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Conceptions of future job activities as a predictor of academic success of engineering technology students

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Conceptions of future job activities as a predictor of academic success of engineering technology students

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INTRODUCTION

Need for the Study

Why is it that some people are able to achieve their objectives in life with apparent ease while others seem to reach in vain for their goals? Why is it that some people, after failing to reach one objective, are able to change course and achieve success while others change direction endlessly, without enjoying success?

Considering for the moment only academic objectives, why do some well-qualified and seemingly well-motivated students persist in a program to graduation while others drift away with little or nothing to show for their initial enthusiasm and high expectations? Surely some have over-extended themselves mentally, financially or emotionally, but others just seem to have picked the wrong route to travel.

Educators and social scientists have tested, surveyed, measured, sorted, observed, inventoried and probed students for years without answering the questions of who will succeed and who will not. Hopefully, the question will never be completely answered, for that would deprive teachers of the enjoyment received when the person who seems destined to failure, manages to beat the predictions and come out on top. If we educators could but improve our performance in career guidance a modest amount we could assist a higher proportion of students to persist to graduation - to the betterment of themselves and of the society that has subsidized their studies. At the same time we could still find the pleasure that comes from the square peg who refuses to give up and eventually adapts himself to fit through the round hole.

Nationally, the U.S. Department of Health, Education and Welfare (16) reports that some 60% to 70% of students entering large universities graduate within ten years, as do 35% to 50% of those entering state colleges and 15% to 30% of those entering public junior colleges (completing four-year degree after transfer). Astin's report (2) is less discouraging, but certainly is not exhilarating. He found that subsequent to the four-year period following initial enrollment, some 81% of the students who entered four-year colleges and universities either had graduated or were still enrolled. For two-year colleges, the corresponding proportion for a two-year period was 66%. Neither of these studies can be called conclusive, but they do show that higher education has sufficient room for increases in effectiveness to the student and to the subsidizing parent society to make worthwhile attempts at improving the matching of students to programs.

While it is recognized that educational institutions cannot guarantee a student success, they are obligated to offer programs of study that are useful to him and to society and to help him in the identification of those programs in which he is most likely to persist. Whatever the actual proportion of students entering higher education and leaving without completing their program, it is a measure of ineffectiveness at a rate that probably cannot be tolerated much longer. The proportion of the total public tax support that can be made available for subsidies to higher education appears to be holding rather steady. But, as faculty salaries increase, faculty output as measured by numbers of people completing programs does not increase proportionately; it has stayed rather constant over the years. Yet we find that a greater proportion of the public is enrolling in post-secondary institutions than ever before and bringing with it a greater variety of backgrounds and of expectations.

Many among this expanding clientele are not satisfied with the concept that it takes at least four years of study beyond the high school to prove one's worthiness to enter society as a contributing member - they want equally valid routes but of shorter duration and of more practical orientation. If higher education is to justify continued public support, even at current levels, it must use every means at its disposal to increase the amount of service rendered for the money spent. This includes an increased commitment to try to show each student the area of study and subsequent employment in which he is most likely to find success and satisfaction. As with industry, productivity should keep pace with wage increases.

Most students admitted to post-secondary education are admitted on the basis of their rank in their high school class, or on the basis of their performance on some standardized performance or aptitude tests, or some combination of these. Supplementing these criteria are the results of interest inventories frequently administered by guidance personnel. Probably the most widely known and used among interest inventories is the Strong Vocational Interest Blank in which respondents are asked to indicate their like, indifference, or dislike to various occupational titles, school subjects and activities, general occupational activities, kinds of people, and personal characteristics. Of these, occupational titles are the most powerful in terms of differentiating between occupations.

It then is reasoned that if a student demonstrates some prescribed level of academic aptitude and shares interests in common with persons employed in an occupational area, he should be urged to seriously consider an educational program leading to entry into that occupational field. Unfortunately, sometime between enrollment and graduation, many, and in some programs most, of the students initially enrolled fall by the wayside for one reason or another.

Likewise it seems reasonable to assume that as a student progresses through a program leading to employment he should become progressively more aware of the everyday activities of persons actually engaged in that occupational area. Students who find these activities to their liking should be encouraged to persist in their studies. Conversely, students who find these activities unacceptable should be expected to change to another area of endeavor. If a way could be found to measure a student's conceptions of his future job activities prior to commitment to a particular program of study, a counselor might be able to supplement the advice he can currently give which is based on existing measures of performance, aptitude and interest.

