.

The key to a good graduate faculty is how active its members are. A good graduate faculty member should be active in professional associations, research, and student development.

Graduate Faculty Technological Expertise

A graduate faculty should have representatives from each of the major areas of technology content.

Each faculty member needs to keep abreast of the developments in the area of his/her technological expertise. This involves knowing the state of the art at both the development and implementation levels of technology. An understanding of the rationale used for the derivation of curriculum in each technology is important. It is vital that each faculty member understand the relationship of their area of technology with the others.

The type of graduate program being offered has a great deal of impact on the faculty needed. A technically-oriented master's degree program designed to produce students who will have supervisory responsibilities in industry requires a faculty with skill in the actual usage of the tools and processes used by industry. A program with a goal of developing educators is in need of a faculty experienced in the classroom that can develop curriculum for use at elementary, middle, and secondary levels. This often requires an ability to distill a large amount of information to its basic concepts and simulating much of what happens in industry.

Summary

Graduate faculty members assume responsibilities for individual, professional, and institutional visibility. This is why an evaluation process is used for member selection. Each individual is obligated to demonstrate leadership traits, which they demonstrate through example to advisees and members of the professional and lay community. Without this commitment to quality education, the profession could not justify an institution's support for graduate education.

Chapter 7

Research and Scholarly Activity

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Research and scholarly activities are central to the purposes of graduate study. Indeed, research has traditionally constituted the core of the graduate program in most disciplines. Contemporary graduate programs in technology education are characterized by a strong emphasis upon the development of research skills. Graduate students are engaged in significant research activities and are involved in the preparation of research reports and the publication of their findings.

The ability to engage successfully in the independent pursuit of disciplined inquiry is a prerequisite to a scholarly career, especially in academe. As a minimum, graduate programs should: (1) immerse students in the body of knowledge in the discipline and related fields; (2) involve students in the evaluations of new applications of knowledge and the assessment of its effectiveness in use; and (3) prepare students to engage actively in the search for new knowledge.

The best graduate programs are characterized by continuous involvement of graduate students in research activities. Early in their graduate programs, students should have an opportunity for meaningful participation in on-going research programs of graduate faculty members. After this initiation, students should have ample opportunities to work as a member of teams engaged in technical research and educational research relevant to technology education. Thesis research, a major component of most research-oriented graduate programs, then provides an opportunity for significant individual research. Ultimately, guided research experiences should enable students to become competent researchers, capable of independently conceptualizing, conducting, and reporting major scholarly endeavors.

Basic Research Techniques

Scholars in technology education need to develop research capabilities in two distinct areas: technical research and educational research. Strategies and techniques of technical research are closely related to the research traditions of the physical sciences. DeVore (1987) described the commonalties and differences between technical research and scientific research, a distinction which must be kept clearly in mind when considering the role of technical research in technology education.

Educational research, on the other hand, utilizes research approaches similar to those used in the social sciences. While there is substantial overlap between these two approaches to research, the differences between them require careful attention from the planners of graduate programs. Each pattern of research has its unique strategies for problem definition, research design, data analysis, and the preparation of the research report.

Technical research should occupy a major role in graduate studies in technology education (Israel and Wright, 1987). As a part of their course work and independent study, graduate students should conduct experimentation in the comparative advantages of materials and products and in the effectiveness of procedures for different applications. They should develop competence in the manipulation of variables in the laboratory setting to conduct scientifically reputable experiments, in the accurate assessment of outcomes, and in the scholarly reporting of findings.

The conceptualization of the technical research project is critical to its success (Weede, 1987). Seymour (1987) provided a concise description of the technical research process, beginning with the conceptualization of the project and continuing through the development of the research design, the preparation of the research proposal, the selection of the procedures to be used in carrying out the investigation, the analysis and reporting of results, and the evaluation of the project.

