DOCUMENT RESUME

ED 389 876 CE 070 352

AUTHOR Chen, Woei-Kae; Chang, Liang-Te
TITLE A Study of Entry-Level Employment Technological Competencies for the Junior College Graduates Majoring in Electronic Engineering.
PUB DATE Oct 95
CONTRACT NSC83-0111-S-027-008-TG
NOTE 10p.; Paper presented at the World Conference on Engineering Education, "Restructuring Engineering Education for Meeting World Needs" (St. Paul, MN, October 15-20, 1995). Research sponsored by the National Science Council.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Competence; Developed Nations; Educational Research; *Electronics; *Engineering Technicians; Entry Workers; Foreign Countries; *Job Skills; *Occupational Information; *Task Analysis; Technical Education; Two Year Colleges
IDENTIFIERS *Taiwan

ABSTRACT

A study examined the technological competencies of the electronic engineering departments of junior colleges in Taiwan. It used a combination of two methods--a revised DACUM (Developing a Curriculum) process and a revised V-TECS (Vocational-Technical Education Consortium of States) process--to analyze the duty/task profile and task/element list of electronic technological competencies for junior college graduates. A questionnaire survey and interviews obtained opinions of electronic workers and teachers. Twelve duties were analyzed: select electronic components; operate electronic instruments; construct analog circuits; construct digital circuits; construct microprocessor system circuits; software design; construct communication circuits; use computer aided drawing; projects; use application software; monitor production management; and conduct technical services. Each task was analyzed into one of three categories: "must-prepared," "should-prepared," and "could-prepared" technological competencies. Results indicated that 11 tasks could be categorized as must-prepared, 53 as should-prepared, and 9 as could-prepared. Most duties contained mainly must- or should-prepared tasks. Contains a list of 11 references and a table illustrating categorization of technological competencies.) (YLB)

A STUDY OF ENTRY-LEVEL EMPLOYMENT TECHNOLOGICAL COMPETENCIES FOR THE JUNIOR COLLEGE GRADUATES MAJORING IN ELECTRONIC ENGINEERING

Woei-Kae Chen
Associate Professor
Department of Electronic Engineering
National Taipei Institute of Technology

Liang-Te Chang
Doctoral student
Department of Industrial Engineering Education
National Taiwan Normal University

ABSTRACT

This paper studies the duty/task profile of the electronic technological competencies and the task/element List of the electronic technological competencies for junior college graduates, based on the DACUM and V-TECS methods used in trade analysis. Opinions of various occupants are obtained from different electronic workers (managers, engineers and technicians) and teachers (lecturers or professors of Electronic Engineering department of junior colleges) through purposive-sampling's questionnaire survey; interviews are also implemented. The *average used frequency*, *importance level*, and *future needs* for each duty/task are analyzed. Based on the analysis, we then classify and present the list of *must-prepared*, *should-prepared*, and *could-prepared* electronic technological competencies for junior college graduates. The results of this research are useful for future curriculum revisions and may be used to improve the quality of the Electronic Engineering education for junior colleges. It has considerable contribution for Electronic Engineering departments to reach their goal of cultivation.

Key words: Electronic Engineering, junior college, technological competencies, DACUM, V-TECS.

1. Introduction

One of the most important reasons for the success of Taiwan's economy during the past forty years was due to the success of education [6]. In particular, the human resource produced via technological education fulfilled the human market strongly demanded by the economic construction [8]. However, in order for Taiwan to become a fully developed country in the future, continuously improving the quality of the human resource is absolutely necessary. Therefore, it is of importance for the junior colleges to adaptively improve their education in quality, in quantity, and in time.