Students with accurate conceptions of future job activities in a given field should find reinforcement of any inclination they might have had towards seeking occupational education leading to employment in that field of work. Students with a poor conception of such duties should be so informed and advised to investigate a particular occupational area more carefully before enrolling or to prepare to be flexible enough to adjust to likely job duties of which they were not previously aware. To explore the possibility of such conceptions being of value, one would need to secure measures of the conceptions of students entering a given field of study and determine whether or not the students with the more accurate awareness of future job activities tended to graduate in a higher proportion than did those students with a less accurate awareness. Such is the intent of this study.

Objectives

The prime objective is to determine whether or not an entering student's ability to foresee his probable job activities upon graduation and entrance into the world of work has a significant bearing on his tendency to complete his program of education. To reach this objective, several intermediate objectives are also sought:

1. Develop scoring scales from existing responses of practicing engineering technicians to an inventory of job activities which are capable of differentiating between the technologies involved.
2. Secure a measure of future job conceptions from entering engineering technology students.
3. Score entering student responses and categorize scores as to accuracy of conception.
4. Determine proportions of those students who graduate with the more accurate and the less accurate conceptions of future job activities.
5. Test for statistical significance the differences between the proportions who graduate in the more accurate versus the less accurate conception groups.

Hypotheses

The following hypotheses, stated in null form, were tested in the study.

1. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Construction Technology scale.
2. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Electronics Technology scale.
3. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Mechanical Technology scale.
4. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Construction Technology scale.
5. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Electronics Technology scale.

6. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Mechanical Technology scale.
7. There is no statistically significant difference between the proportion of entering Construction Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Construction Technology scale.
8. There is no statistically significant difference between the proportion of entering Electronic Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Electronics Technology scale.
9. There is no statistically significant difference between the proportion of entering Mechanical Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Mechanical Technology scale.

Definitions

More accurate conceptions - an entering student whose score on the questionnaire is at or above the mean of all entering students in a given technology program.

Less accurate conceptions - an entering student who scores below the mean of all entering students in a given technology program.

Engineering Technology Program - a two-year program of study at Iowa State University, which prepares one to work as an engineering technician in construction, electronics or mechanical technology.

Entering student - a person enrolled in the Fall Quarter of the first year of an Engineering Technology Program during 1968, 1969 or 1970, and who completed the questionnaire during the first week of classes.

Graduate - a person originally in the sample of entering students who has since completed an Engineering Technology Program, or who is expected to complete his program based on the best estimate of his faculty advisor (after having completed a minimum of four quarters of the program), or who has transferred to another department within the college of engineering and has completed, or is expected to complete, a program in that department.

Practicing Engineering Technician - an employed graduate of an Iowa State University curriculum in engineering technology who was surveyed in the study of such graduates by Trambley (15).

REVIEW OF LITERATURE

Introduction

Just how a given individual decides to enter a particular field of study and later to enter a specific occupation is not clearly understood. Some people appear to have found a clear path to follow and do so with success and with satisfaction. Others appear to have drifted into an occupation by chance - perhaps the first job offered to them in an unsystematic search for employment. Of the latter, some will adapt to their work environment and stay to become satisfied, while others will complain for a lifetime of work, or will change from job to job and never find work which satisfies them.

This chapter describes some observations and conclusions of others who have been trying to construct a logical explanation of the preceding phenomenon that will help counselors and their clients more clearly understand what takes place (or what should take place) before an individual arrives at an occupational choice.

In addition, selected studies related to the use of interest inventories for predictive purposes are summarized that illustrate the general lack of clarity in the area of occupational choice. Also summarized are studies that stress the importance of job activities to the overall satisfaction of persons at work.

Occupational Selection

Ideally, an individual arrives in an occupation after completing a decision-making process in which he interprets information about himself regarding abilities and interests and about the requirements and duties involved in various occupations. This process is influenced by his past experiences and knowledge and on how he perceives the future. When occupational decisions are demanded of a person in his teens, the amount of past experience available as a reference to him is extremely limited. Therefore, he must expose himself to as much new (to him) information about potential careers as possible and must rapidly interpret this information and use it as a basis on which to make his occupational decisions. Since most vocational opportunities of long term growth potential require some sort of post-secondary education to meet entry level requirements, decisions regarding appropriate high school and post-secondary educational programs generally have to be made by age 16 or 17 and are likely to influence the entire working career of the individual.

