A RESEARCH MODEL FOR CURRICULUM DEVELOPMENT AND EVALUATION IN OCCUPATIONAL EDUCATION: APPLICATION TO MECHANICAL TECHNOLOGY IN THE PETROLEUM INDUSTRY OF VENEZUELA

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ABSTRACT

A RESEARCH MODEL FOR CURRICULUM DEVELOPMENT AND EVALUATION IN OCCUPATIONAL EDUCATION: APPLICATION TO MECHANICAL TECHNOLOGY IN THE PETROLEUM INDUSTRY OF VENEZUELA

By

Leonardo Martinez

The purpose of this study was to develop a research model that could be used to analyze the skills and knowledge possessed by job incumbents of an occupation in a selected technological area. The model was designed as a tool for curriculum development and evaluation in occupational education and was applied to a random sample of forty mechanical technicians employed by three petroleum firms in Venezuela. The primary objective was to apply the research model in exploring the skills and knowledge possessed by these technicians, the contribution of the school and the job in teaching them and the relative importance of their skills and knowledge in their job performance.

A sort of 84 cards, containing a content item each, was used. The content was drawn from formal and non-formal sources of training, and was classified according to two curriculum variables. Four questions were asked of each

incumbent. Six analyses of variance were performed and it was found that if a technician was affiliated with a certain company this had a significant effect on the importance he assigned to the content items of the card sort. This effect was attributed to irregular sampling and differences between firms concerning training and utilization of mechanical technicians.

Using a four-dimensional matrix to analyze the frequencies of responses to the card sort, it was found that there are three major curriculum areas of concern in the preparation of mechanical technicians for these firms: (1) the conceptual area, (2) the application area, and (3) the overlapping area. The role of the school was found to be unique in the conceptual area, although the school participates in teaching some items in the other areas. The role of the job is unique in relation to the management items and almost unique in relation to all other items in the application area.

The research model should prove to be an effective and unique tool for curriculum development and evaluation in occupational education. It is unique in that: (1) it includes content items from formal and non-formal sources of training, (2) it is possible to trace any effect of environmental variables, and (3) it uses two curriculum variables that are independent of one another.

After model application, the technical teacher may use the data for an atomistic interpretation with implications for curriculum improvement. The curriculum developer may use the matrix approach for a systems interpretation of the findings.

It was recommended that the model should be applied in conjunction with othe research tools directed to explore influences of affective content and cultural factors, quality of content acquisition and cost-benefit analyses of combinations of formal and non-formal education and training for the preparation of workers in certain occupations. Iterative applications of the model along and across technologies and economic activities may help to identify clusters of content and the basic elements of a general technology curriculum. Finally, some suggestions were made for establishing a process so that the most effective use of the data can be achieved.

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The writer of this dissertation wishes to express his appreciation to the representatives of the companies who were willing to cooperate from the very first moment that they were contacted about this study. The industrial relations and training managers opened the doors of the firms and supplied basic data for the investigation. The immediate supervisors and the technicians were the main actors in this work. They accepted the interviews with a cooperative and encouraging attitude.

It is obvious that the study could not have been completed without the cooperation of these people.

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CHAPTER I

INTRODUCTION

STATEMENT OF THE PROBLEM

The problem of determining the skills and information that should be included in the curriculum for occupational education is not unique to any particular country. A major criterion of the effectiveness of occupational education is the degree to which curriculum content is geared to employment needs. In the United States, for example, this problem has commanded the attention of vocational teachers for many years, and practices of curriculum development have been implemented at all levels to facilitate this kind of effort. Furthermore, curriculum development was identified as a needed force in the Amendments to the Vocational Education Act of 1963.

The rapid economic expansion in many developing nations has resulted in sudden demands being placed on the educational system for more skilled workers, technicians, scientific and managerial personnel. Since the educational structures have not changed rapidly enough to meet this demand, serious constraints have been placed on the growth of these nations. In most cases, curriculum content has failed to meet effectively employment demands because the rigidity of a "national" curricula and change dynamics do not allow for the utilization of simple strategies such as advisory committees.

PURPOSE OF THE STUDY

The purpose of this study is to develop a research model that could be used to explore the skills and knowledge required by job incumbents in order to perform in a given technological area. The research model can be used to find answers to three main curriculum questions: (1) What skills and knowledge do the job incumbents possess? (2) Where did they acquire these skills and knowledge? (3) How important are these skills and knowledge to the performance of their tasks? Included in this study is an application of the model to explore the skills and knowledge possessed by mechanical technicians in the petroleum industry of Venezuela.

IMPORTANCE OF THE STUDY

The research model developed in this study can be used by vocational educators in most developing nations for curriculum development and evaluation purposes. It can be applied and expanded in the evaluation of vocational education and in the development of new technical programs in Venezuela. In general, the model can be applied to many occupations and technological areas. It provides direct and objective criteria for developing an occupational curriculum that is closer to the needs of employment. Iterative use of the model in a group of occupations and technological areas can help to identify clusters of skills and the knowledge that are common to a group of occupations within one or several technological areas.

The use of the model for the development and evaluation of technical education in Venezuela is illustrated by the application carried on in this study.

TECHNICAL EDUCATION IN VENEZUELA

There are three formal sources of technical training in Venezuela: (1) the technical schools (ETI), (2) the polytechnical institute (IPU), and (3) the Universidad de Oriente school for technicians (ETSUDO). The ETI's have operated since 1937 and have graduated technicians since 1954. The curriculum of the ETI's had a two-year basic program, with an exploratory industrial arts content, some general education and training for basic industrial skills. After this program, the students could go into a four-year skill development and technical training program. These two components were basically different from the traditional academic secondary schools, which had a three year general education component where industrial arts was excluded and a two-year college preparatory program, with options in science and the humanities.

Since the ETI's technicians are the greatest technical manpower output of the nation, the curriculum problems of this source may have a significant impact on the economy. Educational planners have realized this fact and introduced some changes in the curriculum structure of secondary education, so that the ETI's will be significantly affected. First, the two-year basic program was replaced by a revised version of the three-year general education program for all schools at the secondary level. The student from the industrial school will be expected to make vocational choices at a later age than before, and the student from the academic schools will be introduced to the world of work through a practical arts curriculum. Second, the four-year skill development and technical training program was replaced by a two to three-year diversified secondary school program, which resembles the American senior high school curriculum of the comprehensive nature. This last replacement will be in effect nationwide beginning September, 1972, and will maintain the traditional academic offerings along with some occupational programs. As a result of these changes, the task of preparing technicians through the formal system has been located in the institutions of post-secondary education.

IPU and ETSUDO have been graduating technicians during the last four years. Four post-secondary schools were recently created to aid in this task, and some of the ETI's may achieve full and legal post-secondary status in the near future.

Traditionally, the technical education curricula has been prepared by the faculty of the engineering schools, with little or no involvement of private industry. Conventional curriculum evaluation devices such as advisory committees and follow-up studies have never been used. As stated in the prescribed program, the requirements for a technician's degree are slightly different than those of the engineering students.

In summary, the responsibility to prepare technicians has been located at the post-secondary level. New schools have been created to assume this role and other institutions are expected to be created in the near future. The process of curriculum development and evaluation needs a close examination. The research model developed in this study can be used for this purpose.

LIMITATIONS

Some limitations were identified and included in this section, in relation to the following aspects: (1) general education, (2) generalizability of findings, (3) affective domain, (4) quality of skill acquisition, and (5) influence of cultural factors.

General Education

Some skills and knowledge included in the occupational curricula are generally referred to as general education.

These would include basic concepts from the sciences, humanities, sociology, language and other behavioral areas. Since an analysis of the importance of these skills and knowledge was not intended, they were excluded from the card sort. Since it is not easy to distinguish between occupational and general content, some items included in the card sort may be part of the general education component of the technical curricula. However, the items excluded were those that appeared to be less obviously occupationally oriented.

Generalizability of Findings

The purpose of this study was to develop a research model for curriculum development and evaluation. The application of the model was confined to one technological area and three firms within that area. Furthermore, the job incumbents from one occupation were interviewed and only two kinds of school background that were present in the defined population were considered. Further replications across these variables should be attempted before the findings reported as part of the application of the research model can be generalized with confidence.

Affective Domain

It is not the intent of this study to consider attitudes, interests and other aspects of the affective domain. Although the importance of conducting research in this area should be recognized, it is beyond the scope of this investigation.

Quality of Skill Acquisition

It was stated in page 2 that the research model can deal with three major problems: (1) learned skills and knowledge, (2) systems of learning, and (3) importance to the job of learned content. One problem that may have implications for curriculum development and evaluation is the quality of content acquisition and its relationships with systems of learning and content importance. An evaluation of this problem may require the application of certain instruments like supervisory rating scales and performance tests. It may also require to examine company records of performance and career ladders. Consideration to this problem was beyond the scope of this study.

Influence of Cultural Factors

It may be argued that certain cultural factors had some unknown influences in the importance and relatedness assigned by the technicians to the questions of the card sort. No attempt was done to explore these factors, but it is expected that their effect will become evident in trying to apply the model from one cultural environment to another.

DEFINITION OF TERMS

The variables used in this study were operationally defined in the context of the local application of the research model. For instance, the levels of the independent variables related to the curriculum content were defined by the items included in these categories, as listed and coded in Appendixes B and D. The levels of the independent variable related to technicians' activities were defined by the kinds of tasks performed by the incumbents, as reported by company officials and line supervisors. These activities were coded and listed in Appendix A, but they are furtherly clarified in this section. The following definitions are included: (1) technician, (2) maintenance technician, (3) operations technician, (4) engineering technician, (5) formal education, and (6) non-formal education.

Technician

For this study, a technician is a graduate from the schools included in this research, defined as technician and reported as such by the companies and engaged in maintenance, operations and engineering activities within the firms.

Maintenance Technicians

These job incumbents performed their work in the refinery, production, gas operations and service station repairs. They were either supervisors or specialists of industrial services, equipment inspection, maintenance of power plants, corrosion detection, balance beams repairs and maintenance of instruments.

