DOCUMENT RESUME

ED 437 889 HE 032 762

AUTHOR	Foster, W. Tad
TITLE	Applied Research in Technology Programs: A Working Draft.
PUB DATE	1999-11-00
NOTE	19p.; Paper presented at the Mississippi Valley Technology Teacher Education Conference (86th, St. Louis, MO, November 5-6,1999).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Business Administration Education; *Doctoral Dissertations; *Engineering Technology; Higher Education; Research Universities; *Technology

ABSTRACT

This study of graduate student research at the doctoral level in four educational disciplines industrial engineering, industrial technology, mechanical engineering, and business administration undertook to determine the type of research (basic or applied) used in the student research, the research methods used, and the topics of research. The data were collected by Dissertation Abstracts International, with a random sample of at least 50 studies in each discipline. A total of 246 studies were analyzed. The data show that the majority of the studies were applied in nature, with a great degree of variation in the methods used and topics considered. The study also finds a body of knowledge and research connected to applications. The seven tables include an analysis of dissertations by research method; list keywords used to describe the studies; list the dissertation topics in the four disciplines; and list recent dissertation topics at a Midwestern doctoral-granting university. (RH)

HE

Applied Research in Technology Programs: A Working Draft

Session I: Issues in the Foundation of the Profession

Dr. W. Tad Foster, Dean
School of Technology
Indiana State University
tchfost@isugw.indstate.edu

A presentation at the 86th Mississippi Valley Technology Teacher Education Conference

November 5-6, 1999

Marriott Pavilion Hotel
St. Louis, Missouri

Technology programs focus on application. Is there a body of knowledge in technology application? Can research be done on application? What is the nature of applied research? To what extent is it accepted on our campuses?

The question posed for this paper begins with a statement – "Technology programs focus on application." While I agree that this is a true statement, none-the-less, it poses significant problems. First, one must grapple with more than 100 definitions of what is meant by technology. Second, it is necessary to resolve the issue of which educational disciplines should be considered technology programs. In the time allotted for this presentation, it is impossible to adequately address all that has been written about either of these issues. Consequently, to allow us to proceed, I ask that you indulge me as I offer you my opinions.

First, I contend that technology is the sum total of human endeavor. It is that which results as humans strive to survive, create, communicate, and meet their needs and wants. Earlier in my career, my colleagues and I defined technology as a "noumenon that occurs through the synergistic interaction of knowledge, thinking skills, and physical processes and results in the extension of human capabilities" (Johnson, Foster & Satchwell, 1989). We defined technology in this way because we believed that all of technology originates in the human mind and builds upon previous accomplishments.

At that time, we offered a four-part categorization of technology that included physical technologies, biological technologies, informational technologies, and organizational technologies as curriculum organizers for technology education. Organizing technologies this way helped us to think about what the technologies had in common that lead to a better understanding of curricular issues. However, we realized that this organization was not perfect in that many new technologies were in multiple categories or seem to be on the borders between two categories.

Based on this conceptualization of technology, it would be consistent to treat most of what is done in what is typically called professional schools or professional programs as technology programs. In addition, many programs often found in the arts and sciences (e.g., art, graphic design, journalism, and computer science) should also be considered technology programs.

Now, this poses an interesting problem as we consider the nature of applied research. In the physical technologies, it is easy to see that some scientists are involved in groundbreaking basic research with little to no consideration for how that knowledge will be used. Another set of scientists with similar academic preparation focus their work on how to get the new knowledge out of the laboratory. This research is then picked up by technologists who grapple with applying the new knowledge and skills to extend our capabilities and solve problems. The systems created by the technologists are supported and maintained by technicians and are controlled by operators and end-users[1]. However, this model of basic research supported by applied research, which is followed by implementation, operation, and maintenance, does not seem to fit as well for technologies such as art and graphic design (and others). In addition, we see a somewhat different model when we consider agricultural and medical technologies. Again, in consideration of the scope of this paper, we will need to leave this interesting issue and focus our attention on the physical model described above that fits most of the research and activity going on in schools of technology today.