There is evidence that young people do actively seek an occupation in which they feel they can fit and be successful. For example, the Center for Research and Development in Higher Education has published data (3) which give insight as to the educational aspirations, and the efforts made to attain these aspirations, of a sample of students in the eleventh grade in four states (California, Illinois, Massachusetts and North Carolina). Examination of questionnaire responses by male students in these states who aspired to attend a junior college or vocational-technical school, indicates that most of the students felt that they needed to attend college to "prepare for a job" and "to get ahead". They felt that they possessed the ability to succeed in college and were trying to obtain information related to occupational and college choices, and to visit colleges, read catalogs, and talk to college students about post-secondary education. They appeared to be interpreting the occupational information they had in a fairly realistic manner, in that their responses to questions like, "what would you like to be...?" were not drastically different than to "what do you think you'll actually become ...?", although a decrease was observed in the doctor, engineer, scientist category and a rise was noted in the electrician, auto mechanic, welder category. The prominent fields of study indicated by this group of potential community college students were: vocational, trade and industrial arts; business; engineering and architecture.

The question concerning what a person goes through psychologically as he struggles with his decisions about what occupation he should follow, and once chosen, how he prepares himself for job entry has attracted much research attention. The interpretation of a person's interest in an occupation offered by Super (13) is easy to follow and answers the question. Super explains the expression of interest in an occupation as an attempt by the individual to describe his ideas about himself in terms of a vocation. Super calls such an expression the "self-concept theory" of vocational development. The implications of this theory to the guidance counselor extend beyond the measurement and evaluation of student abilities and the matching of these results to various vocational requirements.

> "The picturing of the vocational counselor's task as helping a person to formulate an adequate idea of himself, and to find a role appropriate to the kind of person he conceives himself to be and seeks to become, added depth and meaning to the work of vocational guidance."

Super describes the elements of the self-concept theory as:

"Self-concept formation. In infancy the individual begins the process of forming a concept of himself, developing a sense of identity as a person distinct from but at the same time resembling other persons. This is essentially an exploratory process which goes on throughout the entire course of life until selfhood ceases and identity is lost to the sight of man as we know him. How does this concept of self evolve?

"Exploration appears to be the first phase and a continuing process. Just as the infant plays with his toes, or holds his hand in front of his face to observe the movements of his fingers, so the adolescent tries his hand at poetry, or admires the skill revealed by the masterpiece which he has produced in shop. Similarly, the older worker who can no longer maintain the pace which he had set as a younger man tries himself out at new methods of work to which he may be better adapted in view of the physical and psychological changes which he senses in himself. The self is an object of exploration as it develops and changes; so, too, is the environment.

"Self differentiation is a second phase in the development of the self-concept. Moving his hand in front of his face, noting that it moves as he wills it to, whereas his mother's hand appears to move independently, the baby notes 'This is I, that is someone else.' He goes on to ask, 'what am I like?; and thus begins the search for identity. The small boy, son of his father, is aware of the fact that he is smaller, weaker, a milk drinker but not a coffee drinker, and so forth. The adolescent, member of a teen-age group, may be aware of the fact that he does not dress as flashily or talk as much as most of his friends. Similarly the recent graduate working at his first regular job notes differences in his approach to clients as contrasted with that which characterizes his fellow salesclerks, and is conscious of greater interest in the paper work associated with the job than they seen to manifest.

"Identification is another process which goes on more or less simultaneously with differentiation. The man-child, aware of similarities between himself and his father and of himself and his mother, aware and also envious of his father's strength and power, identifies with his father and strives in various ways to be like him. The variety of male roles in our society associated with the variety and prominence of occupations in men's lives, channels the boys identifications importantly, although not solely, along occupational lines. The father, uncle, older brother, neighborhood men, all go to work, come home from work, talk about work (as well as baseball and politics which also are man-dominated), reinforcing the boy's impression that maleness and occupation are more or less synonymous. Men come to the house or apartment in connection with work which the boy has a chance to observe; meter readers, bill collectors, milkmen, mailmen, plumbers, and others. The boy whose father was at first his only male object of identification, finds that he can resemble a number of other males and assume a variety of masculine roles, can choose his identification on the basis of what appeals to him most. This is less true of the girl-child, whose adult counterparts more often work at home or, if they go to work, tend to talk about it less than the man and seem less involved in their occupations. In line with these observations small boys' interests are more likely to agree with their measured aptitudes than those of little girls.