Operations Technicians

These job incumbents were found in the oil production areas. They worked either as supervisors or specialists in the programming of oil production.

Engineering Technicians

These job incumbents were working as specialists in the inspection of industrial equipment for non-destructive testing. They made reports of inspections of working and overhauled machinery. Other engineering technicians worked in the solution of advanced production problems and design of new production systems. Finally, some engineering technicians were engaged in equipment selection for a great diversity of company needs, acting as mediators between the departments requesting the equipment and the suppliers.

Formal Education

As used in this study, formal education refers to the system operated by the national government of Venezuela to prepare technicians through institutions like ETI, IPU and ETSUDO.

Non-formal Education

This system of learning refers to the technical training that takes place on the job, either through programs of a classroom nature or on-the-job learning through job rotation. Other non-formal learning activities promoted by the incumbents themselves or by the companies that are not related to job oriented skill training are excluded.

CHAPTER II

REVIEW OF THE LITERATURE

The problem of determining the skills and knowledge that should be included in the curriculum affects occupational education across jobs, levels of education, geographical zones and technological areas. Some effort has been made to find adequate solutions to this problem. The first part of this review focuses on studies using research procedures that may differ basically from those included in this study. The second part includes a representative sample of works that may have used research procedures somewhat related to the features included in the model. The discussion of these studies emphasizes the uniqueness of this research model.

GENERAL PROCEDURES

In general, the process of determining curriculum content has been approached through several procedures: (1) traditional advisory committees, (2) surveys, mainly of the follow-up type, (3) observation of worker's performance and interviews of job incumbents and their immediate supervisor, and (4) empirical procedures.

An example of a survey was the Position Analysis Questionnaire, applied by Mecham and McCormick (6) at Purdue University. Their objective was to develop a procedure for establishing job requirements on the basis of synthetic or generalized validity, building up data on the attributed requirements of the individual job elements. The instrument include 189 job elements of a "worker oriented" nature (4, p. 13).

The study conducted by Schill and Arnold (10) and reported in the next part of this review is an example of the interview procedure. One question that has been raised regarding the use of interviews is whether the information should be gathered from the job incumbents, from their supervisors or from both. Madden and others (5) addressed themselves to this question and analyzed the level of agreement between workers and supervisors in reporting the task demands of the worker's job. They found that there was a 90 percent agreement between these groups. Since they did not find evidence of exaggeration of the reports given by job incumbents, they recommended gathering data directly from workers (4, p.12).

An empirical procedure for identifying the skills and knowledge to be included in the occupational curriculum has been suggested by Moss and others (8) at the University of Minnesota. In the development of the rationale, they have indicated that the present methods for organizing content for vocational programs typically begin with the subjective identification of needed cognitive competencies. From their interpretation, educators infer these competencies by observing the worker or by asking him and his supervisor to estimate the concepts to perform satisfactorily. Moss and his group (8, p. 72) stated that the results of this approach are biased by suggestions from the investigator or by unrealistic occupational expectations. These researchers developed and tested an empirical method for identifying both the technical concepts possessed by workers on the job and their psychological structure. They experimented with a procedure to develop maps of the technical concepts possessed by selected workers. This procedure was based on the assumption that if a group of highly productive workers can be identified and if the psychological organization of the concepts possessed by these workers can be empirically determined, there will be an organizational structure of the content that can be used as a model for developing learning experiences. The conceptual structure, as perceived by these investigators, can be identified using free association methodology. Three pieces of research have been reported from these researchers to test free association methodology. The first one determined that free association could yield reliable data and produce a conceptual map with face validity for the radio and television repair occupation. The second one determined that the maps were sufficiently precise to be related to qualify of performance in the same occupation. The third one referred to radio communications repair and compared the conceptual structures among both occupations and identified a conceptual map for curriculum development purposes. In summary, free association methodology consists of: (1) selecting a sample of workers in the occupation to be studied, (2) having their immediate supervisors to rate these workers on an effectiveness scale, (3) developing a list of major technical words used in the occupation, (4) refining the list and arranging it into four forms of free association test booklets, and (5) applying the tests to the workers, analyzing the data and developing the maps. Ammerman (2, p.174) reported using free association methodology in a feasibility study for the Army. The results of his experiences point out the need to look at the selection of stimulus words. Depending on the curricular goals, different types of conceptual structures need to be sought. He also reported some response and structural consistency in the methodology, while suggesting that there are many procedural questions that need to be explored before this approach can become generally used for curriculum development.

RELATED PROCEDURES

A pioneering study was conducted by George L. Brandon at Michigan State University (3). He developed a research methodology to discover the basic understandings that are critical to technical jobs. An extensive review of the literature was done and two conferences were held with specialists and consultants from the universities, research organizations, employment and personnel management offices and independent researchers from various disciplines. As a result of this project, a matrix approach for curriculum research was suggested. This approach has been adapted, modified and improved in subsequent applications by other investigators. In summary, the matrix can be built in a six-step procedure: (1) defining job titles to be used in the horizontal side of the matrix, (2) describing in detail the current and future job activities, (3) defining elements to be compared in the vertical side of the matrix (courses, concepts, skills, etc.), (4) selecting and training raters, (5) applying the instrument to a sample of job incumbents, and (6) analyzing the data. The use of raters can be substituted by direct interviews of job incumbents.

Schill and Arnold (11) attempted to establish an empirical basis that would enable them to make more accurate decisions concerning curriculum content in technical education prior to establishing training programs. They selected a random sample of technicians in Illinois and collected data through a structured interview of job incumbents, using a modified version of the Q-sort technique. Ninety-nine cards were finally developed from school catalogs. The cards contained content information similar to a course description. A panel of experts examined the cards for content validity and understandability and rated each card on a continuum from abstract to application. Three pilot studies with technicians helped to improve the card sort. Finally the technicians selected for the study analyzed each card and sorted them into three piles: (1) closely related to job performance, (2) somewhat related, and (3) totally unrelated. The related and somewhat related were sorted again into the left hand tail of a normal curve. Values from zero to seven were assigned according to the degree each card was related to job performance. The researchers concluded that there was a common core of knowledge required of the various technologies and level of job function within the technologies (11, p.86). The identification of items for their common core was done through simple inspection of the responses arranged in rank order. The items somewhat related to job performance were subjected to a two-mode factor analysis using items and individuals via the principal axis rotation method, although they recognized the limitations of using factor analysis for this case. The items set aside as common core were compared with the abstract to application continuum and the academic disciplines classification, using chi-square analysis.

Al-Buckhari (1) studied the role played by the secondary industrial schools and the employment system of Jordan in preparing middle level skilled manpower. He used questionnaires and interviews to determine the working status of secondary industrial school graduates and the extent to which they utilized the curriculum components taught in the schools while on their jobs. He reported a consistent trend from the specific to the general in regard to skills and theory used on the job and learned on the job. The more specific the training provided by the schools, the less like it was to be relevant to job demands. The more general and theoretical the topics taught in the schools, the greater the likelihood of being relevant to job demands.

DISCUSSION

Different criteria may be used to select an appropriate research procedure or to evaluate those currently used for this problem. If accuracy is less important than costs and coverage, survey procedures can be used. If accuracy is most important, free association can be tried. If a balance is sought between these factors, observation and interview can be combined with empirical procedures.

Free association methodology promises to be a rather accurate tool. However, it needs to be used in combination with a conventional task analysis approach in order to give meaning to the conceptual maps (8, p.4). The application of free association methodology may encounter some practical inconveniences. Subjectivity may be present when the rating or selection of workers is done by the supervisors. Test application may require cooperation and healthy attitudes from workers and supervisors, which is difficult to obtain and extremely time-consuming.

Observation and interview can be used with confidence if some precautions are taken to prevent biases and if the appropriate statistical procedures are used to analyze the data. The temptation to force the data into artificial distributions should be avoided.

Certain features provide uniqueness to the research model developed in this study. First, the curriculum was broken down to a higher degree of specificity in relation to skills and knowledge possessed by the job incumbents. These levels need to be more comprehensive than the four components used by Al-Buckhari (1) and even more than the course content selected from college catalogs by Schill and Arnold (11). Second, an improved version of the card sort was used, selecting items from formal and non-formal sources of training, analyzing the job demands and developing specific and clear statements of skills and knowledge. Using this procedure, there was no doubt as to what part of the content the technician was reacting. Third, the research model can answer the question of content importance to job performance, but it also helps to identify the contribution of formal and non-formal sources of training in relation to the knowledge and skills possessed by the technicians.

Finally, the process of content organization into cards was carried on in a way that eliminated subjectivity. Instead of asking the supervisors what the job incumbents needed to know, they were asked to tell what tasks the technicians were expected to perform and what specific training they had received on the job. The interviews with the technicians were done in a way that avoided suggestions, personal preferences or interpretations by the researcher.

CHAPTER III

RESEARCH PROCEDURES

The purpose of this study, as described earlier, was to develop a research model that could be used to explore the skills and knowledge possessed by job incumbents in certain occupations and technological areas. Since the model was used to explore the skills and knowledge possessed by mechanical technicians in the petroleum industry of Venezuela, the research procedures were described in relation to that application.

OBJECTIVES

The primary objective was to apply the research model by exploring the skills and knowledge possessed by the mechanical technicians, to find out where they had acquired them and the relative importance of these skills and knowledge to job performance.

Three independent variables related to the technician and his job were considered: (1) school background, (2) company affiliation, and (3) kind of activity performed by the technician.

In relation to school background, technicians from two of the three technical institutions were employed by the three participating firms. It was considered appropriate to avoid school identification. It was also agreed with company officials that company identification and technicians' names would remain anonymous. Three kinds of activities were identified as performed by the mechanical technicians: (1) maintenance, (2) operations, and (3) engineering. The description of these activities was given in pages 7 and 8.

Two independent variables related to curriculum content were considered: (1) subject matter classification of the content, and (2) kind of human performance required by the job.