Educational research, as it is applied in technology education, is quite similar to educational research in other specialties within education. Educational research focuses upon the ways people learn specific content or develop competencies in specific settings, upon predicting the outcomes of educational treatments, and upon the management of the educational enterprise for maximum efficiency (Sowell and Casey, 1982).

As an educational specialty, technology education has uniqueness in content, setting, and purpose; it also has significant commonalties with related educational disciplines. Consequently, graduate students in technology education may engage in the study of educational research and the development of educational research competencies in courses which serve only technology education majors or in courses which serve graduate students in several specialties in education, or in some combination of general educational research courses and specific technology education research courses.

Investigations into the educational problems in technology education require mastery of the full range of education research designs and techniques. Researchers in technology education need competencies in conducting educational research through survey research techniques, naturalistic inquiry, historical research, casual-comparative studies, and correlation methodologies (Borg and Gall, 1983). In addition to competence in descriptive research, technology educators should develop skill in working with experimental and quasi-experimental designs (Campbell and Stanley, 1963). Research using experimental designs is essential to the process of hypothesis testing and verification which is required to expand the knowledge base of technology education.

Statistics

Graduate students in technology education need to understand the assumptions, applications, and limitations of non-parametric and inferential statistics. They need to be comfortable with the theory and applications of probability, with simple non-parametric statistical treatments suitable for action research in classroom and laboratory settings, with appropriate data analyses in exploratory investigations utilizing quasi-experimental designs, and with the wide range of statistical treatments suitable for testing hypotheses under experimental conditions.

While the actual computation of virtually all statistical manipulations may be most efficiently performed by computers, researchers must assume responsibility for selecting appropriate statistical tests and for insuring that the assumptions underlying those statistical treatments are met in the research setting. Reliance upon software, a statistical consultant, or a computing center cannot be substituted for a thorough understanding of the statistical analyses which are being performed to test hypotheses or to assess the outcomes of research. As advancing technology makes it relatively easy to perform multiple complex computations, it becomes ever more imperative that the researcher employ only the most appropriate statistical treatments to avoid unnecessary introduction of spurious "findings" from irrelevant analyses.

Research Papers

Graduate programs in technology education should emphasize the preparation of research papers in each graduate course. The selection of topics for study and the technologies to be utilized should, of course, be consistent with the content and purposes of the courses. Research papers provide graduate students with opportunities to build research, writing, and reportorial competencies through a series of guided experiences within the relatively sheltered setting of graduate courses. As faculty members provide feedback on content, procedures, organization, and presentation, graduate students have opportunities to build their capabilities in the presentation of the findings of their disciplined inquires in forms which communicate to professional colleagues. Competence in the preparation of research papers undergirds the process of writing for professional journals and other formal, public presentations of research findings.

Journal Writing

Graduate students who intend to make contributions to the advancement of their profession must become effective in presenting their ideas and research findings in print. Scholarly publication in journals, monographs, and books is still the primary means of disseminating research findings, despite the advent of much faster means of transmitting information. While it is possible that the pre-eminent role of professional journals may be supplanted by electronic media, the skills needed to prepare manuscripts for publication are highly transferable to other media.

The preparation of good articles for professional journals is a complex and difficult process. The research findings must be organized and presented in a format which can be subjected to reflective analysis, first by the reviewing panel or editorial board, and later by the readers of the journal. Because the journal is a public forum for scholarship, there are no limitations upon access to the findings by other scholars. As a result, scholarly publication exposes the written presentation to potential refutation in ways which are unknown in the spoken forum or the research paper prepared to meet the requirements of a graduate course.

Journal publication offers the best forum currently available for the concise presentation of research outcomes. By frequent, consistent publication of the results of their research, technology educators can become widely recognized for their expertise and for their contributions to the advancement of knowledge in the field. It is possible to develop substantial spheres of influence within the profession, using journal publications as the primary mode.