"Role playing is a type of behavior which accompanies or follows identification. The small boy who identifies with his father seeks to emulate him: in his imagination or in his overt behavior the boy acts as he thinks his father does, later he bats left-handed because the baseball player with whom he now identifies is left-handed, and later still he aspires to be a physician and starts ninth-grade biology with zest because the man who did wonders for him when he was ill was a physician. Whether the role playing is largely imaginative or overtly participatory it gives some opportunity to try the role on for size, to see how valid the concept of oneself as a left-handed baseball player, or as a student of biology preparing to be a physician, actually is.

"Reality testing stems as readily from role playing as role playing does from identification. Life offers many opportunities for reality testing, in the form of children's play (thus the raft a small boy built at age nine may have diverted him from a career as a ship builder by sinking with his weight on it:, in school courses (how many men were convinced by high school algebra that they were not cut out to be engineers?), in extracurricular activities (the girl who sang the lead role in the high school musical last year has gone on to a school of dramatic arts), and in part-time or temporary employment (as in the case of the draftee assigned to be a medical corpsman who unexpectedly discovered that the role of medic sat well upon him and went on to medical school). These reality testing experiences strengthen or modify self-concepts, and confirm or contradict the way in which they have been tentatively translated into an occupational role.

"Translation of self concepts into occupational terms. The translation proceeds in several ways, although it should be noted that much of the theorizing on the subject is done by analogy from other aspects of developmental psychology and from everyday observation rather than inferentially from carefully collected and analyzed data. (1) Identification with an adult sometimes seems to lead to a desire to play his occupational role; this global vocational self concept, assumed as a whole, may be just as totally discarded when subjected to reality testing. (2) Experience in a role in which one is cast, perhaps more or less through chance, may lead to the discovery of a vocational translation of one's self concepts which is as congenial as it is unexpected. (3) Awareness of the fact that one has attributes which are said to be important in a certain field of work may lead one to look into that occupation; and the investigation may lead to confirmation of the idea that the role expectations of that occupation are such that one would do well in it and enjoy it. Here the translation may be made bit by bit, as when success in algebra leads to electing physics in the senior year of high school, and good work there leads to the belief that one's scientific as well as mathematical abilities and interests make engineering appropriate.

"Implementation of the self-concepts. The implementation or actualizing of self-concepts is the result of these processes as professional training is entered or as education is completed and the young man or woman moves from school or college into the world of work. In an early phase, the premedical student enters medical school, proud of his developing sense of professional identity. In a later phase, the young engineering graduate gets his first job as an engineer, and rejoices in his new title, symbol of his having converted a self concept into a reality; the young executive trainee who finishes his rotations through the planned sequence of training positions and settles at his own desk, with his own nameplate in front of him, feels that he has finally achieved success. At the other extreme, the high school dropout who never did well in his studies, who was never accepted by his classmates, and who is fired from the job that he finally got only after a number of rejections, finds the occupational translation of his self-concept as ne'er-do-well confirmed and implemented. After a series of negative experiences, it takes a great deal of reeducation to help him develop more positive self-concepts,

> to find a suitable occupational translation of this favorable picture of himself, and to turn it into a reality. With the population explosion in the labor years to come, the unfortunates who enter the market with poor self-concepts and inadequate vocational translations of these self-concepts will have all too many opportunities to confirm them.
>
> "These appear to be the elements of a self-concept theory of vocational development. They are still not formulated as testable hypotheses, but, judging by the research results so far, they do suggest and permit the formulation of hypotheses which tend to stand up when tested, and they can be helpful to counselors in dealing with the vocational decision making of students."

Under the self-concept theory a counselor must be able to provide his clients with more information about a vocation than just the entry requirements and how to meet them. The job itself is of major significance since it is in the job that time and effort and talent must be invested and satisfaction derived. The advisee must be made aware of the day-to-day aspects of various occupations so that he may evaluate and decide what groupings of occupations would likely be satisfying to him.