Currently, the Electronic, Computer, and Communication industry in Taiwan are short of human power both for quality and quantity. This is closely related to the current education environment of Taiwan. Possible reasons include: (a) the update of the class material taught at school is too slow in comparison to the rapid growth of the new technologies; (b) too much emphasis has been made to the theoretical courses, which resulted the decrease of lab courses; (c) the integration between different courses is not sufficient. When one graduated from a junior college and become an industry freshman, one often found that what he had learned at school was not enough to give him a good start. For those who learned well at school, they know only theories, which is difficult to be applied to the practical world. For those who did not learned well at school, they know neither theory nor practical work. As a result, it is often that industry have to spend a long time training new employees, even though they are already junior colleges graduates.

It is therefore important to integrate industries and academics so that the graduates of junior colleges attain necessary technological competencies required by the market. This paper focuses on the study of the technological competencies of the Electronic Engineering departments of junior colleges in Taiwan. We develop the duty/task profile and task/element list of Electronic Technological Competencies for junior college graduates. The frequency, importance level, and future needs for each duty/task are analyzed and surveyed. Based on the analysis, we then classify and present the list of *must-prepared*, *should-prepared*, and *could-prepared* electronic technological competencies for junior college graduates.

2. Research Methods

The major research methods used in this paper are trade analysis, and questionnaires and interviews. The details of the two methods are described as follows:

- Trade analysis: We use the combination of a revised DACUM (Developing a Curriculum) [9,10] and a revised V-TECS (Vocational-Technical Education Consortium of State) methods to analyze the duty/task profile and task/element list of electronic technological competencies. For the revised DACUM, we invite professional workers in electronic industry to attend the DACUM competent analysis expert meeting. For the revised V-TECS, we invite scholars and teachers to organize a research team to analyze and develop the task/element list of technological competencies.
- Questionnaires and interviews: The main subjects of consideration for questionnaires and interviews are the electronic industry, including electronic shops, companies, and corporations in the Taiwan area. we confirm whether a company is willing to accept our questionnaires or interviews by phone. When one is confirmed we send a person to interview the company or mail them three questionnaires to be filled (one for a manager, another for an engineer, and the other for a technician). We also survey junior colleges with Electronic