A long list of subject matter groups taken from formal and non-formal sources of training was analyzed and organized into eight distinct groups or levels: (1) fluids, (2) heat, (3) structures, (4) mechanical technology, (5) industrial technology, (6) management, (7) mathematics and science, and (8) electricity. Each of these levels was defined by the content included in them as shown in Appendix B.

Six kinds of human performances required by the job were also considered: (1) skills, (2) related information, (3) measurements, (4) communications, (5) science, and (6) mathematics. This classification system was adapted from the studies conducted by Donald Maley at the University of

Maryland and reported by one of his associates (7). This system was used by these researchers in the development of the cluster-concept program of vocational education at the secondary level. It was also defined in this study by the kinds of specific performances included in each classification, as shown in Appendix B.

The content items included in each pair of levels of the two classification systems of the card sort are identified in Appendix C.

Four independent variables were controlled. Technological characteristics of the occupations were controlled by selecting mechanical technicians only from the petroleum industry of Venezuela. Individual differences, age and work experience were controlled by random selection of technicians from the lists supplied by the companies.

The primary dependent variable was the relative importance and relatedness to the job assigned by the technicians to the content of each card. The following dependent variables were specifically examined: (1) frequencies of responses to the questions of the card sort, (2) weight of relative importance assigned to each content item, and (3) mean importance score, obtained by averaging the frequencies of responses to the question of content importance.

INSTRUMENT DEVELOPMENT

A sort of 84 content items written on cards was used. Each card contained two parts: (1) a behavioral statement describing the knowledge or skills involved, and (2) a group of content elements associated with the stated behavior. The behavioral statements of each item were included in Appendix D. These statements were so clear and specific that the technicians could react to the cards without reading the content elements. However, they were invited to read such elements when needed to clarify their thinking in relation to a specific behavior.

The process of instrument development consisted of four stages: (1) analysis of the curriculum in the schools of the formal system (ETI, IPU, ETSUDO), (2) analysis of training programs in the non-formal system, (3) development of tentative card sort, and (4) card sort refinement.

The analysis of training programs in the formal system included visiting each school and interviewing school officials and teachers of technical subjects. The course syllabi were collected and discussed with each teacher. They were asked to state in behavioral terms their expectations of the skills and knowledge that the technicians should have at the end of each course.

The analysis of training programs in the non-formal system included interviews with company training officials and the immediate supervisors of the technicians. The training officials were asked to supply the programs of systematic training that each technician was expected to follow. They were also asked to provide the syllabus for each course included in the program. The immediate supervisors were asked to describe in simple terms the tasks performed by the technicians and to supply additional information with regard to skills and knowledge learned through job rotation.

The data collected from formal and non-formal sources of training were organized into a tentative card sort. Each card was coded according to the levels of the two independent variables related to curriculum content. The sort was given to a group of technical teachers for review of content consistence. A trial run was performed with five mechanical technicians not included in the sample. This trail helped to make corrections and to estimate the time needed for each interview.

SAMPLE SELECTION

The process of sample selection consisted of three stages: (1) identification of the population of mechanical technicians in the petroleum industry, (2) analysis and classification of the activities performed by these job incumbents and (3) sample selection.

In a preliminary interview, the industrial relations officers from the companies were asked to provide a list of their technicians, indicating: (1) name or company identification number, (2) school background, (3) company assignment (unit of work and geographical location), and (4) name or company identification number of the immediate supervisors. Fifteen of these supervisors were interviewed. The job descriptions provided by these supervisors were used to develop a system of classification of technicians' activities, shown in Appendix A. A population of 65 mechanical technicians was identified as fitting within these three groups, and was distributed by firm and activity as shown in Appendix E.

Since the number of technicians working on engineering activities was relatively small, 100 percent of this group and about 50 percent of the maintenance and operations technicians were selected at random, until a final sample of 40 technicians was organized.

DATA COLLECTION

The investigator conducted personal interviews with each of the 40 mechanical technicians included in the sample. Before card sort application, the technicians were oriented to the objectives of the study and the operation of the instrument. It was made clear to them that : (1) the study was not promoted by the companies, (2) the results could not be used for personnel evaluation purposes, (3) the names of the company and the technicians would remain anonymous, and (4) the results could positively contribute to the advancement of technical education in Venezuela. Basically, the cards were randomly organized and presented to the job incumbents. Four questions, one at a time, were asked. Each time, the technician was expected to read the cards and answer the question by sorting them into piles. The questions were:

1. <u>What content items have you learned</u>? The technician organized the cards into two piles, the "learned" and the "not learned" items. A non-learned item was defined as one that was completely forgotten and would need some retraining if requested for application.
2. <u>From the learned items, which ones were learned in the school and which ones on-the-job</u>? Since some items could have been learned in a combination of school and job, the decision was to be based on where the major learning effort took place. They were asked to distinguish between initial learning, skill acquisition and task repetition.
3. <u>From the learned in the school items, which ones are important to your present job performance</u>?
4. <u>From a combined pile of items learned in the school and important to job performance and learned on-the-job, what is the relative importance of these items</u>? The technicians were asked to organize five piles on a continuum from most to least important to job performance.

The data collected on each interview were tabulated on a simple check-mark format, translated into computer codes and punched on computer cards.

ANALYSIS

The statistical analysis of the data was performed to test whether the relatedness and importance assigned by the technicians to the content of each card could be attributed to the specific demands of his job or to variables like school background, company affiliation or technician's activities. This test was achieved by crossing the two independent variables associated with curriculum content with each of the three independent variables associated to the technician and his job. Using the frequencies of responses to the fourth question as the dependent variable, six analyses of variance tests were performed, considering technicians nested each time within firms, activities and schools, and considering content items nested each time within subject matter classifications and human performance requirements of the job. These tests were performed through the computer, using a multivariate program developed by Jeremy Finn at the State University of New York, Buffalo. This program was available at the Computer Center, Michigan State University. Use of these facilities was made possible in part, through support from the National Science Foundation.

CHAPTER IV

FINDINGS

The purpose of this study was to develop a research model that could be used to analyze the skills and knowledge possessed by job incumbents of an occupation in a selected technological area. The model was applied to a random sample of 40 mechanical technicians employed by three oil companies in Venezuela to determine: (1) their skills and knowledge, (2) the role of the formal and non-formal systems of training in preparing technicians, and (3) the relative importance of their skills and knowledge in job performance. A sort of 84 cards, containing a content item each, was presented to the technicians. They were asked four questions related to each item. The findings are presented and discussed in this Chapter.

JOB REQUIREMENTS AS CRITERIA OF CONTENT IMPORTANCE

It was necessary to test whether the relatedness and importance assigned by the technicians to the content of each card could be attributed to the specific demands of his job, to his school background, to his firm affiliation or to his work activity. Therefore, the two independent variables associated with curriculum content were crossed with the three variables associated with the technician and his job. Using the frequencies of responses to the fourth question as the dependent variable, six analyses of variance tests were performed. The results of each of the multivariate tests for equality of men vectors are presented in Figure 1 (page).

Since the probability level for all comparisons was selected as 0.05, it is observed in Figure 1 that only the comparison of firms and subject matter was found to be statistically significant.

Each of the cells of Figure 1 yielded a set of univariate and step down F-tests, which are included in Appendixes F and G. The mean importance scores for each of these tests are presented in Appendixes H and I, and the correlation matrixes for each test are presented in Appendixes J and K.

Comparing the results reported in Appendixes F and H it is observed that:

1. Technicians from school two considered the items grouped as heat to be more important to their jobs than did those from school one. This was only significant in the step down F-test (p less than 0.0495), when the variance component from regression was eliminated.

2. Technicians working in maintenance and engineering activities found the items classified as mechanical technology to be more important to their jobs than did those working in operations. This was significant both in the univariate (p less than 0.0043) and the step down F-test (p less than 0.0079).

3. Technicians from firms one and three considered the items classified as mechanical technology to be more important to their jobs than did those from firm two. This was significant both in the univariate (p less than 0.0001) and the step down F-test (p less than 0.0002).

	Two Schools	Three Activities	Three Firms
Eight Subjects	F=2.0394 df=8 and 31 p less than 0.0743	F=1.2412 df=16 and 60 p less than 0.2654	F=2.3420 df=16 and 60 p less than 0.0092
Six Human Performance Requirements	F=1.6190 df=6 and 33 p less than 0.1731	F=1.3176 df=12 and 64 p less than 0.2310	F=1.6424 df=12 and 64 p less than 0.1022

Figure 1. Results of the multivariate F-tests for equality of means vectors.

4. Technicians from firms two and three considered the items classified as management to be more important to their jobs than did technicians from firm one. This was significant both in the univariate (p less than 0.0183) and step down F-test (p less than 0.0192).

5. Regardless of firm affiliation, school background or activity performed, the technicians consistently rated the items classified as industrial technology as the most important to their jobs, and those classified as structures as less important. This can be observed in Appendix H.

Comparing the results reported in Appendixes G and I it is observed that:

1. Technicians from school one considered the items classified as skills to be more important to their jobs than did those from school two. This was significant both in the univariate (p less than 0.0377) and the step down F-test (p less than 0.0377).

2. Technicians from school one considered the items classified as related information to be more important to their jobs than did those from school two, but it was only significant in the univariate F-test (p less than 0.0348).

3. Maintenance technicians considered the items on measurement to be more important to their jobs than did operations or engineering technicians. This was significant both in the univariate (p less than 0.034) and the step down F-test (p less than 0.0205).

4. Technicians from firm three considered the items classified as related information to be more important to their jobs than did those from firms one and two. This was significant both in the univariate (p less than 0.0427) and the step down F-test (p less than 0.0137).

5. Although the trend for human performance requirements comparisons was not as conclusive as it was for subject matter comparisons, the technicians considered the items classified as communications to be the most important ones to their job. This can be observed in Appendix I.

In terms of the correlation matrixes for subject matter and human performance requirements comparisons, it is observed in Appendixes J and K that:

1. There is a mild correlation between the importance scores assigned to fluids, heat and structures. Its value ranges from 0.44 to 0.58 for all comparisons.