Along the same line as Super's discussion of a person's self-concept being expressed in the individual's choice of vocation, Holland (6) states that vocational choice is an expression of personality and that instruments designed to inventory interests are, in fact, personality inventories:

> "The choice of an occupation is an expressive act which reflects the person's motivation, knowledge, personality, and ability. Occupations represent a way of life, an environment rather than a set of isolated work functions or skills. To work as a carpenter means not only to use tools but also to have a certain status, community role, and a special pattern of living. In this sense, the choice of an occupational title represents several kinds of information:

the subject's motivation, his knowledge of the occupation in question, his insight and understanding of himself, and his abilities."

Holland goes on to suggest that:

"Apparently, a young person, by virtue of his heredity, family background, and school experience, learns to cope with some environmental tasks better than with others. With or without professional guidance, consciously or unconsciously, he perceives more or less accurately what he can do, what he cannot do, what he likes to do, and what he dislikes doing. Moreover, the young person acquires knowledge, more or less valid, about various occupations. On this basis he tentatively selects vocations that will, first, permit him to engage in activities and roles that are attractive to him and, second, enable him to avoid activities and roles that are distasteful or difficult."

The knowledge about various occupations held by current secondary-school students is criticized by Holland as being too general. He contends that students need to be made more aware of the great variety of possible niches for them within an occupational area. He suggests that vocational counselors might be more effective if they were to concentrate on the coordination of part-time work experience for students and on student interaction with people employed in different vocations rather than on talking with students about jobs and schools and test scores. His summary reveals his concern over the present state of the art in interest evaluation:

"The area of vocational interests is a kind of no man's land...."

A term of such importance and of such specialized usage as "interest" in vocational guidance should be more precisely defined than it is for everyday use. A typical dictionary (17) definition is hardly adequate:

"excitement of feeling, accompanying special attention to some object." Super and Crites (14) have provided us with more workable definitions of the term, settling on a four-part definition as being adequate:

> "Expressed Interest - a verbal statement by the individual that he likes or dislikes an object, activity, task or occupation. Depending on the phrasing of the statement being responded to, information is gained regarding expectations, preferences or fantasies.
>
> "Manifest Interest - an interpretation of an individual's interests based on his participation in an activity (a hobby or club) or occupation.
>
> "Tested Interest - the use of objective tests, rather than inventories, to measure an individual's knowledge related to an occupation. Thus an interest in science should reveal itself as a higher score for the individual on items pertaining to knowledge about scientific subjects on a test than for people in general.
>
> "Inventoried Interest - also calls for a response to items concerning objects, activities, tasks or occupations, but responses are evaluated in the form of a score arrived at by experimentally determining the weight to be given in the scoring system for all possible responses to the items."

The questionnaire responses analyzed in this study do not fit the "Expressed Interest" part of the preceding definition in that no likes or dislikes are called for. Rather, the assumption is made that anyone responding to the instrument has some degree of positive feeling towards engineering technology. Neither do the responses fit the "Manifest Interest" category in that auxiliary data collected on the questionnaire pertaining to related work experience are not included in the analysis of the responses to the job activity items, answers to which need not have come from activities or from occupational experiences.

The data analyzed in this study do fit the "Inventoried Interest" definition in that evaluation of the responses requires scores which were determined by a scoring system comprised of experimentally determined weights. One might also consider the questionnaire to be a form of an objective test and the results then could be considered as "Tested Interests" in that responses evaluate how well a subject understands, or at least recognizes, the day-to-day job activities of persons employed in a field of engineering technology. However, the items on the questionnaire, and the treatment of responses to those items are best defined by the "Inventoried Interest" portion of Super and Crites definition of interest, to which they add:

> "in answering the questions in an interest inventory an individual records a series of self-perceptions, which in turn are summated by the scoring scale in such a way as to reveal the similarity or dissimilarity of his self-concept to the self-concept which has been found to be characteristic of persons in the occupation being scored."

Related Studies

The concept of using results from some form of interest inventory to predict some kind of future performance has been tried in the past, with quite mixed results. As would seem natural, most of these studies have employed scales on the Strong Vocational Interest Blank, (hereafter referred to as SVIB), due to its widespread acceptance and popularity.

The relationship between score on an interest inventory and academic performance as indicated by grades received seems hazy enough to conclude that there is none. Super and Crites (14) reported several studies by others who, in some instances, found small but statistically significant correlations between SVIB scores on specific scales such as engineering and grades in engineering studies. Other studies referred to by Super and Crites reported no significant results either positive or negative.

Strong (12) reports similar results from studies of his own and by others. Correlations between scores on a given interest scale and grades in related academic programs were sometimes positive and sometimes negative and occasionally statistically significant, but were not considered to be of any practical value.