A Study of Applied Doctoral Research

Three questions were posed for this paper. "Is there a body of knowledge in technology application? Can research be done on application? What is the nature of applied research? To what extent is it accepted on our campuses?" By no means is it possible to answer each of these questions in this paper. Many books have been written on the subject of applied research. What can be done is to approach the issue from the perspective of what is currently being done, then see if that provides us with any insights and guidance. To that end, a study of graduate student research at the doctoral level in four educational disciplines (i.e., industrial engineering, industrial technology, mechanical engineering, and business administration) was designed and completed. The primary purpose of this study was to determine the type of research (i.e., basic or applied), the research methods used, and the topics of the research in four educational disciplines at the doctoral level.

Method

The methods used in this ex-post facto study constitute a modification of the methods used by Foster (1992) in a study of graduate research in industrial education and related fields. Two major differences exist between this study and Foster's earlier study. In the current study, master's theses were not considered. In addition, this study involves a comparison of four educational disciplines. Whereas in the 1992 study, only one field of

---

[1] It should also be noted that the technologists typically function within a business organization that is created. organized, and run by another set of technologists with backgrounds in marketing, administration, accounting, and the like.

study, industrial education (i.e., industrial arts education and industrial education), was considered.

The data for this study were collected from the available information maintained by *Dissertation Abstracts International* (DAI). A keyword search was conducted using the computerized, "ProQuest Digital Dissertations" search engine. Each search returned between 88 and 350 studies. A sample of at least 50 studies for each discipline was randomly selected from the resulting sets. A major limitation of this study is that one cannot be sure that all of the relevant studies in a particular discipline were included in the possible pool of studies. The way the authors described their study and the way the search engine retrieves the abstracts creates this limitation.

Each keyword search resulted in many studies being included that were actually outside of the intended discipline. Studies were eliminated from the final sample if the keyword (i.e., discipline) was not included in the title, abstract, or the list of keywords. In several cases, one of the subject groups included in a particular study matched one of the educational disciplines. For example, one study, which was clearly an education study (i.e., a study of the effectiveness of a particular instructional technique), used a class of business administration students as one of the groups in the study. This study was rejected. After eliminating those studies that did not fit the criteria, it was determined that the total number of studies for three of the four disciplines was small enough to include all of the studies in the final sample.

During analysis, it became obvious that the keyword search method did not identify all of the studies in the industrial technology field. Consequently, a list of graduate theses and dissertations was secured from one doctoral-granting, Midwestern program with degrees in industrial technology. A fifth search using ProQuest was conducted using the author's name and dissertation title from this list. This search resulted in 35 additional studies that clearly fit the industrial technology classification. However, for comparison purposes, the principal investigator for this study decided to treat this data as a fifth group versus merging that data with the industrial technology group.

The data were analyzed using descriptive statistics to determine the type of research (i.e., basis or applied), the research method(s) employed, the keywords used by the author to describe the study, and the topic of the research. Each study was classified by a list of research methods (see Foster, 1992) adapted from methods identified by Borg and Gall (1989) and Cohen and Manion (1984). The research topic for each study was determined by analyzing the content of the study's title and abstract. For reporting purposes, the topics were grouped, if possible, into commonly occurring categories.

Results

The sampling process resulted in 35 – 55 studies in each of the five fields of study. A total of 246 studies were analyzed for this study. Table 1 contains an analysis of the type of research and research methods used for the four fields of study and one program.

Table 1. An analysis of doctoral dissertations in four disciplines and one program by research type and method.