2. There is a mild correlation between the importance scores assigned to related information and skills (0.606 to 0.678) and between the scores assigned to communications and related information (0.515 to 0.546).

THE SCHOOL AND THE JOB AS TRAINING AGENCIES

The frequencies of responses to the card sort were organized and presented in Appendixes L-1 to L-8 and M-1 to M-6. Appendixes L-1 to L-8 refer to subject matter classifications, while Appendixes M-1 to M-6 refer to human performance requirements of the job. Item identity in column one of each of these Appendixes corresponds to that in Appendix D. Columns two to five summarize the frequencies of responses to the first three questions of the card sort so that it is possible to examine the frequencies of responses by content item, question and curriculum variable. Columns six to eight summarize the frequencies of responses to each of the five alternatives of question four. The mean importance score presented in column nine was obtained by averaging these frequencies. Column six represents the sum of frequencies of responses to the first two alternatives to question four. Column eight represents the sum of frequencies for the last two alternatives. This illustrates both central tendency and dispersion of scores around the mean.

The analysis of these findings can be approached from two different perspectives. First, the curriculum developer or the technical teacher may want to explore the responses to the card sort in relation to one specific content item, a group of items or a curriculum variable. This atomistic interpretation will be appropriate for curriculum evaluation and improvement. Second, a system may be needed to develop an overview of the problem and to make interrelated observations. This second line of inquiry was selected in this report.

Figures 2 (page 35) and 3 (page 38) represent a matrix approach to allocate content items to a four-dimensional space, according to where the items were learned, the kind of content involved, the degree of importance to the job and the relative utility of the item. The decision to allocate an item according to the system of learning was based on the proportions of columns two and three against column four (Appendixes L-1 to L-8 and M-1 to M-6). If the sum value of columns two and three for an item was larger than its value in column four, the item was allocated as learned in the school and vice versa. The decision to allocate an item as being above or below average in importance was based on the value of the mean importance score. Items with mean values from 1.00 to 3.00 were included as at or above average. Items with mean values greater than three were represented as below average. The third dimension of the matrix offers two options, according to the curriculum variable selected for analysis. The decision to allocate an item according to the utility ratio was based on the proportions of frequencies of columns three and five against two and four for each item. If the sum value of columns two and four was equal or greater than the sum value of columns three and five, the decision was made to assign a high utility ratio to this item and vice versa.

Subject Matter Classifications

Selecting subject matter classifications as the curriculum variable for analysis through the matrix approach, the 84 content items of the card sort were represented in Figure 2 (page 35). This Figure can be observed in reference to Appendix D for content identification. The following findings can be reported according to the system of learning.

Non-Formal

1. The contribution of the non-formal system of training in the preparation of mechanical technicians is concentrated in the mechanical technology, industrial technology and management items. All items learned on the job and included within these three groups were considered average or above average in importance to the job.

2. All content items classified as management were learned by the technicians on the job. Most of these items have a high utility ratio, although some items missed the high utility category by two or three frequencies.

Learning System	Formal				Non-Formal			
Importance to the Job	At or Above Average		Below Average		At or Above Average		Below Average	
Utility Ratio	High	Low	High	Low	High	Low	High	Low
Fluids	1,3	2,7	5	4			6	
Heat		9,10,14,15	8	11,12,13,16				
Structures	21	22,23	19	17,18,20 24				
Mechanical Technology	28,39,41 42	25,30,37 40,29	35,31	33,34,38	26	27,32,36 43,44		
Industrial Technology	45	47		54	46,48,49 50,51,52 55,57	53,56		
Management					58,59,61 62,63,64 65,66,69 71,72	60,67,68 70		
Mathematics & Science		73,76,78 79,80		74,75,77				
Electricity			81	82				83,84

Figure 2. Allocation of Content Items according to systems of learning, importance to the job, utility ratio and subject matter classifications.

3. Most of the items classified as industrial technology and learned on the job have a high utility ratio and were considered average or above average in importance to the job. Item (56) missed the high utility category by two frequencies.

4. Only six out of twenty items classified as mechanical technology were learned on the job, but they are included in the school curriculum and continually stressed on the job by assignment rotation.

Formal

1. The contribution of the formal system of training in the preparation of mechanical technicians is concentrated in the fluids, heat, structures and mathemathics and science items. This system shares responsibility with the job concerning some mechanical technology items, and it also has a weak contribution in relation to the industrial technology items. The school failed to contribute in the management items.

2. Excepting items (29), (40), (34) and (38) in mechanical technology and (47) and (54) in industrial technology, all other items learned in the school have a broad and general theoretical orientation.

3. Of the thirteen items in industrial technology, three were learned in the school. Of those learned in the school, two are above average in importance and only one has a high utility ratio.

4. More than half of the content items classified as heat and structures have below average importance. Only items (8) and (21) have a high utility ratio.

5. Although some items in mathematics and science were reported to have above average importance, none was included in the high utility ratio category. In fact, the data in Appendix L-7 show that items (73), (78), (79) and (80) had a frequency of response that fluctuated from three to six cases. The larger frequencies for these items are in columns three and five. On the other hand, item (76) was reported as above average in importance by a larger group of technicians, but did not reach the high utility ratio category.

Human Performance Requirements

Selecting human performance requirements for analysis through the matrix approach, the 84 content items of the card sort were allocated and represented in Figure 3(page 38). This Figure can be observed in reference to Appendix D for content identification. The following findings are reported according to the system of learning.

Non-Formal

1. The non-formal system shares some responsibility in the preparation of mechanical technicians in skills, related information, measurement and communication items.

2. Excepting item (21), all other items classified as skills and having a high utility ratio were learned on the job.

3. All related information items learned on the job were considered above average in importance. Excepting item (67), all items in this group have a high utility ratio. Item (67) missed the high utility ratio by one frequency.

4. All items classified as measurement, learned on the job and considered above average in importance have a high utility ratio.

5. All items classified as communications learned on the job were considered above average in importance. Excepting items (60) and (70), all these items have a high utility ratio. Items (60) and (70) missed the high utility category by two and three frequencies respectively.

Formal

Excepting skill items (29), (40), (34), (38) and (54) and measurement item (47), all other items learned in the school have a broad and general theoretical orientation.

Learning System	Formal				Non-Formal			
Importance to the Job	At or Above Average		Below Average		At or Above Average		Below Average	
Utility Ratio	High	Low	High	Low	High	Low	High	Low
Skills	21	07,14 15,22 23,25 29,30 40		11,12 13,16 20,24 34,38 54	69,49 50,51 52,63 64,65 59	27,32 36,43 44,53 56,68	06	84
Related Information	28,39	09,10 37	05,31 35	33	26,55 66,72 57	67		
Measurement	03,45	02,47	08	04,82	46,48			83
Communications	41,42				58,61 62,71	60,70		
Science	01	73	19,81	17,18				
Mathematics		76,78 79,80		74,75 77				

Figure 3. Allocation of content items according to systems of learning, importance to the job, utility ratio and human performance requirements of the job.

Discussion

Once the findings of the application have been presented, it is convenient to examine and relate them to the research model as a tool for curriculum development and evaluation in occupational education.

Firm Effect

The fact that a technician was affiliated with a certain firm had a significant effect on the importance he assigned to the items of the card sort. This effect could be attributed to the following factors: (1) irregular sampling, (2) differential manpower policies, and (3) technological differences.

Irregular Sampling

Two forms of irregular sampling were present in the study (see Appendix E):

1. Only firm two employed and trained mechanical technicians for operations. Two of the findings support this confounding: (1) technicians from firms one and three gave greater importance to mechanical technology items than did technicians from firm two, and (2) maintenance and engineering technicians gave greater importance to mechanical technology items than did operations technicians. The major role of the operations technician is oil production programming. He is trained to do a job that requires the application of a specific kind of technology. Other firms employ other kinds of job incumbents for the programming job. The mechanical technician who works in operations gets the same training given to technicians from other specialties that perform the same job. The line supervisors reported that there are certain advantages in training mechanical technicians for this work role.

2. All technicians from firm three included in the population and selected for the sample are from school one. In the school comparisons, technicians from school one gave greater value to the skills and related information items than did those from school two. Technicians from firm three also gave greater value to these items than technicians from firms one and two, although only the univariate test for related information was significant.

Differential Manpower Policies

Another factor that may be confounded with the firm effect is the lack of homogeneity in manpower policies between firms, particularly concerning differential training and utilization of technicians for supervisory and non-supervisory work. Technicians from firms two and three received planned, institutionalized and on-the-job supervisory training, in addition to related skill training. Technicians from firm one received more skill related training specific to the material components of their environment. This may be reflected in the higher values assigned by technicians from firms two and three to the management items.

Technological Differences

The main effect of firm affiliation could also be explained by technological differences between firms. However, the researcher neither observed indicators of these differences nor had access to the kinds of data that would help to explore this possibility.

Independence of Curriculum Variables

An observation that can be made from the data is that the two systems of curriculum content classification are independent of one another. This is supported by the following findings: (1) The main effect of firms was present only in the subject matter comparisons, (2) all technicians gave greater value to the communications and industrial technology items, two groups that do not overlap, as shown in Appendix C, and (3) maintenance technicians gave greater importance to content items classified as mechanical technology and measurements than did operations technicians, referring again to two groups of items that do not overlap.

Model Application

As suggested at the outset, the research model developed in this study could be used to explore some curriculum questions concerning knowledge and skills possessed by the job incumbents, the place of learning and their relative importance to the job. The knowledge and skills possessed by the mechanical technicians were explored in relation to two curriculum content variables. Content items from formal and non-formal sources of training were used in the card sort. The frequencies of responses to each item and curriculum variable may be an useful resource for an atomistic analysis. For example, certain items being taught in the school and having low importance and utility may require particular attention. Some items that are important for a few job incumbents, whether learned in the school or on the job, may be questioned. Certain items learned on the job may be incorporated into the school curriculum. Other items that are taught in the school but are more efficiently learned on the job may be left to that training domain. This is the kind of analysis that may be of more interest to the technical teacher because it is at his level that the necessary improvements must be made on an item by item basis.