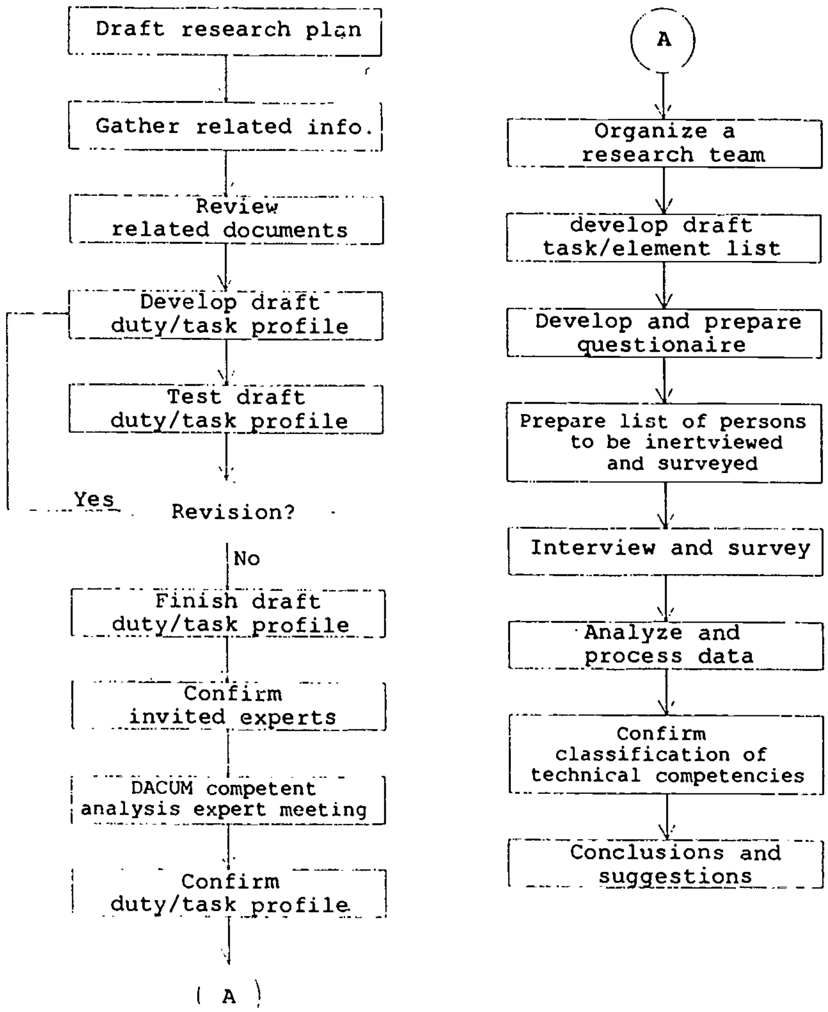

Figure 1. The research steps

Engineering departments. We give two questionnaires (each is filled by a lecturer or a professor) for all of the junior colleges of Taiwan.

Based on the above methods, the major steps of our studies are outlined in Figure 1. We now selectively describe the details of these steps:

- Develop draft duty/task profile (apply V-TECS method): Based on the results of literature review and related documents, we develop a draft duty/task profile. This is done for several iterations until we are satisfied with the draft.
- Confirm invited experts: We decided to invite nine experts from electronic industry as members of the DACUM competent analysis expert meeting.
- DACUM competent analysis expert meeting: This meeting reviews and makes necessary revisions to the draft duty/task profile of technological competencies, and confirms it from the industry's point of view.
- Organize a research team (apply V-TECS method again): Organize a research team to develop the task/element list of technological competencies.

- Develop and prepare questionnaire: Based on the results of the previous steps, we designed a questionnaire to survey the average used frequency, importance level, and future needs for each duty/task. This questionnaire is further revised and enhanced by an expert meeting.
- Confirm the list of companies and junior colleges to be interviewed and surveyed: We decide to interview 5 companies randomly selected from the "Top 500 companies, 1992," published by the China Credit Information Corporation. For questionnaires, both industry and junior colleges are surveyed. We will refer these two kinds of questionnaires as *industry questionnaire* and *educational questionnaire*. We decide to survey 60 companies, which are purposively sampled from the list of members of the trade union of Electrical and Electronic Instruments (1993-1994), Taiwan. Three questionnaires are mailed for each company, giving a total of 180 questionnaires for industry questionnaire. There are 33 junior colleges that offer Electronic Engineering departments in Taiwan. We decide to survey all of these departments --- two questionnaires for each department, giving a total of 66 questionnaires for educational questionnaire.
- Analyze and process data: After we received the replied questionnaires, we used hundred percent as basis to describe the background information. Each of the tasks of the technological competencies is given a weight by calculating its average used frequency, importance level, and future needs. For a given duty, we then rank each of its tasks according to their weights. Note that the calculation of weights and the ranking are done independently for both industry questionnaire and educational questionnaire. We then apply *spearman rank correlation* to test whether the ranks derived from industry questionnaire and educational questionnaire are consistent.

3. Results

The duty/task profile of electronic technological competencies for junior college graduates, derived by the DACUM competent analysis expert meeting, has 12 duties. These duties are further divided into 73 tasks. We will not show the entire duty/task profile in this paper. However, all of these duties and tasks can be found in Table 2 (although Table 2, to be explained later, is not designed for this purpose).

In addition to the duty/task profile, we further developed the task/element list of electronic technological competencies. In the task element list, each task is written by the constructional behavioral object method, through the analysis of its cognitive, psychomotor, and affective domains. Readers who are interested in the task/element list may refer to [4] for details.

The questionnaires were mailed to each recipients on March 15, 1994. With the help of telephone tracing, the ratio of replied questionnaires

	Number of mailed questionnaires	Number of replied questionnaires	Number of valid replied questionnaires	Number of invalid replied questionnaires	Valid replied ratio
Industry	180	168	166	2	92.2%
Education	66	64	63	1	95.5%
Total	246	232	229	3	93.9%

Table 1. The reply ratio for the questionnaires

were relatively high. Shown in Table 1 are the percentage of reply ratio for the questionnaires.