Graduate students should begin their publication programs while they are engaged in graduate study. Many senior colleagues or faculty members are willing to assist potential authors by critiquing manuscripts or by including the writers in a multiple-author arrangement. Such experiences can serve as a springboard to later publication success, building confidence and competence which will facilitate the efficient preparation of future journal articles.

Research Applications

Technology educators are, fundamentally, consumers of research findings rather than producers of those findings. That is, educators rely much more heavily upon the findings of others than upon knowledge generated as a result of their own disciplined inquiry. Consequently, an important objective of the research component of graduate study in technology education should be the development of the capabilities needed to analyze the applicability of research findings in the professional practice setting (Gay, 1987).

Research findings make their primary contribution as they are applied to resolve actual problems facing humankind. Technology educators need to be capable of translating the outcomes of technology research into modifications of procedures or techniques to improve their efficiency and/or effectiveness. To do so requires comprehensive understanding of the limits of generalizability, the effects of probability upon replications, and the monitoring of the effectiveness of the application of research findings in a new setting. Thus, graduate programs should provide appropriate experiences in reading and interpreting research findings in technology education. These experiences typically precede the actual involvement of graduate students in research; it is also desirable to continue the reading and interpretation experiences throughout the program of graduate study.

Basic and Applied Research

By definition, virtually all research in technology education is applied, rather than basic. While there are occasional exceptions, for example, when a technical research activity unexpectedly yields new knowledge or a new combination of chemicals, such examples are cited much more frequently than their actual occurrence merits. The creation of new knowledge is generally conceded to fall within the realm of scientific research--and is actually much rarer, even in the "pure" sciences, than most observers believe. The discovery of truly new knowledge is a rare and esoteric event, difficult of accomplishment even with the best of planning, design, and research management.

Technology education is a focus of the applications of knowledge developed in other disciplines, both in the physical sciences and in the social sciences. Consequently, technology educators must build their capability to integrate knowledge generated by basic and applied research in diverse disciplines and in a variety of settings. To apply research findings from the physical sciences and the social sciences frequently requires that action-research activities be undertaken to assess the effectiveness of the new and frequently experimental integration of knowledge from disparate sources.

Professional Development

Research is a dynamic enterprise, one in which new work is built upon the findings of previous generations of scholarly activity. Consequently, the scholar is faced with the continuing need to build competence in research after completing formal graduate degree requirements. On the one hand, the researcher must cope with the exponentially expanding knowledge base upon which the subsequent research must be built. In addition, research techniques, the tools of the scholar, undergo continuing evolution and development--and sometimes revolutionary change.

It is a paradox that research and scholarly activities also serve as primary means for professional career development for many technology educators. It is, after all, the individual professional who must develop, and it is frequently more efficient to approach the need for new knowledge through independent research and scholarly activity than to enroll in and attend formal courses or workshops to master new technical information or to become competent in new techniques in professional scholarship. Thus, the technology educator uses research skills to enhance professional competence, not only in research, but also in technical skill development and in the enhancement of professional competencies.

Summary

Research plays a prominent role in graduate programs in technology education. As graduate students engage in the diverse forms of disciplined inquiry in their field, they have opportunities to challenge the best work of their predecessors, to interact with the best minds of the day, and to contribute to the development of their discipline. Their success in these endeavors will be determined, in large part, by the strength of their preparation in the foundations of technical research and educational research.

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Chapter 8

Program Development and Implementation

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Most colleges and universities operate on a foundation of democratic principles which provide for faculty participation in the decision-making process and ensure academic freedom. Faculty participation generally comes through the department/college/university committee structure that correlates to some extent with the administrative structure of the organization. Universities are bureaucratic organizations. Therefore, program leaders will have to know the unique features of the bureaucracy and how to make it work to best advantage politically to effectively develop and implement a quality technology education program.

Because universities are large bureaucracies, change comes slowly. Tucker (1984) stated that "institutions of higher education in particular are conservative and resistive of change." The conservative, change-resistive nature of the university tends to make the development and implementation of quality graduate programs in technology education a difficult task for the novice.