The matrix approach helped to develop an accurate and objective analysis of the contribution of the school and the job as training agencies. The concept of content utility provided an appropriate dimension for this analysis.

The interaction of the school and the job in the preparation of mechanical technicians for the petroleum industry of Venezuela has defined three major curricular areas of concern: (1) The conceptual area, (2) the application area, and (3) the overlapping area.

Conceptual Area

This area includes the content items in the heat, fluids, structures and mathematics and science subject matter classification. This area is the major and unique concern of the school. Almost all items in the conceptual areas have low utility ratio, including the few that were considered above average in importance to the job. All items in this area have a broad and general theoretical orientation.

Application Area

This area includes mechanical technology, industrial technology and management items, and skills, related information, measurement and communications items. This area is the major and almost unique concern of the job. All items in the application area are average or above average in importance to the job and almost all of them have a high utility ratio. Those with low utility are very specific to the technological environment and some may involve a high level of practice and sophistication that is normally achieved on the job. Other items have broader theoretical orientation but are more efficiently learned on the job. The most outstanding feature of this area, however, is the absolute concern of the job for the training of management content.

Overlapping Area

This area is similar in scope to the job domain but excludes the management items that are unique to the training programs of the firms. Some items in this area are mainly handled by the school and other items by the job. The trends in the overlapping area are not as clear-cut as in the other areas. The job is more effective in items considered above average in importance to the job, particularly the skills included in mechanical and industrial technology items. Some skills learned mostly in the school have a specific and practical orientation, but not as specific to the job as those learned within the firms.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to develop a research model that could be used to analyze the skills and knowledge possessed by job incumbents of an occupation in a selected technological area. The model was applied to a random sample of forty mechanical technicians employed in maintenance, operations and engineering activities by three petroleum firms in Venezuela. The primary objective was to apply the research model in exploring the skills and knowledge possessed by these technicians, the contribution of the school and the job in teaching them and the relative importance of their skills and knowledge in their job performance.

A sort of 84 cards, containing a content item each, was used in interviewing the technicians. The content of the cards was drawn from an analysis of the school curricula and the training programs conducted by the firms. Fifteen immediate supervisors of the technicians were interviewed and asked to provide task descriptions that were used to identify content items learned through job rotation. The content of the cards was classified according to two curriculum variables: (1) subject matter, and (2) human performance requirements of the job.

Four questions, one at a time, were asked of the job incumbents: (1) What content items have you learned? (2) From the learned items, which ones were learned in the school and which ones on the job? (3) From the learned in the school items, which ones are important to your present job performance? and (4) From a combined pile of items learned in the school and important to job performance and learned on the job, what is the relative importance of these items? Each time, the technician read the cards and organized them into piles according to the alternatives to the questions.

Six analyses of variance tests were performed to ascertain if the relatedness and importance assigned by the technicians to the card sort could be attributed to job demands or to school background, activity and firm affiliation. The frequencies of responses to the four questions of the card sort were organized and interpreted through a four-dimensional matrix. This matrix allowed a systems interpretation of the data.

Conclusions

The research model should prove to be an effective tool for curriculum development and evaluation in occupational education. The model is unique in the following features:

(1) it includes specific content items from formal and non-formal sources of training, (2) it is possible to study a population of incumbents on the job thereby enabling the researcher to trace any effect environmental variables may have on the relatedness and importance assigned to the content items, and (3) it uses two curriculum content classification systems that are independent of one another, having clear meaning to the curriculum developer and the technical teacher. After model application, the technical teacher may analyze the frequencies of responses to certain items, subject matter groups or human performance requirements of the job. The curriculum developer may profit from using the matrix approach and obtain a systems interpretation of the findings.

Future users of the model should consider its limitations. It is evident to this researcher that the study does not generate data to explore some aspects of curriculum development like the general education component, the quality of content acquisition, and the influence of affective content and cultural factors.

The data collected in relation to the application of the model made it possible to analyze the skills and knowledge possessed by the mechanical technicians, to find out where they acquired them and the relative importance of these skills and knowledge to job performance. It is evident from the data that there are three major curriculum areas of concern in the preparation of mechanical technicians for the petroleum industry of Venezuela: (1) the conceptual area, (2) the application area, and (3) the overlapping area. The role of the school is unique in relation to the conceptual area and the school participates in teaching some of the content items in the application and overlapping areas. Few items learned in the school are above average in importance to the job, and only a relatively small proportion of technicians considered them to be important to their jobs. Excepting some skills in the overlapping area, all items learned in the school have a broad and general theoretical orientation.

The role of the job is unique in relation to the management items, and almost unique in relation to all other items in the application area. All items learned on the job are considered above average in importance and almost all of them were considered important by a relatively high proportion of incumbents. All items classified as management are learned by the technicians on the job.

The fact that a technician was affiliated with a certain company had a significant effect on the importance he assigned to the content items of the card sort. This main effect of firms can be attributed to irregular sampling and to differences between firms concerning training and utilization of mechanical technicians. Irregular sampling may originate in the distribution of incumbents within the companies. Only one of the firms employed mechanical technicians as operators. They assigned less importance to the mechanical technology items than did maintenance and engineering technicians from the other firms. The mechanical technicians employed in one of the firms had only one type of school background and assigned greater value to skills and related information requirements than did those from the other type of school and the other two firms. Concerning differential training and utilization of technicians, those who received company training for supervisory positions assigned greater value to the items classified as management than did those who received training for skill development and technological specialization. No evidence was sought or observed that could be used to relate the main firm effect to technological differences between companies.

Recommendations

Any attempt to identify specific curriculum implications based on the results of this study should recognize the facts that there are certain limitations to be considered and that the data generated by the model is only one of various sources of information to be explored for curriculum development. Then, only procedural recommendations are considered pertinent and they are presented in relation to the following aspects: (1) comprehensive research framework, (2) model replications, and (3) curriculum development processes.

Comprehensive Research Framework

It is recommended that the model should be applied as a part of a group of projects directed to generate data concerning crucial problems. The model will provide information concerning learned cognitive and psychomotor content, systems of learning and importance to the job of learned content. Other research projects should deal with (1) affective content and its relationship with systems of learning and content importance to the job, (2) influence of cultural factors in the importance and relatedness assigned by job incumbents to the content items, (3) quality of content acquisition and its relationships with systems of learning and content importance, and (4) cost-benefit analysis of certain combinations of formal and non-formal education for the preparation of specified groups of incumbents. Pooling these sources of information, the curriculum developer may be able to attack the crucial problems with a higher level of comprehensiveness.

Model Replications

Once it is accepted that the model should be applied in a comprehensive research framework, consideration should be given to how to apply the model in a larger scale. It is recommended that the model should be used for a planned analysis of several technological areas and occupations. One possible enlargement would be to consider the standard classification of economic activities and a finite group of technologies as dimensions of a matrix. A sample of firms within each economic activity and a sample of incumbents across technologies within each firm can be selected. This would provide answers to the curriculum questions of the model along and across economic activities. Clusters of skills and knowledge can be identified along and across technologies, providing the basic information for the preparation of a general technology curriculum.

Curriculum Development Processes

After obtaining a comprehensive array of data concerning the crucial problems, the curriculum specialist needs to establish a process so that the most effective use of the information can be achieved. The following steps should be considered:

1. Develop a set of implications for educational policy concerning role definition between the school and the job in the education and training of workers. These implications should specify the areas of unique and mutual concern, the general objectives of a partnership between these sources of training and specific guidelines concerning the operation of the partnership.

2. Encourage local discussion of the findings, particularly those that can be derived from an atomistic analysis of the data. Groups of teachers should be motivated to introduce significant changes in their content areas.

3. Develop curriculum models for certain technologies, using the data obtained through iterative applications of the research model along and across technologies and economic activities. These curriculum models should meet the following minimum requirements: (1) define the roles of the school and the job in the accomplishment of the curriculum objectives, (2) identify the content elements of a general technology curriculum with implications for vertical and horizontal articulation, (3) discuss implications for methodology based on content importance, utility, quality and costs, (4) discuss cost-benefit implications, particularly social and individual investments and returns, and (5) provide guidelines for career development with implications for guidance and counseling. These guidelines should emphasize improved development and utilization of skilled and technical personnel within the companies.

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APPENDICES

APPENDIX A

CODE DESCRIPTION OF THE SAMPLE

Technician Number	Activity Description	Activity Code	Firm Code	School Code
01	Maintenance -refinery -industrial services.	1	1	1
02	Engineering -refinery -equipment inspection.	3	1	2
03	Engineering -refinery -equipment inspection.	3	1	2
04	Maintenance -refinery -mechanical services.	1	1	1
05	Maintenance -refinery -mechanical services.	1	1	1
06	Maintenance -refinery -mechanical services.	1	1	1
07	Maintenance -refinery -mechanical services.	1	1	1
08	Maintenance -refinery -mechanical services.	1	1	1
09	Maintenance -refinery -mechanical services.	1	1	1
10	Maintenance -refinery -mechanical services.	1	1	1
14	Maintenance -production -steam plants.	1	2	2
15	Maintenance -production -instruments.	1	2	1
16	Maintenance -production -work control	1	2	1
17	Maintenance -production -civil construction -piping.	1	2	1
18	Maintenance -production -planning	1	2	2
19	Maintenance -production -planning	1	2	1
20	Operations -production -programming	2	2	1
21	Operations - production - gas	2	2	2
22	Operations -production -programming	2	2	2
23	Operations -production -service-lake	2	2	2

Appendix A (continued)

Technician Number	Activity Description	Activity Code	Firm Code	School Code
24	Operations-production-programming-water surface	2	2	1
25	Operations-production-programming-water surface	2	2	1
26	Maintenance-production-balance beams.	1	2	1
27	Operations-production-programming-underground	2	2	1
28	Operations-production-land surface.	2	2	1
29	Operations-production-underground	2	2	1
30	Operations-production-steam lift	2	2	1
31	Maintenance-production-balance beams.	1	2	1
32	Operations-production-land-surface	2	2	1
33	Maintenance-production-planning	1	2	1
34	Engineering -production-special projects	3	2	1
35	Engineering-production-special projects	3	2	1
36	Engineer-equipment selection and evaluation.	3	3	1
37	Engineering-equipment selection and evaluation	3	3	1
38	Maintenance-gas operations-instruments	1	3	1
39	Engineering-industrial gas-piping	3	3	1
40	Maintenance-gas operations-instruments	1	3	1
41	Engineering-domestic gas-piping	3	3	1
42	Maintenance-gasoline service stations.	1	3	1
43	Engineering-equipment selection and evaluation	3	3	1

APPENDIX B

CLASSIFICATION SYSTEMS OF THE INDEPENDENT VARIABLES RELATED TO CURRICULUM CONTENT

I. Kind of Human Performance Required by the Job.

1. SKILLS: Hand, machine, mental
2. RELATED INFORMATION: Technical, social, operational, occupational, economic, safety, hygiene, personal standards, standards of occupational performance.
3. MEASUREMENT: Time, temperature, weight, volume, length, width, depth, meters, instruments, systems of measurement.
4. COMMUNICATIONS: Vocabulary, symbols, drawings, blueprints, systems of communications, speech, language, maps.
5. SCIENCE: Physics, electrical and magnetic systems, power.
6. MATHEMATICS: Geometry, trigonometry, algebra, calculus.

