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Introduction

Developing A Curriculum (DACUM) was a workshop held to examine the occupational field entered by graduates of the Industrial Technology Electrical Systems (IT-ES) degree program at Central Connecticut State University (CCSU). The DACUM process was used to conduct a locally relevant job analysis as the basis for establishing an up-to-date curriculum for IT-ES program.

DACUM grew out of a curriculum development effort directed at technical training for the Women's Job Corp program in Clinton, Iowa in the 1960's. This curriculum project was conducted by Experimental Projects Branch, Canada Department of Manpower and Immigration and the General Learning Corp of New York (Norton, 1985). The DACUM movement continued to grow in Canada, but it was not until 1975 that Robert Norton, the person most associated with DACUM in the United States, learned about it. Late in 1976, Robert Norton conducted his first DACUM workshop at Colorado State University in Fort Collins. During the late 1970's, many technical and community colleges implemented DACUM analyses for curriculum development. Eventually, Norton was recruited to train DACUM facilitators. A DACUM on DACUM was conducted in October 1982, which provided the basis for the development of the DACUM Handbook with guidelines for implementing formalized training of DACUM facilitators (Norton, 1985). In 1983 Norton took DACUM international, and since then DACUM has been widely used nationally and internationally for training and educational curriculum development. The DACUM process continues to be very successful in identify critical curricula, especially for vocational and technical programs.

Purpose

The purpose of this study was to identify the tasks that are performed by persons employed as electrical technologists. DACUM is ideally suited for identifying the competencies that should be delivered by existing training and educational programs, as well as the competencies that should be addressed in the development of new programs. Once competencies are identified, existing program and instructional materials are reviewed to determine if they address all the required tasks. Necessary modifications are made to ensure the relevance of the program (Norton, 1992).

Methodology

The DACUM process is based on three premises (a) expert workers are the best people to describe/define their job, (b) any job can be effectively described in terms of the tasks that successful workers in that occupation perform, and (c) specific attitudes and knowledge are needed in order for workers to perform each task correctly (Norton, 1992). A committee of 8-12 expert workers in the occupational area implements the DACUM process. Committee members are recruited directly from business and industry. An expert worker is defined as an outstanding employee in the specific occupational area. Because of their current occupational expertise, committee members do not need any advance preparation. The committee works under the guidance of a trained facilitator for two days to develop a DACUM chart, which is a detailed and graphic portrayal of the tasks involved in the occupation being studied.

The committee identifies the general areas of job responsibilities called duties (typically 8-12 per job), then specifies tasks (competencies) performed in connection with each duty (typically 75-125). Modified and structured small group brainstorming techniques are used to obtain the collective expertise and consensus of the committee. High quality task and duty statements usually result from this interaction. Other outcomes of DACUM workshops include lists of tools, equipment, supplies, and materials pertinent to the occupation; traits and attitudes important to workers in that occupation; and general knowledge and skill areas that are prerequisites to job performance (Norton, 1992).

Once the DACUM workshop is completed, task verification or validation is recommended. Verification is the process of having additional occupational workers and immediate supervisors review and confirm or refute the importance of the task statements. A mailed questionnaire can be used to collect the desired information. The questionnaire lists all identified tasks with scales for ranking the importance of each task. Verification provides further evidence that the process has identified the right tasks. It also permits greater business, industry and education involvement, provides further information useful in instructional planning, and elicits greater public confidence in the relevance of the program being studied (Norton, 1992).

The two-day DACUM workshop was held in January 1998 at Central Connecticut State University (CCSU). Karen Wosczyna-Birch, a trained DACUM facilitator and leader in the community technical college system in Connecticut, conducted the workshop. The workshop included the following procedural steps: (a) orient committee to DACUM process; (b) review the occupation; (c) identify the general duties; (d) identify the specific tasks performed in each duty area; (e) refine task and duty statements; (f) sequence task and duty statements; and (g) identify the critical knowledge, skills, and behaviors required of workers, and the tools, equipment, supplies and materials used by workers (Norton, 1985).

Robert Norton, of the Center on Education and Training for Employment at Ohio State University, recommended choosing recent graduates who are top workers to participate on the DACUM committee. Ten industrial representatives, including seven recent graduates of the Industrial Technology Electrical Systems, two current part-time students, and one electrical engineer, participated in the workshop. The participants represented a cross-section of the industries that have hired program graduates over the last decade.

The DACUM approach was applied to identify the actual duties and tasks performed by entry-level industrial technologists in electrical industries in Connecticut. The DACUM analysis also generated a list of skills, knowledge, and attributes required of workers in the field. A task verification questionnaire was prepared following the guidelines in the DACUM Handbook The questionnaire was mailed to 40 workers who graduated from the program between May 1993 and May 1997 and were employed in Connecticut. Graduates and the cooperative education office identified supervisors, and the task verification questionnaire was mailed to 40 current or past supervisors of IT-ES cooperative education students or graduates. The final response rate was 52.5% (21) from industry representatives and 50.0% (20) from IT-ES graduates for an overall response rate of 51.3%. Five companies returned the questionnaire indicating that they did not have positions suitable for IT-ES graduates.