It is often said that "people resist change." However, it may be more accurate to say that "people resist being forced to change." This is especially true for university faculty who resist being forced to change. Because change brings with it some risks and resistance, the developers of technology education graduate programs should consider the following factors related to change:

1. Few institutions change spontaneously. Hefferlin (1972) suggests that the most important factor influencing change is the market conditions under which educational institutions operate. A department's curricular offerings must be able to attract students, and the working conditions must attract faculty members who are willing to implement the curriculum.

2. Each university has its unique, historic orientation for change. This orientation tends to be self-perpetuating, which suggests that for meaningful change to take place, it may be easier to replace persons than to change their attitudes. Frequently, curricular changes must take place at the time when established professors retire or leave and new ones are hired to replace them.

3. Changes in colleges and universities do not take place unless the faculty is convinced of the desirability of the change.

4. The institutional structure can be an aid or a barrier to change in curriculum and program. The decision making process may be facilitated by clear procedures, by the nature of the committees within the department, and by the rules that govern the curriculum at the institution. Written departmental and college bylaws and policies may assist in the change process.

Open communication with faculty, students, and administrators will be required to effectively implement graduate curriculum changes. To provide a vehicle for communication, a research-based document outlining the program and the premises and philosophy should be developed. The development of such a document can also assist the developers in clarifying their ideas and programmatic direction. Such a document should be prepared following the prescribed institutional guidelines and should consider factors such as department goals, administrative support, faculty support, financial support, students, and evaluation.

Department Goals

The graduate curriculum should be responsive to the needs of the students, the needs of the discipline, the needs of the community, and the needs of the institution. While the curriculum necessarily reflects the capabilities of the faculty, it can become stagnant if not monitored and correlated with the departmental goals. The goals and objectives for the department must be congruent with the desire to have a graduate program in technology education. Once the departmental goals and objectives have been established within the institutional and societal framework, then the curriculum can effectively be changed.

Administrative Support

It is imperative to have administrative support for the establishment of a quality program in technology education. The first line of administration is at the department level. The department chair/head should lead the faculty in moving the graduate program in the direction of technology education. The department administrator may be the person who will carry the proposals for curriculum change to the higher level of the university. Even if the chair/head is not the person who carries the program proposals forward, he/she will know the bureaucratic maze and likely will have the political contacts to assist. Department administrators also can facilitate or hinder implementation of a graduate program. They control factors such as faculty teaching schedules, budget allocations, and appointment of faculty to department curriculum committees. Thus, it is imperative that the department administrator be supportive of a technology education graduate program.

The college dean also needs to be supportive for a program to be developed and implemented. In most cases to gain the support of a dean who may or may not understand technology education, it will require the development of a comprehensive document with a strong research base to justify the importance of the program. The purpose for a comprehensive, research-based document is effective communication with administrators and university curriculum committee members.

Faculty Support

A major consideration in the development of graduate programs to reflect technology education is the involvement of faculty. The faculty of a university in effect "own" the curriculum. Hence, curricular changes should not be forced upon the faculty by administrators; rather, the changes should involve contributions from faculty and faculty committees.

The department's faculty will be responsible for developing and delivering new courses. Without faculty commitment, it will be difficult for a program to be implemented effectively. Where faculty are not fully supportive of technology education, an effective strategy to implement change is called "incrementalism." Incrementalism is a change process that moves in small steps, or increments. 1ᶜ effect, it allows for an evolutionary change over time.

Financial Support

Quality programs cannot be developed and implemented unless there is sufficient financial support. During development, it may require a commitment of faculty time to review the literature, develop the research base, review the institutional components, and prepare the documents and course outlines for the program. All of these tasks take time and cost money. In addition, once approval has been granted, funds must be available for instruction when implementation of the program takes place.