Method	Group 1 IE	%	Group 2 IT	%	Group 3 ME	%	Group 4 BA	%	Group 5	%	Total	%
Survey (1)	5	10	35	65	3	5	29	56	7	20	79	32
Delphi (1.1)	1	2	5	9	0	0	0	0	0	0	6	2
Observation (2)	0	0	0	0	0	0	0	0	0	0	0	0
Causal-Comparative (3)	0	0	1	2	0	0	10	19	1	3	12	5
Correlational (4)	2	4	0	0	0	0	0	0	0	0	2	1
Experimental (5)	8	16	4	7	9	16	9	17	17	49	47	19
Quasi-Experimental (6)	1	2	4	7	0	0	0	0	2	6	7	3
Test Development (7)	0	0	0	0	6	11	1	2	2	6	9	4
Observational - Participant (8)	0	0	0	0	0	0	0	0	0	0	0	0
Observational - Non-participant (9)	0	0	0	0	0	0	0	0	0	0	0	0
Case Study (10)	7	14	1	2	1	2	1	2	3	9	13	5
Evaluation (11)	0	0	1	2	0	0	0	0	0	0	1	0
Research & Development (12)	19	38	0	0	22	40	0	0	3	9	44	18
Historical (13)	0	0	0	0	0	0	0	0	0	0	0	0
Philosophical (14)	0	0	0	0	0	0	0	0	0	0	0	0
Combination (15)	7	14	3	6	14	25	1	2	0	0	25	10
Type												
Basic	1	2	0	0	7	13	4	8	0	0	12	5
Applied	49	98	54	100	48	87	48	92	35	100	234	95
Total n	50		54		55		52		35		246	

The data indicate that 234 (95%) of all the studies reviewed were applied research. Doctoral candidates employed 11 of the sixteen research methods used to classify these studies to complete their studies. Of the eleven methods used, 79% of the researchers employed either the survey (32%), experimental (19%), research and development (18%), or combination (10%) methods. Quantitative observation, qualitative observation, historical, and philosophical methods were not used. Doctoral candidates in industrial technology (with the exception of the program reviewed independently) and business administration predominantly used the survey method to complete the dissertation (65% and 56% respectively). Doctoral candidates in industrial engineering and mechanical engineering utilized a broader range of methods. In these fields, research & development methods were used most often (38% and 40% respectively), followed by combination methods and experimental methods.

Table 2 contains a summary of the keywords used to describe the studies. A total of 85 keywords was used to describe the 246 studies. Table 2 contains a list of the top 17 keywords. The keywords not reported in Table 2 were used 5 or fewer times, with the majority of them being used only once. "Industrial technology" was not used as a keyword for any study.

Table 2. Most popular keywords used to describe studies in four disciplines and one specific program.

Keyword	Group 1 IE	Group 2 IT	Group 3 ME	Group 4 BA	Group 5	Overall Total
Industrial Education	2	43	2	1	18	66
Mechanical Engineering	0	0	50	0	2	52
Industrial Engineering	32	5	3	1	10	51
Higher Education	7	16	3	11	1	38
Computer Science	7	0	11	5	2	25
Technology Education	2	15	0	0	8	25
Business Administration	4	0	0	14	5	23
Management	4	0	0	7	4	15
Vocational Education	0	9	0	0	6	15
Administration Education	0	5	0	6	0	11
Artificial Intelligence	2	1	5	0	3	11
Business Education	0	0	0	10	1	11
Curriculum & Instruction (Educ.)	0	6	1	2	1	10
Operations Research	6	0	3	1	0	10
Adult & Continuing Education	1	0	0	6	0	7
Industrial Psychology	3	0	0	3	1	7
Applied Mechanics	0	0	4	0	2	6
Total Number of Studies	**50**	**54**	**55**	**52**	**35**	246

Tables 3 through 6 illustrate the major topics for doctoral research in industrial engineering, industrial technology, mechanical engineering, and business administration. The most common topics for industrial engineering dissertations was artificial intelligence (24%) and engineering education (20%). For industrial technology dissertations, the most common topics were curriculum content/higher education (40.7%) and educational program evaluation/higher education (31.9%). All of the studies in industrial technology were related to industrial technology education at the university level. The most common topics for mechanical engineering were design of systems (21.8%), software development (18.2%), and artificial intelligence/expert systems (16.4%). In business administration, the major topics were higher education/program evaluation (23.1%) and higher education/pedagogy (9.6%).

Table 3. Topics of industrial engineering dissertations.

TOPICS	**#**	**%**
Artificial Intelligence/Expert Systems/Software Development	12	24
Engineering Education	10	20
Production Control	5	10
Application of I.E. Principles/Techniques	4	8
Predicting Human Performance	4	8
Problem solving/Decision Making	3	6
Systems Analysis	3	6
Ergonomics	2	4
Quality	2	4
Training/Human Resource Development	1	2
Business Organization	1	2
Community Ergonomics	1	2
Product/Process Design	1	2
Robotics/Programming Language Development	1	2

Table 4. Topics of industrial technology dissertations.