Findings of the DACUM Task Verification Questionnaire

Through the DACUM workshop, the major duties and tasks associated with jobs held by IT-ES graduates were identified. The nine major duties were; (a) maintain quality control standards, (b) participate in project management, (c) provide technical support services, (d) prepare technical documentation, (e) participate in product design, (f) participate in process design, (g) perform administrative duties, (h) support marketing functions, and (i) continue professional development. Multiple tasks were specified under each duty. Although not all DACUM participants performed every task listed, a majority of the participants performed each task.

The task verification questionnaire consisted of the list of actual duties and tasks performed by entry-level industrial technologists in the electrical field in Connecticut as identified through the DACUM process. Respondents were asked to indicate the importance of each task and how frequently each task is performed by entry-level workers using a three-point Likert scale (Essential = 5, Important = 3, and Not Important = 1). Analysis of the responses was based on mean ratings that had continuous values from 1.9 to 4.5. The mean ratings were divided into five groups from essential to not important.

Of the 112 tasks listed, only 4 items received a mean rating of 4.0 or higher, with 4.5 being the highest rating. These essential tasks were all technical support functions under three different major duties: trouble shooting technical problems, documenting technical procedures, and providing technical information and technical expertise to marketing.

Fourteen tasks received mean ratings of 3.5 to 3.9, a range defined as very important. Of the 14, 5 were under professional development, indicating the importance of professional development in any technical job. Under the duty of maintaining quality control standards, two tasks were rated in this range; (a) establishing technical procedures and (b) evaluating customer complaints. Three tasks under providing technical support services were rated as very important. They were (a) preparing technical reports and documentation, (b) providing diagnostic services and (c) determining needed technical resources. The related task of researching technical resources under the process design duty was also rated in this range. Under administrative duties the tasks of (a) maintaining technical reports and (b) technical documentation were rated as very important. Developing customer loyalty was the final task rated in this range.

The mean rating range from 3.0 to 3.4 was defined as important. Twenty tasks were rated in this range. This included 4 task under continuing professional development and 6 tasks under preparing technical documentation. Table 1 lists these twenty tasks, listed by duty. The remaining 74 tasks were rated below 3.0 and were categorized as only somewhat important or not important depending on the average rating.

Also included in the task verification questionnaire was the list of skills and knowledge required of workers in the field for respondents to rate in terms of importance. The importance of 72 specific knowledge and skills as rated by respondents and the mean rating was calculated for each knowledge or skill item. Items with a mean rating of 4.0 and higher were considered essential to the IT-ES graduate, while items with a mean rating of 3.0 to 3.9 were classified as important. Those items receiving a mean rating of 2.50 to 2.9 were grouped as only somewhat important, while items rated below 2.50 were considered not important.

The skills and knowledge are easily grouped in categories. Table 2 presents the categories, skills, and ratings. Three general skills received essential ratings; (a) interpersonal skills, (b) problem solving skills, and (c) analytical skills. Technical writing, composition and oral communication skills were also rated as essential. The management related skills that received a rating as essential were time management, team building, and organization skills. Ethics also received a high rating as essential. Leadership skills, oral presentation skills, management and quality standards knowledge were rated as important. Economics and marketing received a lower rating as only somewhat important

Several skills related to computers were listed. Computer related skill rated as essential knowledge areas were Windows, Microsoft Office, and e-mail knowledge. Keyboard skills, and knowledge of the Internet and AutoCAD were rated as important skill areas. Networking skills, as well as an understanding of DOS and computer architecture were rated as only somewhat important, while knowledge of HTML, computer programming, microprocessor architecture, and electronic design software were rated as not important.

Knowledge of electronic devices and concepts received an overall rating of 3.9. Three specific skills in this category were rated as essential; (a) trouble shooting, (b) circuit analysis, and (c) reading electrical schematics. The ratings for specific electronic devices listed were from 3.0 to 3.7 for the most part, which indicates this knowledge is important. Knowledge of integrated circuits was rated as essential. Only harmonics, relay logic and basic soldering skills received a rating below 3.0 in the somewhat important range.

Math skills received an overall rating as important, with algebra, trigonometry, and statistics rated as important. Calculus and linear algebra were rated as only somewhat important. Science knowledge was given an overall rating of important. All specific science areas were rated as important except chemistry, which was rated as only somewhat important.

In summary, the DACUM outcomes indicate the importance of technical writing, communications, and basic computer skills. General skills such as problem solving, analytical, interpersonal, and organizational are some of the most valuable skills for any graduate. Technical knowledge, especially related to technical support services, is also critical for IT-ES graduates. This includes trouble shooting skills and circuit analysis abilities. On the other hand, chemistry, calculus, economics, and marketing knowledge were not rated as important for IT-ES graduates from CCSU.