Recruiting Qualified Students

Most institutions require that programs generate sufficient instructional units for the program to continue. Courses with low enrollments tend to be cancelled, as are programs with few majors. To recruit qualified students, it will require a quality program and will take extra effort by the faculty. Hence, the faculty need to be committed to the program and fully entrenched in technology education philosophy to effectively attract the students.

Evaluation

How do we know if the technology education program is quality unless a comprehensive evaluation is conducted? A research and evaluation program should be established at the beginning of the program development implementation. Universities, and graduate programs, in particular, have a major research and development mission. Hence, research should be conducted at each institution concerning the content, experiences, students, and outputs concerning the graduate program. Several institutions should collect similar program data for comparison purposes across institutions to determine the most effective models and experiences for preparing technology education professionals at the graduate level.

After considering these factors, it must be understood that curriculum change is a political process at universities. Curriculum change to reflect technology education can be used for purposes beyond the actual program itself. In some cases, departments have used these curricular changes to establish a "position" or "reposition" themselves on campus. Positioning is important for future considerations--including resource distribution. A quality, research-based curriculum change can demonstrate that the department is scholarly, futuristic, and a credit to the university.

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Summary

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This monograph has addressed the issue of essential elements for quality technology education programs at the graduate level. A survey was conducted to determine what elements were important to consider in the change process of converting graduate programs in industrial arts to technology education. The Graduate Studies Committee then analyzed and summarized the survey data and developed the outline used to organize this monograph. They also identified the authors based upon their experience and credentials with technology education and graduate level study. The result of this effort is an important piece of work that can help curriculum developers, innovators, and leaders focus in on the basic elements that assure quality in graduate level technology education.

As with all major curricula changes the first element to consider is the philosophical underpinning of the discipline and the primary goals of the curriculum. Paul DeVore reminds us to look at our purpose in the real context of the society we live in today. That society is highly technological and impacted by changes in the social order and the life-giving and life-sustaining environment. He furthers, "The preparation of citizens who can act intelligently and responsibly in the complex technological world . . . is a primary order of business in a democratic society . . . and [sic] for graduate programs of technology education . . ."

Indeed the issue of technological literacy is a primary concern of technology teacher education and should be a major issue for debate, study, and research at the graduate level. Our over-indulgence in pedagogical technique must give way to studying the discipline, its structure, paradigms, and content; while at the same time exploring new ways to deliver the exciting new program. Author Ronald Jones offers a systems approach as an alternative to the traditional method of developing curriculum. He cautions curriculum developers to be careful about the process of revision; that in many cases starting over may actually be easier than retrofitting obsolete courses.

Reference to the Jackson's Mill Curriculum Study provides some guidance in the structure of content organizers in construction, manufacturing, communication, and transportation. At the graduate level some technological updating is necessary and appropriate. This is a change compared to industrial arts in that many graduate educators felt that the technical responsibility belonged to the undergraduate process. Research in the technical areas should be recognized as an important contributor for the total development of the technology educator.

Too many times in the past, the instructional approach of graduate faculty relied exclusively on the use of stand up lectures or student presentations. Donald Maley provides a menu of instructional strategies in Chapter III that should whet the appetite of all technology educators. This quality element (instruction) cannot be ignored in the delivery of technology education. Strong preparation by both the student and the instructor can create an environment that will allow the exchange of ideas and information. Both formal and informal interaction can create a spirit of togetherness that allows mentors to maximize their input at both the instructional and personal levels. Such activity creates professionalism and has been the benchmark of the most popular and well-respected graduate programs in the past. The missions of technology education have the potential to provide such professionalism by uniting around the potential of technological literacy for our citizens as we enter the 21st century.