TOPICS	#	%
Curriculum Content/Higher Education	22	40.7
Educational Program Evaluation/Higher Education	17	31.5
Pedagogy	8	14.8
Women Studies	2	3.7
Artificial Intelligence/Simulation/Training	1	1.8
Higher Education Administration	1	1.8
Learning Style	1	1.8
Personality Traits	1	1.8
University Faculty Development	1	1.8

Table 5. Topics of mechanical engineering dissertations.

TOPICS	#	%
Design of Systems	12	21.8
Software Development	10	18.2
Artificial Intelligence/Expert Systems	9	16.4
Engineering Education	4	7.3
Engineering Communication	3	5.5
Heat Transfer/Thermal Conductivity	3	5.5
Robotics	3	5.5
Failure Analysis	2	3.6
Computer Integrated Manufacturing/NC	1	1.8
Cryogenic Leaking	1	1.8
Development of Mathematical Equations	1	1.8
Erosion of Metals	1	1.8
Measurement of Sound Reverberations	1	1.8
Industrial Investment Planning	1	1.8
Mine Pit Wall Construction	1	1.8
Rapid Depressurization of Vessels	1	1.8
System Analysis	1	1.8

Table 6. Topics of business administration dissertations.

TOPICS	#	%
Higher Education/Program Evaluation	12	23.1
Higher Education/Pedagogy	5	9.6
Program Evaluation/Non-Educational	4	7.7
Shared Values/Business Persons	3	5.8
Higher Education/Recruiting	3	5.8
Decision Making Techniques	2	3.6
Job Needs Analysis	2	3.6
Business Success Factors/Personal & Company	2	3.6
Higher Education/Administration	2	3.6
School Administration	2	3.6
Software Development/MIS	2	3.6
Women's Studies	2	3.6
Attitudes towards Discrimination Laws	1	1.9
Consumer Behavior	1	1.9
Higher Education/Faculty	1	1.9
Hospital Personnel Roles	1	1.9
Innovation	1	1.9
Personality Traits	1	1.9
Personnel/Hiring	1	1.9
Personnel/Peer Feedback Systems	1	1.9
Research Methods	1	1.9
Total Quality Management	1	1.9
Transfer of Training	1	1.9

The analysis of dissertations (see Table 7) completed in a doctoral-granting, Midwestern univeristy revealed that the most common topics were pedagogy (25.7%), total quality management and SPC (14.3%), non-destructive testing (11.4%), and artificial intelligence/expert systems (8.6). A casual comparison to the other groups revealed that the dissertations completed in this program more closely resembled those completed in the industrial engineering group. Consequently, combining this group of studies with the industrial technology group would significantly change the mix of topics by adding a variety of technical topics.

Table 7. Topics of recent dissertations in a doctoral-granting, Midwestern university.

TOPICS	#	%
Pedagogy	9	25.7
Total Quality Management & SPC	5	14.3
Non-Destructive Testing	4	11.4
Artificial Intelligence/Expert Systems	3	8.6
Human Resource Development	2	5.7
Job Needs Analysis	2	5.7
Material Science	2	5.7
Alternative Fuels	1	2.9
Industrial Technology Literacy Testing	1	2.9
Material Processing/Laser/Ceramics	1	2.9
Program Evaluation/Higher Education	1	2.9
Offset Printing/Dot Gain Control	1	2.9
PLC Programming	1	2.9
Software Development/Non-AI	1	2.9
Women's Studies	1	2.9

Discussion

It is clear from the data, that the vast majority of the studies completed in the four disciplines under consideration were applied in nature. As would be expected, there was a great deal of variation in the research methods used and in the topics the researchers considered. Research in the engineering disciplines typically employed experimental, research and development, and combination designs. Whereas, researchers in industrial technology (with the exception of the IT program reviewed independently) and business administration relied heavily on the survey method (65% and 56% respectively).