By analyzing the statistic figures of the average used frequency and importance level, we can classify each task into one of the following three categories: *must-prepared*, *should-prepared*, and *could-prepared* technological competencies. We define a must-prepared technological competency as one with high average used frequency and high importance level, and a *could-prepared* technological competency as one with low average used frequency and low importance level (a should-prepared technological competency falls in between). Therefore a must-prepared task should be included into requirement courses, while a could-prepared task can be designed as part of selective courses. According to our categorization, we conclude that 11 tasks of the electronic technological competencies can be categorized as must-prepared, 53 tasks can be categorized as should-prepared, and 9 tasks an be categorized as could-prepared. The results of our categorization is shown in Table 2.

It is interesting to note that according to our categorization, most of the duties contain mainly must-prepared or should-prepared tasks. The only exception is duty G (constructing communication circuits), where all of its tasks are considered as should-prepared tasks. Does this imply that duty G is unimportant at all? Since Communication technology has been designated as the industry of emphasis by our government, this result seems unreasonable and unbelievable. The following are possible reasons explaining this result:

- By examining the type of companies that we surveyed, we found that there are 12 companies that are in communication business (that is about 1/5 of the total companies). Since there are a total of 12 duties, this sampling ratio appears to be fair. However, after additional querying, we found that most of these companies are merely business agents, rather than manufacturers. There are not much research and development going on. Therefore it is possible that they consider the construction of communication circuits unimportant.
- Currently most of the Electronic Engineering departments of junior colleges in Taiwan are oriented toward the teaching of computer courses. This is true for either five-year programs or two-year programs. Therefore it is possible that the educational questionnaire considers constructing communication circuits as unimportant.

4. Conclusions and suggestions

We have studied the duty/task profile and the task/element list of electronic technological competencies for junior college graduates. In addition, we further classify tasks into must-prepared, should-prepared, and could-prepared electronic technological competencies. we conclude on the following observations and suggestions.

We recommend the Ministry of Education to periodically review the status of the students graduated from junior colleges. After one graduated for three years, is his job strongly related to what he learned at school? How useful is his knowledge learned at school. This can be important references to future revision to the duty/task profile of electronic technological competencies.

For the design of selective courses, we recommend junior colleges to follow the spirit of DACUM. Instead of offering fixed selective courses, it would be helpful for junior colleges to organize expert meetings in designing courses. We also recommend junior colleges to strengthen their cooperation with industry. This can shorten the distance between theories and practices so that better technicians can be cultivated.

The results of industry questionnaire and educational questionnaire are not always consistent. Although it is natural for people with different background to have different opinions, it is worthy of studying the underline reasons that caused the differences. It would be necessary and helpful for a future research on this issue.

Finally, it is interesting that both industry and education questionnaires do not consider the construction of communication circuits as an important duty. Since Communication technology has been designated as the industry of emphasis by our government, further research should be devoted to this issue.

5. Acknowledgment

This research is supported in part by the National Science Council under contract NSC83-0111-S-027-008-TG, which is gratefully acknowledged.

6. References

[1] P. V. Barden and P. Krishan, "Occupational Analysis of Educational Planning," Columbus: Charles E. Merril Publishing Company, 1975.
[2] A. Beamchomp, "Curriculum Theory," Kogg Press, 1975, 3rd.
[3] E. Carlisle, "The Process of Task Analysis: Integrating Training's Multiple Mothords," Journal of Instructional Development, 6(4), 1983, PP.31-35.
[4] Woei-Kae Chen and Liang-Te Chang, "A Study of Entry-Level Employment Technological Competencies for the Junior College Graduates Majoring in Electronic Engineering," Report NSC83-01110s-027-008-TG of National Science Council of Taiwan, pp.74-110, 1994.
[5] V. C. Fryklund, "Occupational Analysis Techniques & Procedures," New York: The Bruce Publishing Company, 1978.
[6] Wen-Rong Kauo, "Six-year National Construction Plan," Technical Human Resource Education Conference, 1991.
[7] C. L. Legere, "Occupational Analysis for Training," Education Technology, 18(3), 1978, PP.27-35.