II. Subject Classification

1. FLUIDS: Hydrodynamics, hydrostatics, fluid mechanics, hydraulic engines, fluid power.
2. HEAT: Heat elements, thermodynamics, heat transfer, internal and external combustion engines.
3. STRUCTURES: Statics, dynamics, cinematics, applied mechanics, strength of materials, machine elements, machine design, mechanisms.
4. MECHANICAL TECHNOLOGY: Materials, processes, lubrication, metallurgy, production, drafting, blueprint reading, corrosion, heat treating.
5. INDUSTRIAL TECHNOLOGY: Ventilation, refrigeration, air conditioning, instrumentation, controls, automatic systems, piping, petroleum production and refinery, hygiene, safety.
6. MANAGEMENT: Labor, management, organization, technical writing, computer applications.
7. MATHEMATICS AND SCIENCE: Optics, geometry, algebra, calculus.
8. ELECTRICITY: Electrical and magnetic circuits, power systems.

APPENDIX C

IDENTIFICATION OF CONTENT ITEMS INCLUDED IN EACH PAIR OF LEVELS OF THE TWO CLASSIFICATION SYSTEMS OF THE CARD SORT

	Fluids	Heat	Structures	Mech.Tech.	Ind.Tech.	Management	Math-Sc.	Electricity
Skills	06,07	11,12 13,14 15,16	20,21 22,23 24	25,27,29 30,32,34 36,38,40 43,44	49,50,51 52,53,54 56	64,65,68 69,59,63		84
Related Information	05	09,10		26,28,31 33,35,37 39	55,57	66,67,72		
Measurement	02,03 04	08			46,67,48 45			82,83
Communications				41,42		70,71,58 60,61,62		
Science	01		17,18 19				73	81
Mathematics							74,75 76,77 78,79 80	

APPENDIX D

CODE DESCRIPTION OF THE CARD SORT

Card Number	Knowledge or Skill Content	Human Performance Code	Subject Code
01	To know basic hydrodynamic principles	5	1
02	To perform basic hydrodynamic measurements.	3	1
03	To perform basic hydrostatic measurements.	3	1
04	To perform density measurements.	3	1
05	To know basic principles and industrial applications of fluid mechanics.	2	1
06	To repair rotative equipment.	1	1
07	To perform calculations related to the design and maintenance of hydraulic and pneumatic machinery.	1	1
08	To perform calorimetric measurements.	3	2
09	To know basic principles of combustion engines.	2	2
10	To know specific principles of internal combustion engines.	2	2
11	To perform thermodynamic measurements and calculations.	1	2
12	To perform heat transfer measurements and calculations.	1	2
13	To perform combustion measurements and calculations.	1	2
14	To perform calculations related to the design and maintenance of internal combustion engines.	1	2
15	To perform calculations related to the design and maintenance of steam engines and turbines.	1	2
16	To perform calculations related to the design and maintenance of steam generators.	1	2
17	To solve dynamic problems.	5	3
18	To solve cinematic problems.	5	3
19	To analyze structural forces.	5	3
20	To analyze strength of machine components.	1	3
21	To perform laboratory tests of metals; to select steel and other metals for specific construction purposes.	1	3

Appendix D (continued)

Card Number	Knowledge or Skill Content	Human Performance Code	Subject Code
22	To forecast and solve problems of design in the production of metallic components.	1	3
23	To design mechanical systems.	1	3
24	To analyze speed and acceleration of mechanical systems.	1	3
25	To perform heat treating of metals.	1	4
26	To know basic principles of corrosion.	2	4
27	To diagnose mechanical surfaces that are liable to be affected by corrosion.	1	4
28	To know basic principles of lubrication.	2	4
29	To solve lubrication problems.	1	4
30	To perform laboratory tests of lubricants.	1	4
31	To know the theoretical functioning of diesel engines.	2	4
32	To repair and maintain diesel engines.	1	4
33	To know the theoretical functioning of gasoline engines and automobiles.	2	4
34	To repair and maintain automobiles	1	4
35	To know basic principles of welding.	2	4
36	To weld and cut a variety of metals; to design welding procedures.	1	4
37	To know basic procedures for steel and non-steel casting.	2	4
38	To make models for casting; to prepare casts; to operate casting equipment.	1	4
39	To know the theoretical functioning of machine tools.	2	4
40	To work on basic and special machine tools; to perform accurate machine work ($\pm$.002mm); to perform basic machine tool calculations.	1	4
41	To interpret blueprints of mechanical components; to draw mechanical components.	4	4
42	To interpret blueprints of mechanical systems; to draw mechanical systems; to design tooling procedures.	4	4
43	To plan mass production procedures	1	4
44	To select raw materials, design or improve production procedures using non-metallic industrial materials.	1	4
45	To know basic principles of industrial control and measurements.	3	5

Appendix D (continued)

Card Number	Knowledge or Skill Content	Human Performance Code	Subject Code
46	To use non-electric measuring devices for individual work; to decide on appropriate tolerances for equipment repairs; to calibrate non-electric measuring instruments.	3	5
47	To use non-electric measuring devices for mass production work; to identify sources of error in product control.	3	5
48	To trouble-shoot, repair and calibrate measuring instruments.	3	5
49	To calculate piping dimensions; to interpret piping blueprints; to design piping lines; to develop piping budgets.	1	5
50	To develop optimum maintenance programs of minimum costs.	1	5
51	To operate planned maintenance systems.	1	5
52	To supervise maintenance shop work.	1	5
53	To analyze and solve quality control problems.	1	5
54	To perform refrigeration measurements and calculations.	1	5
55	To know basic environmental risks and methods of prevention.	2	5
56	To solve problems related to programming oil production; to perform measurements and calculations for production programming.	1	5
57	To know basic principles of oil refinery.	2	5
58	To know basic supervision principles; to solve supervision problems; to diagnose training needs of personnel.	4	6
59	To apply systematic procedures for problem solving; to forecast problems and to establish priorities.	1	6
60	To know basic techniques for diagnosis and solution of motivation and human relations problems of workers.	4	6
61	To solve problems of failures of interpersonal communications; to communicate effectively within the organizational structure.	4	6
62	To analyze the behavior of working groups, to lead teams of workers; to train workers.	4	6

Appendix D (continued).

Card Number	Knowledge or Skill Content	Human Performance Code	Subject Code
63	To apply work simplication methods; to improve work planning and resource utilization.	1	6
64	To determine optimum procedures for work development; to develop work specifications from basic data.	1	6
65	To analyze project activities; to estimate time and costs for project development.	1	6
66	To know basic principles of enterprise organization.	2	6
67	To know basic financial principles for non-financial supervisory personnel.	2	6
68	To interpret financial statements of the enterprise; to develop feasibility studies for setting-up small or middle size industries.	1	6
69	To analyze work procedures for specific production problems; to establish production and maintenance procedures and levels of output.	1	6
70	To use data retrieval systems; to interpret technical data from the computer.	4	6
71	To develop technical reports.	4	6
72	To know basic labor laws, unionism and collective negotiation.	2	6
73	To know basic principles of physical optics.	5	7
74	To solve basic geometric problems.	6	7
75	To solve problems of analytical and space geometry.	6	7
76	To solve trigonometric problems.	6	7
77	To solve problems of basic algebra.	6	7
78	To solve problems of higher algebra.	6	7
79	To solve problems of infinite calculus.	6	7
80	To solve problems of advanced calculus.	6	7
81	To know basic principles of electricity and magnetism.	5	8
82	To perform basic electrical measurements and calculations.	3	8
83	To perform electrical measurements and calculations related to the maintenance and test of transformers and electric motors.	3	8
84	To interpret blueprints of electrical installations; to diagnose problems and maintain electrical installations.	1	8

APPENDIX E

POPULATION AND SAMPLE RELATIONSHIPS

	Technician's Activities			Firm
	Maintenance (Code 1)	Operations (Code 2)	Engineering (Code 3)	Totals
Firm 1				
Population	17	-	2	19
Sample	8	-	2	10
Percent	47	-	100	55.5
Firm 2				
Population	17	19	2	38
Sample	9	11	2	22
Percent	53	52.6	100	58
Firm 3				
Population	3	-	5	8
Sample	3	-	5	8
Percent	100	-	100	100
Activity Totals				
Population	37	19	9	65
Sample	20	11	9	40
Percent	54.5	52.6	100	61.5