This study helps to demonstrate that there is a body of knowledge and research (in fact, there seem to be several) connected to application. Several fields of study (e.g., education, management, technology, nursing, and athletic training) draw upon (and sometimes add to) a particular knowledge base to develop a solution to a problem or to develop a new application to extend human capabilities. Is this an agenda that will be accepted on our campuses? Most definitely. Especially when one considers that most schools of technology are located in universities that do not have research as their primary mission. In fact, many of them are on campuses of former teachers' colleges that are steeped in the traditions of action-oriented, applied scholarship. In addition, one must consider that most of the full professors in the four disciplines considered in this study achieve their rank and tenure based upon their work in the scholarship of application, integration, and teaching (Boyer, 1990)

Those of us involved in industrial technology and many from engineering technology approach research from an action orientation. Philosophically, we contend that meaningful education must be hands-on education and we maintain a large infrastructure of laboratories to support hands-on, instructional activities. Consequently, we bring a somewhat unique perspective to applied research; a problem-solving perspective. That perspective will serve us well as we expand our efforts in the scholarship of application. And given that a growing number of institutions that offer IT degrees are offering the doctorate, it is imperative that we become contributing members to the knowledge base supporting our particular field.

In addition to other issues facing industrial technologist, it remains to be demonstrated that we have something unique to offer applied research. Many disciplines approach the same problems from difference perspectives. For example, almost every discipline on a university campus addresses, in some way, pedagogy issues, quality issues (i.e., quality management), and leadership issues. The concern is that as industrial technologists get more deeply involved with technical and management issues, our research begins to look like the research coming out of one of the other disciplines (e.g., engineering and business). In a recent conversation with a dean of a large Midwestern school of technology, he stated that the Graduate Dean opposed the expansion of their graduate program on the grounds that an adequate knowledge base did not exist for technology separate from that of the other schools on that campus.

Last year, Dr. Ernest Savage presented a paper to this group, in which, he outlined the new Ph.D. in Technology Management that is offered by Indiana State University and delivered by a consortium of seven institutions. During the approval process there was a great deal of debate at the state level. Most of the criticism of the program focused on two things: (a) the ability of our faculty to deliver a doctoral program, and (b) the lack of a clear knowledge base to support research in technology management. I believe we do have a knowledge base, and it is found in the scholarship of application. I also believe we have an opportunity to develop an environment for scholarship that is different from that typically found at research institutions (i.e., one that values teaching as well as scholarship). However, just because I believe it does not make it so. We have a lot of work to do. Thank you.

References

Borg, W. R. & Gall, M. D. (1989). Educational research: An introduction (5th ed.). New York: Longman.

Boyer, E. L. (1990). Scholarship reconsidered: Priorities of the professoriate. Princeton, NJ: The Carnegie foundation for the advancement of teaching.

Cohen, L. & Manion, L. (1984). Research methods in education (2nd ed.). Dover, NH: Croon Helm.

Foster, W. T. (1992). Topics and methods of recent graduate student research in industrial education and related fields. Journal of Industrial Teacher Education, 30(1), 59-72.

Johnson, S. D., Foster, W. T., & Satchwell, R. (1989). Sophisticated technology, the workforce, and vocational education. Springfield, IL: Illinois State Board of Education.

032 762

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Applied Research in Technology Programs: A Working Draft	
Author(s): Dr. W. Tad Foster	
Corporate Source: Mississippi Valley Technology Teacher Education Conference	Publication Date: 11/5/99

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following options and sign the release below.

[X] Sample sticker to be affixed to document

Check here
Permitting microfiche (4"x 6" film), paper copy, electronic, and optical media reproduction

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Sample
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 1

Sample sticker to be affixed to document [ ]

or here
Permitting reproduction in other than paper copy

"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY
Sample
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 2

Sign Here, Please

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature: W. Tad Foster	Position: Dean
Printed Name: W. Tad Foster	Organization: School of Technology, Indiana State Univ.
Address: Indiana State University School of Technology Terre Haute, IN 47809	Telephone Number: (812) 237-3166
	Date: 1/27/00

OVER