Paul Brauchle investigated the area of tests and measurements as another element important for quality graduate education. He makes the point that assessment is vital to our understanding of whether we are doing what we say we are doing and whether we are measuring what we want to measure. Two needs arise in graduate education; one to conduct quantitative research as part of the graduate experience, and one to apply test and measurement techniques after graduation in the classroom. Both are critical, and both make a major difference in quality and capability of the graduate. Yet, not all tests and measurements are quantitative and in some cases alternative methods may not only be appropriate, but the only way to assess progress.

Philosophy, content, and instruction are only as good as the faculty who work with the graduate students each day. Chapter VI reported on the process for qualifying for graduate faculty status. Each institution is different and the standards do vary from program to program. What makes an outstanding graduate faculty member? Usually it is involvement, professionalism, expertise in a particular area, the ability to do and supervise research, recognition in scholarly endeavors, and the desire to mentor graduate students. Graduate status is difficult to maintain unless the university is willing to provide the necessary resources (released time, preferred schedules, and funding) to allow the professor to maintain his/her scholarly activity. Both Post and Umstattd agreed that visibility and institutional support are vital for retaining qualified graduate faculty.

Quality research does not have to be earth shaking at either the master's or doctoral level. Daniel Householder makes an important point when he reminds us that the creation of new knowledge is "rare" even in the pure sciences, that generally all research in technology education is applied rather than basic, and that we are primarily consumers of research findings. But that does not negate the importance of the process of research in our field. Good solid research techniques supported by well designed and managed programs of study provide an element of excellence that will produce leaders and scholars in our field. In addition to basic and applied research, Householder makes the case for professional writing (journals, monographs, and books) as the primary method to make contributions to the advancement of the profession. With perhaps the exception of the Jackson's Mill cooperative effort, most leadership in the past has been provided to the profession by major graduate programs and the national association. The influence of applied research by graduate students has the potential to provide new ideas in curriculum and instruction, evaluation techniques to measure progress in our classrooms, and validation techniques to support the philosophical underpinnings for the discipline.

Applied research can provide us with many new ideas but the conversion of those ideas into action at the university level is a function of the faculty. According to author Erekson, faculty feel ownership of the curriculum and must be convinced of the value of the new in order to make change. His chapter carefully outlines all of the ingredients of the change process and the necessary support needed to implement a modern technology education graduate program. He cautions us to be patient because the process of change is painfully show and politically ingrained at most institutions. Yet, "a quality, research-based curriculum change can demonstrate that the department is scholarly, futuristic, and a credit to the university."

The essential elements of a quality technology education program are basic to all graduate programs. They represent the best thinking in contemporary graduate education and have significant implications for our profession as we make the change from industrial arts to technology education. This monograph is the result of one of the many goals identified in the Professional Improvement Plan of the Council on Technology Teacher Education, an affiliate council of the International Technology Education Association. It is dedicated to the curriculum planners, innovators, and leaders of graduate level technology education everywhere.

Previous CTTE Monographs

1	*An Analysis of Graduate Work in Institutions with Programs for Industrial Arts Education Personnel*	Miller and Ginther	1965
2	*Measuring Creative Abilities in Junior High School Industrial Arts*	Moss	1966
3	*Teacher Competencies for the Cybernated Age*	Stadt and Kenneke	1970
4	*Graduate Programs in Industrial Education*	Bjorkquist et al.	1974
5	*The Developmental Growth of Elementary School Students and the Role of Industrial Arts in the Process*	Rcsser	1978
6	*Implications of Piagetian Theory for Early Childhood Industrial Arts: Cognitive Development*	Dahl	1979
7	*Industrial Arts Builds the Skills in People that America Needs*	Maley	1980
8	*Doctoral Programs in Industrial Arts Education: Their ranking and Distinguishing Characteristics*	Koble	1980
9	*Work and Education in the Eighties*	Jones et al.	1983
10	*A Primer for Selecting Graduate Programs*	Wright et al.	1987
11	*Elements and Structure for a Model Undergraduate Technology Teacher Education Program*	Henak et al.	1989

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