APPENDIX F

UNIVARIATE AND STEP DOWN F-TEST FOR ALL SUBJECT MATTER COMPARISONS

	Variable	Mean Sq. Bet	Univariate F	P Less Than	Step Down F	P Less Than
	1. Fluids	2.0539	2.2583	0.1412	2.2583	0.1412
	2. Heat	3.7955	1.1724	0.2858	4.1258	0.0495*
	3. Struct.	0.1713	0.0632	0.8028	0.4871	0.4898
Schools	4. Mech.	1.6780	2.0412	0.1613	1.4524	0.2363
df=1 and 38	5. Ind.	0.2649	1.0844	0.3044	0.2932	0.5917
	6. Mgmt.	3.2114	3.5057	0.0689	2.8174	0.1027
	7. M-Sc	2.5744	0.6406	0.4285	0.3848	0.5395
	8. Elect.	10.8125	2.6187	0.1139	3.3573	0.0766
	1. Fluids	0.4863	0.5049	0.6077	0.5049	0.6077
	2. Heat	0.0290	0.0085	0.9916	0.1375	0.8720
	3. Struct.	1.6938	0.6287	0.5390	1.5086	0.2353
Activities	4. Mech.	4.2114	6.3678	0.0043*	5.6148	0.0079*
df=2 and 37	5. Ind.	0.4998	2.1634	0.1293	0.9048	0.4144
	6. Mgmt.	0.2149	0.2115	0.8104	0.3446	0.7112
	7. M-Sc	0.4542	0.1089	0.8972	0.3792	0.6876
	8. Elect.	2.8179	0.6433	0.5314	1.0935	0.3481
	1. Fluids	0.5106	0.5307	0.5926	0.5307	0.5926
	2. Heat	0.6844	0.2019	0.8181	0.3865	0.6822
	3. Struct.	0.3056	0.1104	0.8959	0.0920	0.9124
Firms	4. Mech.	6.4758	12.0014	0.0001*	11.1297	0.0002*
df=2 and 37	5. Ind.	0.5998	2.6580	0.0835	0.4107	0.6666
	6. Mgmt.	3.6980	4.4678	0.0183*	4.4841	0.0192*
	7. M-Sc	2.1398	0.5243	0.5963	0.8144	0.4522
	8. Elect.	10.6706	2.6973	0.0807	1.3997	0.2624

*Significant at P less than 0.05

APPENDIX G

UNIVARIATE AND STEP DOWN F-TESTS FOR ALL COMPARISONS OF HUMAN PERFORMANCE REQUIREMENTS

	Variable	Mean Sq. Bet	Univariate F	P Less Than	Step Down F	P Less Than
	1. Skills	1.7043	4.6372	0.0377*	4.6372	0.0377*
	2. Rel.Inf.	1.9074	4.7976	0.0348*	1.0744	0.3067
Schools	3. Meas.	5.4485	3.5982	0.0655	1.3590	0.2514
df=1 and 38	4. Comm.	0.7426	1.6977	0.2005	0.0062	0.9375
	5. Science	2.3880	0.8158	0.3722	2.0759	0.1588
	6. Math.	5.5312	1.3285	0.2563	0.5910	0.4476
	1. Skills	0.0353	0.0837	0.9199	0.0837	0.9199
	2. Rel.Inf.	0.6443	1.5158	0.2330	1.8962	0.1649
Activities	3. Meas.	5.2645	3.7130	0.0340*	4.3585	0.0205*
df=2 and 37	4. Comm.	0.2742	0.6034	0.5523	0.1733	0.8416
	5. Science	2.2616	0.7670	0.4717	1.7423	0.1909
	6. Math.	0.1477	0.0334	0.9672	0.0636	0.9386
	1. Sills	0.4557	1.1423	0.3301	1.1423	0.3301
	2. Rel. Inf.	0.3342	3.4410	0.0427*	4.8523	0.0137*
Fluids	3. Meas.	0.2123	0.1255	0.8825	0.0036	0.9965
df=2 and 37	4. Comm.	1.6240	4.2563	0.0217*	2.2739	0.1184
	5. Science	0.6076	0.2000	0.8197	0.1107	0.8956
	6. Math.	5.3962	1.3053	0.2833	1.7873	0.1838

*Significant at P less than 0.05

APPENDIX H

MEAN IMPORTANCE SCORES FOR ALL SUBJECT MATTER COMPARISONS

		Fluids	Heat	Struct.	Mech.	Indust.	Mgmt.	M & Sc.	Electr.
Schools	1.	2.159	2.658	3.125	2.746	1.306	1.9125	2.232	2.654
	2.	2.755	1.847	2.952	3.285	1.520	2.650	2.900	1.286
Activities	1.	2.130	2.500	3.324	2.550	1.190	2.035	2.498	2.054
	2.	2.291	2.576	3.636	3.585	1.546	1.919	2.227	2.909
	3.	2.524	2.476	3.144	2.572	1.438	2.213	2.167	2.611
Firms	1.	2.090	2.275	2.890	2.198	1.076	2.780	2.717	1.300
	2.	2.408	2.519	3.136	3.355	1.487	1.840	2.400	2.545
	3.	2.080	2.830	3.234	2.228	1.285	1.678	1.750	3.448

APPENDIX I

MEAN IMPORTANCE SCORES FOR ALL HUMAN PERFORMANCE REQUIREMENTS COMPARISONS

		Skills	Rel. Inf.	Meas.	Comm.	Science	Math.
Schools	1.	2.948	2.538	2.810	1.807	3.119	1.921
	2.	3.138	3.112	3.782	2.117	2.476	2.900
Activities	1.	2.674	2.511	2.520	1.816	3.341	2.135
	2.	2.755	2.929	3.154	2.058	2.624	1.955
	3.	2.645	2.542	3.794	1.764	2.731	2.166
Firms	1.	2.878	2.517	3.102	2.043	2.705	2.807
	2.	2.700	2.852	2.993	1.999	3.112	2.074
	3.	2.426	2.202	2.795	1.302	3.094	1.250

APPENDIX J

CORRELATION MATRIXES FOR ALL SUBJECT MATTER COMPARISONS

		Fluids	Heat	Struct.	Mech.	Indust.	Mgmt.	Math-Sc	Elect.
Comparing Schools	1.	1.000							
	2.	0.500	1.000						
	3.	0.579	0.501	1.000					
	4.	0.216	0.243	0.033	1.000				
	5.	0.331	0.379	0.228	0.470	1.000			
	6.	0.031	-0.016	-0.279	-0.094	-0.201	1.000		
	7.	0.356	0.264	0.212	-0.111	-0.051	0.140	1.000	
	8.	0.426	0.290	0.375	0.065	0.424	-0.195	0.135	1.000
Comparing Activities	1.	1.000							
	2.	0.444	1.000						
	3.	0.580	0.512	1.000					
	4.	0.291	0.213	0.132	1.000				
	5.	0.342	0.354	0.292	0.440	1.000			
	6.	0.089	-0.064	-0.296	0.020	-0.145	1.000		
	7.	0.392	0.237	0.199	-0.068	-0.005	0.173	1.000	
	8.	0.330	0.323	0.417	-0.085	0.325	-0.256	0.112	1.000
Comparing Firms	1.	1.000							
	2.	0.447	1.000						
	3.	0.558	0.497	1.000					
	4.	0.200	0.251	0.005	1.000				
	5.	0.328	0.350	0.213	0.391	1.000			
	6.	0.153	-0.030	-0.274	0.180	0.016	1.000		
	7.	0.380	0.258	0.219	-0.123	-0.015	0.130	1.000	
	8.	0.358	0.306	0.371	-0.061	0.331	-0.127	0.165	1.000

APPENDIX K

CORRELATION MATRIXES FOR ALL COMPARISONS OF HUMAN PERFORMANCE REQUIREMENTS

		Skills	Rel. Inf.	Meas.	Comm.	Science	Math.
Comparing Schools	1.	1.000					
	2.	0.606	1.000				
	3.	0.323	0.184	1.000			
	4.	0.401	0.537	0.200	1.000		
	5.	0.174	0.229	0.176	0.069	1.000	
	6.	0.142	-0.025	0.085	-0.148	-0.007	1.000
Comparing Activities	1.	1.000					
	2.	0.660	1.000				
	3.	0.428	0.269	1.000			
	4.	0.435	0.546	0.273	1.000		
	5.	0.097	0.218	0.215	0.059	1.000	
	6.	0.196	0.052	0.148	-0.099	-0.040	1.000
Comparing Firms	1.	1.000					
	2.	0.678	1.000				
	3.	0.381	0.270	1.000			
	4.	0.394	0.515	0.239	1.000		
	5.	0.110	0.167	0.130	0.056	1.000	
	6.	0.140	0.001	0.117	-0.228	-0.014	1.000

APPENDIX L-1

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS FLUIDS

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
01	19	14	1	6	9	6	5	2.75
02	13	16	2	9	7	3	5	2.86
03	14	13	8	5	7	3	12	2.95
04	12	19	5	4	3	5	9	3.30
05	29	4	4	3	11	7	16	3.33
06	5	4	18	13	11	-	12	3.35
07	11	14	6	9	9	3	5	2.64

APPENDIX L-2

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS HEAT

(1)	(2) Learned in the School	(3)	(4)	(5)	(6)	(7) How Important to the Job	(8)	(9)
Item No.	Important to the Job	Not Important	Learned on the Job	Not Learned	Most	Average	Least	Mean Importance Score
08	16	14	5	5	6	6	9	3.38
09	15	21	1	3	4	5	7	2.75
10	18	19	1	2	8	4	7	2.90
11	8	23	-	9	1	3	4	3.37
12	10	19	-	11	2	-	8	4.00
13	7	22	1	10	2	-	6	3.37
14	9	20	2	9	3	2	6	3.00
15	6	18	1	15	3	2	2	2.86
16	4	17	2	17	2	1	3	3.33

APPENDIX L-3

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS STRUCTURES

(1)	(2) Learned in the School	(3)	(4)	(5)	(6) How Important to the Job	(7)	(8)	(9)
Item No.	Important to the Job	Not Important	Learned on the Job	Not Learned	Most	Average	Least	Mean Importance Score
17	9	24	-	7	2	1	6	3.44
18	14	19	-	7	3	1	10	3.79
19	19	13	2	6	3	7	11	3.71
20	11	21	2	6	3	5	5	3.23
21	13	14	7	6	7	6	7	2.95
22	6	19	1	14	4	-	3	2.57
23	13	16	1	10	5	5	4	2.85
24	12	11	1	16	3	4	6	3.23