Implications

The application of the DACUM occupational analysis process to the Industrial Technology Electrical Systems specialization is a clear example of continuous improvement at the program level within the university setting. The DACUM occupational analysis conducted for this study identified the major duties and tasks performed in jobs held by graduates of the Industrial Technology Electrical Systems (IT-ES) program. This analysis provided a description of the nature of work for IT-ES graduates. The curriculum of the IT-ES program was evaluated based on the results of this study. Several changes were made to this IT specialization as well as to the IT core for all specializations. An Introduction to Quality Assurance course was added to the core. The previous choice between two management courses or two marketing courses was changed to require all students to take one basic management and one basic marketing course. In terms of the Electrical Systems specialization, the analog course was divided into two courses addressing semiconductor devices in the first and linear circuits in the second. The electrical power systems course, which deals mainly with industrial wiring, was deleted as a requirement, as was the Introduction to Material Processing course. A list of restricted electives was defined, which includes the following courses: Data Acquisition and Control, Programmable Logic Controllers, Robotics, Computer Science I, Applications of Programming, and Electrical Power Systems. Finally, the name of the specialization was changed to Electronics Technology.

The findings of this study reaffirm the NAIT curriculum model that includes a balance between theory and application, and between general education and technical course. The findings support the value of current course requirements in technical writing, communications, and computer skills. General skills such as problem solving, analytical, interpersonal, and organizational should be fostered throughout the educational program. Technical knowledge, mathematics, and science are also important for IT-ES graduates. The DACUM process provides a method for identifying the major duties and tasks performed by industrial technology graduates in industry and business, a task that has often proved to be evasive because of the broad nature of the degree and the lack of the use of 'industrial technologist' as a job title.

References

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Table 1. Important Tasks By Duty

Task Statements	Importance Mean
1. Maintain Quality Control Standards Establish QC standards	3.2
Develop training procedures	3.2
2. Participate in project management	
Maintain QC throughout project	3.3
3. Provide technical support services	
Install electrical & mechanical equipment	3.0
Provide on-site technical services	3.3
Distribute technical literature	3.0
4. Prepare technical documentation	
Review product specifications	3.0
Write technical reports	3.2
Write 'user-friendly' instructions	3.4
Review electrical/mechanical drawings	3.3
Revise electrical/mechanical drawings	3.1
Maintain project records	3.1
5. Participate in product design	
Determine customer need	3.2
Participate on planning teams	3.1
6. Participate in process design	
7. Perform administrative duties	
Disseminate technical information	3.3
Enforce company policies	3.1
8. Support marketing functions	
9. Continue professional development	
Attend professional seminars and conferences	3.3
Pursue advanced degrees	3.2
Obtain professional certification	3.2
Read professional journals & trade publications	3.3

Note. Importance of task was rated on a 3-point scale. Essential = 5, Important (Import.) = 3, and Not Important (Not Import.) = 1.

Table 2. Skills and Knowledge Ratings

Skills and General Knowledge	Importance Mean
Problem solving skills	4.8
Analytical skills	4.7
Interpersonal skills	4.5
Oral communication skills	4.3
Technical writing skills	4.2
Organization skills	4.2
Time management skills	4.2
Ethics	4.2
Letter/composition writing skills	4.0
Team building skills	4.0
Oral presentation skills	3.9
Leadership skills	3.7
Quality Standards: (i.e. ISO 9000, SPC, Military, OSHA)	3.7
Management skills and knowledge (theories)	3.6
Marketing	2.7
Economics including global	2.5

Table 2. Skills and Knowledge Ratings (continued)

Windows	4.8
Microsoft Office	4.5
E-mail	4.1
Keyboard skills	3.9
AutoCAD	3.2
Internet (search engines)	3.2
DOS literacy - VAX	2.9
Computer architecture	2.9
Networking skills (LANs, cabling etc.)	2.9
Microprocessor architecture	2.4
Computer Programming (i.e. C++, Basic, Cobal)	2.1
Electronic design software (i.e. PCAD)	2.0
HTML (web pages design)	1.7
Knowledge of electronic devices and concepts (general rating of 3.9)	
Trouble shooting skills	4.3
Read electrical schematics	4.2
Integrated circuits (analog and digital)	4.0
Circuit analysis ability	3.9
analytical Instrumentation: (multimeters, oscilloscopes, spectrum analyzer)	3.7
Digital logic gates	3.6
Transformers	3.6
Digital communications	3.5
Fiber optics	3.5
Control systems	3.5
Electrical codes and standards (how to reference and apply)	3.4
Transducers	3.4
Motors (stepping, VFDs, MCC)	3.4
Signal processing	3.3
PLCs (programmable logic controls)	3.1
Harmonics	2.9
Relay (ladder) logic	2.8
Basic Soldering ability	2.7
Math skills:	3.8
Algebra	3.6
Statistics	3.2
Trigonometry	3.1
Calculus I/ Applied calculus	2.6
Linear algebra	2.6
Science Knowledge:	3.3
Physics	3.3
Materials	3.2
Energy processing	3.1
Chemistry	2.6

Note. Importance of skill and knowledge was rated on a 3-point scale. Essential = 5, Important (Import.) = 3, and Not Important (Not Import.) = 1.