As to predicting overall persistence in a program of study, rather than grades and grade averages, Strong (12) reported encouraging results in his study of dental school graduates. Of those completing their dental education in six years or less, 91% of those scoring A on the dental scale of the SVIB had graduated, 93% of those scoring B+, 67% of the B's, 67% of the B-'s, and 25% of the C group. Of the 176 dental students in the total study group, about 45% of them had scored A on the dental scale, 23% had B+, 18% had scored B, 9% were B-, and 6% were C.

On the other hand, a related study by Kibrick and Tiedeman (7) produced inconclusive results. They had hypothesized that in order for a person to persist in an occupation, he must:

> "(1) satisfy superiors who have the right to deny continuing access to the position and (2) satisfy himself that his course is of continuing virtue."

They argue that failure to meet either condition will eventually terminate the pursuit. Their study of nursing students indicated, among other things, that the relationship between the students self-concept of themselves as future nurses and their tendency to persist in the program was only random. They concluded that portion of their study by saying: "The pattern seems unworthy of further remark".

Lewis, Wolins and Hogan (9) investigated the possibility of using responses to the SVIB by Iowa State University freshmen in engineering to predict those that would graduate in engineering and those that would not. Results were sufficiently encouraging for the authors to suggest that the addition of SVIB responses to existing high-school average and ISU Mathematics Placement Test scores could increase the predictive validity of the combination by 10% or more in a replication of the study.

An example of yet another predictive use of an interest inventory is the study by Ghei (5) who used responses to the Minnesota Vocational Interest Inventory to predict job performance as evaluated by supervisory personnel at IBM. Responses of employees rated as "high achievers" were used to construct a scoring scale which could be used as a screening device for prospective employees. Ghei estimated that the scale could select about 65% of new employees who could be expected to receive "high achiever" ratings in the future, as compared to the 50% expected by chance alone.

The interest inventory approach to predicting persistence has achieved enough success (although far from universal) to be worthy of further effort, especially if the items used in the questionnaire were to emphasize job activities rather than job titles. It seems that a person would need more detailed background information about an occupational area to be able to answer questions about actual job activities existing in the area than he would need to indicate likes or dislikes of various job titles. It is then reasoned that a "good" score on a job activities scale is a superior indicator of interest than is an equally "good" score on a like-dislike scale. This concept has attracted the attention of the American College Testing Program (1) as evidenced by their entry into the field of guidance counseling for students considering post-secondary vocational-technical programs in 1970. Their "Career Planning Profile" has sections for: student information, ability measures, and vocational interest.

The last section is designed to encompass a wide range of occupational areas, currently containing twelve scales - Agriculture, Carpentry, Mechanical, Electrical, Scientific, Health, Artistic, Social Service, Business Contact, Business Management, Business Detail and Household. These categories were chosen as an expansion of the six occupational types used by Holland (6) and differed from common measures of vocational interest, such as the SVIB, in that the students respond to lists of specific job activities rather than occupational titles. The response is indicated on a five-point scale from "dislike very much" to "like very much".

The students average score (from 1 to 5) on each scale is reported to him, along with his relative standing compared to other students completing the profile at the same time and place. However, he is not furnished any information relating how his interests compare to those of persons engaged in any of the twelve occupational areas. A measure of concurrent validity was made wherein scores of people in, or planning to enter, a given category of employment were compared to scores of similarly defined groups representing other categories. For example, a group of engineering technology males scored well on the Scientific, Business Management, Carpentry, Mechanical and Electrical scales when compared to a group of healthy females. Results from the 'ability measures' section of the profile were examined for strength as predictors of academic success and were found to have modest abilities. No attempt to use results of the vocational interest section for predictive purposes was reported.

One also wonders about the long range effect of the actual work a person performs, his day-to-day activities on the job. Do these activities contribute significantly to his persistence in a career field? One might assume that they do and evidence is available to substantiate the assumption. Kleingartner (8) studied engineering technicians and draftsmen (as defined by their employers) to find out what aspects of their work were influential contributors towards job satisfaction and persistence. The most important reasons given by the subjects for trying to succeed were; prospect of increased earnings, <u>interest in their work</u>, and the desire for promotion. Dunnette, Campbell and Hakel (4) have also investigated the question of what factors contribute to job satisfaction or dissatisfaction. They concluded that some people were satisfied (or dissatisfied) with their job because of the intrinsic aspects of work, other because of the extrinsic aspects and yet others because of combinations across both categories. Among engineers and scientists in the study, achievement and <u>work itself</u> were the most frequent sources of satisfaction, followed closely by responsibility. Sources of dissatisfaction were quite scattered, but work itself was among the least frequent causes of concern.