APPENDIX L-4

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS MECHANICAL TECHNOLOGY

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
25	6	17	2	15	3	3	2	3.00
26	9	4	18	9	17	4	6	2.26
27	3	2	14	21	10	3	4	2.23
28	22	8	3	7	16	4	5	2.32
29	11	5	6	18	9	1	7	2.65
30	8	7	-	25	4	2	2	2.50
31	15	15	5	5	7	2	11	3.15
32	7	6	12	15	7	2	10	3.31
33	11	20	5	4	1	5	10	3.94
34	9	15	7	9	2	2	12	4.00
35	22	6	10	2	11	8	13	3.03
36	9	11	10	10	9	3	7	2.95
37	7	22	2	9	5	2	2	2.33
38	4	25	2	9	1	-	5	3.83

APPENDIX L-4
(continued)
FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS MECHANICAL TECHNOLOGY

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
39	17	17	4	2	12	1	8	2.80
40	9	19	6	6	7	3	5	2.73
41	35	2	3	-	24	9	5	2.13
42	34	3	3	-	24	4	9	2.30
43	1	6	10	23	5	2	4	2.81
44	5	6	6	23	4	3	4	2.90

APPENDIX L-5

FREQUENCIES RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS INDUSTRIAL TECHNOLOGY

(1)	(2) Learned in the School	(3)	(4)	(5)	(6)	(7) How Important to the Job	(8)	(9)
Item No.	Important to the Job	Not Important	Learned on the Job	Not Learned	Most	Average	Least	Mean Importance Score
45	19	3	11	7	14	8	8	2.70
46	8	7	13	12	9	3	9	2.90
47	8	6	2	24	4	3	3	2.90
48	5	1	17	17	11	6	5	2.63
49	8	2	19	11	16	6	5	2.37
50	2	2	18	18	14	3	3	2.15
51	-	-	21	19	18	1	2	1.76
52	-	2	24	14	12	2	10	2.79
53	2	4	13	21	8	2	5	2.60
54	4	23	1	12	-	2	3	3.80
55	2	1	28	9	22	4	4	1.93
56	-	-	18	22	13	2	3	2.05
57	6	4	20	10	8	6	12	3.04

APPENDIX L-6

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS MANAGEMENT

(1)	(2) Learned in the School	(3)	(4)	(5)	(6) How Important to the Job	(7)	(8)	(9)
Item No.	Important to the Job	Not Important	Learned on the Job	Not Learned	Most	Average	Least	Mean Importance Score
58	-	3	27	10	26	1	-	1.40
59	1	-	19	20	13	4	3	2.15
60	-	2	18	20	16	2	-	1.50
61	2	-	26	12	26	2	-	1.57
62	-	1	22	17	16	6	-	1.73
63	4	2	25	9	24	3	2	1.69
64	4	-	20	16	16	6	2	2.00
65	3	1	24	12	19	3	5	1.99
66	5	5	19	11	20	1	3	1.82
67	-	-	19	21	16	2	1	1.77
68	-	1	17	22	8	5	4	2.47
69	3	1	20	16	18	3	2	1.82
70	-	-	17	23	11	4	2	2.00
71	5	1	27	7	27	4	1	1.66
72	14	2	19	5	25	3	5	2.09

APPENDIX L-7

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS MATHEMATIC AND SCIENCE

(1)	(2) Learned in the School	(3)	(4)	(5)	(6)	(7) How Important to the Job	(8)	(9)
Item No.	Important to the Job	Not Important	Learned on the Job	Not Learned	Most	Average	Least	Mean Importance Score
73	6	20	1	13	2	2	3	3.00
74	12	18	1	9	2	2	9	3.77
75	7	24	-	9	1	1	5	3.57
76	16	21	-	3	5	2	9	2.25
77	11	27	-	2	4	1	6	3.36
78	5	23	-	12	2	1	2	3.00
79	4	22	-	14	2	-	2	3.00
80	3	20	-	17	2	-	1	2.66

APPENDIX L-8

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS ELECTRICITY

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
81	21	19	-	-	3	4	14	3.81
82	10	22	1	7	2	2	7	3.63
83	1	6	3	30	1	-	3	3.25
84	6	10	7	17	5	2	6	3.25

APPENDIX M-1

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS SKILLS

(1)	(2) Learned in the School	(3)	(4)	(5)	(6)	(7) How Important to the Job	(8)	(9)
Item No.	Important to the Job	Not Important	Learned on the Job	Not Learned	Most	Average	Least	Mean Importance Score
06	5	4	18	13	11	-	12	3.35
07	11	14	6	9	9	3	5	2.64
11	8	23	-	9	1	3	4	3.37
12	10	19	-	11	2	-	8	4.00
13	7	22	1	10	2	-	6	3.37
14	9	20	2	9	3	2	6	3.00
15	6	18	1	15	3	2	2	2.86
16	4	17	2	17	2	1	3	3.33
20	11	21	2	6	3	5	5	3.23
21	13	14	7	6	7	6	7	2.95
22	6	19	1	14	4	-	3	2.57
23	13	16	1	10	5	5	4	2.85
24	12	11	1	16	3	4	6	3.23
25	6	17	2	15	3	3	2	3.00
27	3	2	14	21	10	3	4	2.23

APPENDIX M-1
(continued)

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
29	11	5	6	18	9	1	7	2.65
30	8	7	-	25	4	2	2	2.50
32	7	6	12	15	7	2	10	3.31
34	9	15	7	9	2	2	12	4.00
36	9	11	10	10	9	3	7	2.95
38	4	25	2	9	1	-	5	3.83
40	9	19	6	6	7	3	5	2.73
43	1	6	10	23	5	2	4	2.81
44	5	6	6	23	4	3	4	2.90
49	8	2	19	11	16	6	5	2.37
50	2	2	18	18	14	3	3	2.15
51	-	-	21	19	18	1	2	1.76
52	-	2	24	14	12	2	10	2.79
53	2	4	13	21	8	2	5	2.60

APPENDIX M-1
(continued)

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
54	4	23	1	12	-	2	3	3.80
56	-	-	18	22	13	2	3	2.05
59	1	-	19	20	13	4	3	2.15
63	4	2	25	9	24	3	2	1.69
64	4	-	20	16	16	6	2	2.00
65	3	1	24	12	19	3	5	1.99
68	-	1	17	22	8	5	4	2.47
69	3	1	20	16	18	3	2	1.82
84	6	10	6	18	5	2	6	3.25

APPENDIX M-2

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS RELATED INFORMATION

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
05	24	4	4	3	11	7	16	3.33
09	15	21	1	3	4	5	7	2.75
10	18	19	1	2	8	4	7	2.90
26	9	4	17	9	17	4	6	2.26
28	22	8	3	7	16	4	5	2.32
31	15	15	5	5	7	2	11	3.15
33	11	20	5	4	1	5	10	3.94
35	22	6	10	2	11	8	13	3.03
37	7	22	2	9	5	2	2	2.33
39	17	17	4	2	12	1	8	2.80
55	2	1	28	9	22	4	4	1.93
57	6	4	20	10	8	6	12	3.04
66	5	5	19	11	20	1	3	1.82
67	-	-	19	21	16	2	1	1.77
72	14	2	19	5	25	3	5	2.09

APPENDIX M-3

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS MEASUREMENT

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
02	13	16	2	9	7	3	5	2.86
03	14	13	8	5	7	3	12	2.95
04	12	19	5	4	3	5	9	3.30
08	16	14	5	5	6	6	9	3.38
45	19	3	11	7	14	8	8	2.70
46	8	7	13	12	9	3	9	2.90
47	8	6	2	24	4	3	3	2.90
48	5	1	17	17	11	6	5	2.63
82	10	22	1	7	2	2	7	3.63
83	1	6	3	20	1	-	3	3.25

APPENDIX M-4

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS COMMUNICATIONS

(1) Item No.	(2) Learned in the School: Important to the Job	(3) Learned in the School: Not Important	(4) Learned on the Job	(5) Not Learned	(6) How Important to the Job: Most	(7) How Important to the Job: Average	(8) How Important to the Job: Least	(9) Mean Importance Score
41	35	2	3	-	24	9	5	2.13
42	34	3	3	-	24	4	9	2.30
58	-	3	27	10	26	1	-	1.40
60	-	2	18	20	16	2	-	1.50
61	2	-	26	12	26	2	-	1.57
62	-	1	22	17	16	6	-	1.73
70	-	-	17	23	11	4	2	2.00
71	5	1	27	7	27	4	1	1.66

APPENDIX M-5

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS SCIENCE

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Learned in the School		Learned	Not	How Important to the Job			Mean
Item No.	Important to the Job	Not Important	on the Job	Learned	Most	Average	Least	Importance Score
01	19	14	1	6	9	6	5	2.75
17	9	24	-	7	2	1	6	3.44
18	14	19	-	7	3	1	10	3.79
19	19	13	1	6	3	7	11	3.71
73	6	20	1	13	2	2	3	3.00
81	21	19	-	-	3	4	14	3.81

APPENDIX M-6

FREQUENCIES OF RESPONSES AND MEAN IMPORTANCE SCORES OF CONTENT ITEMS CLASSIFIED AS MATHEMATIC

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Learned in the School		Learned	Not	How Important to the Job			Mean
Item No.	Important to the Job	Not Important	on the Job	Learned	Most	Average	Least	Importance Score
74	12	18	1	9	2	2	9	3.77
75	7	24	-	9	1	1	5	3.57
76	16	21	-	13	5	2	9	2.25
77	11	27	-	2	4	1	6	3.36
78	5	23	-	12	2	1	2	3.00
79	4	22	-	14	2	-	2	3.00
80	3	20	-	17	2	-	1	2.66