[8] Tsung-Ming Lin, "The Present and Future of the Vocational and Technological Education of the Republic of China," Journal of Industrial and Vocational Education, pp.7-9, 1991.
[9] A. Nicholls and S.H. Nicholls, "Developing a Curriculum: a principle guide (2nd), "London: George Allen and Unwin, 1978.
[10] Noton and E. Robert,`"DACUM Hand Book: Leadership Training Series No.67, "Ohio State University, Columbus, National Center for Research in Vocational Education.
[11] R. Weissman, "Job Analysis Techniques: A Review, "Journal of Studies in Technical Careers, Vol. III, No.2, Spring 1981, P.184.

Duty \ Task	Must-prepared	Should-prepared	Could-prepared
A Select electronic components		1.Select basic passive devices 2.Select basic active devices 3.Select analog ICs 4.Select digital ICs 5.Select ADC/DAC 6.Select sensors/ transducers 7.Select peripheral devices 8.Select connection devices 9.Select materials	
B Operate electronic instruments	2.Operate DVM 6.Operate Digital/Analog oscilloscopes	1.Operate R.L.C. meters 3.Operate function generators 4.Operate frequency counters 5.Operate IC testers 7.Operate Spectrum analyzers	
C Construct analog circuits		1.Assemble DC low-voltage circuits 2.Assemble low-frequency amplifier circuits 3.Assemble high-frequency amplifier circuits 4.Assemble power amplifier circuits 5.Assemble low-frequency oscillation circuits 6.Assemble high-frequency oscillation circuits 7.Assemble filter circuits 8.Assemble wave circuits 9.Assemble driver circuits	
D Construct digital circuits		1.Assemble combinatorial logic circuits 2.Assemble sequential logic circuits 3.Assemble counter/timer circuits 4.Assemble display/driver circuits 5.Construct logic control circuits 6.Construct EPLD/FPGA firmware	
E Construct micro-processor system circuits		1.Select microprocessors 2.Select memory ICs 3.Select interface ICs 4.Construct memory circuits 5.Construct microprocessor interface circuits 6.Construct microprocessor system circuits 7.Familiar with assembly language	
F Software design	1.Operate DOS 2.Operate Windows	3.Operate UNIX 4.Familiar with high level language 5.Familiar with low level language	

Table 2. The categorization of technological competencies

Duty \ Task	Must-prepared	Should-prepared	Could-prepared
G Construct communi-cation circuits			1.Assemble AM transmitter circuits 2.Assemble AM receiver circuits 3.Assemble FM transmitter circuits 4.Assemble FM receiver circuits 5.Assemble ultrasonic transmitter circuits 6.Assemble ultrasonic receiver circuits 7.Assemble infrared transmitter circuits 8.Assemble infrared receiver circuits
H Utilize computer aided drawing		1.Use basic drawing 2.Use electronic drawing 3.Operate drawing software(e.g., ORCAD, AUTOCAD) 5.Operate PC board layout software(e.g.,PADS,PCAD)	
I Projects	4.Operate instruments and equipment	1.Investigate new products and technology 2.Analyze new products and technology 3.Construct prototype products 5.Write technical reports 6.Declare new products	
J Use application software		1.Use word processing software 2.Use management software 3.Use statistic software	4.Use publishing software
K Monitoring production management	1.Maintain safe work 2.Maintain sanitary work 3.Control production process 4.Control production quality		
L Conduct technical services	1.Use maintenance skill 2.Maintain product functions	3.Analyze product markets 4.Establish trade markets	

Table 2. The categorization of technological competencies