Summary

The problem of predicting 'academic success' (with its varied definitions) has been attacked frequently and on many fronts. Methods using combinations of academic information - test scores, high school rank, college grades and the rest - have been the most popular. Various interests inventories have also been used, but to a lesser degree. On occasion, usable results have been obtained by these methods, although not routinely.

The effort in this chapter has been to concentrate attention on the potential ability of one device - an interest inventory - to accomplish one purpose - prediction of graduation from a program. The method does not appear to be commonly used; evidence was not found that an instrument of the type used in the study (APPENDIX) had been used for the purpose stated in the "Objectives", page 5.

If one were pessimistically inclined, this chapter, with its citing of numerous negative and inconclusive results could almost prevent an additional attempt to use an interest inventory as a device to predict something as elusive as graduation from a program. However, the successes that were observed were encouraging, especially Strongs use of the SVIB with dental students (12), and when coupled with a conviction that the available job inventory is a good instrument for discriminating between programs, made the obvious risk seem worthwhile.

PROCEDURE

Introduction

Two sets of responses to the Job Characteristics Inventory (APPENDIX) developed by Trambley (15) were used to test the prime question of this study; namely, does an entering student's prior knowledge about the job activities performed by engineering technicians seem to have any bearing on whether or not the student will persist in his studies and eventually graduate from his program?

Trambley (15) had secured usable responses to the questionnaire from 315 engineering technicians who had graduated from Iowa State University in Construction, Electronics, or Mechanical Technology during the period 1962 through 1967. A sample from this set of responses was used as the criterion group for the development of the scoring keys - one each for Construction, Electronics, and Mechanical Technology.

The second set of responses was obtained from 272 students who entered an Engineering Technology Program during the fall quarter of 1968, 1969, or 1970, and who completed the questionnaire during their first week of classes. The eventual success of these students, where success is defined as graduation, was then examined in light of their earlier responses to the questionnaire.

Graduates

Trambley's (15) sample of 315 was randomly reduced to 240 (80 in each group) to provide equal sized groups for future computations of overlap between the distributions of criterion group scores on various trial scoring keys. Then, for the 53 items on the questionnaire, values of chi-square were computed for each program according to the formula:

$$\chi^2 = \frac{\Sigma(O - E)^2}{E}$$

where: χ^2 = Chi-square

O = Observed value in the Cell

E = Expected value in the Cell

The "expected" values for each program were based on the number of respondents in that program group who would have responded "Yes" (or "No") to that item if the members of that group responded <u>in the same proportions</u> of "Yes" or "No" as did all graduates considered together. The "observed" values were the actual numbers of "Yes" (or "No") responses in a program group.

The items on which a given program differed to a statistically significant degree from the graduates in general were then considered for use in the construction of a scoring key with which "Yes" - "No" responses to the questionnaire could be converted to a numerical score. The procedure used to develop the keys was essentially as described by Strong (11) for the SVIB keys. A "Yes" response to an item used in the scoring key was assigned a value of plus 1 if the graduates in the particular program responded "Yes" by a significantly <u>greater</u> amount than did graduates in general; a minus 1 if they responded a significantly <u>lesser</u> amount; and zero if their response, either "Yes" or "No", was about the same as for the graduates in general.

Several trial scoring keys were developed, in which items were added or deleted according to their statistical significance until a key was developed for each of the three programs which would best discriminate between the graduates of that program and the remaining two. The criteria used for judging the discrimination was the degree to which individual scores in one distribution could be matched by individual scores on another. Obviously, as this matching of scores decreases, the discriminating power of the key increases. Strong (11) reports the use of Tilton's method of quantifying this matching of scores in the selection of items to be used for various scoring keys for the SVIB. The Tilton method requires the solution of the equation:

$$Q = \frac{1}{2}\left(\frac{M_1 - M_2}{SD_1 + SD_2}\right)$$

where:

Q = Index

M = Mean Score of Distributions

SD = Standard Deviation of Distributions

and the use of Table 1 to convert Q values to percent overlap.

Once each program had been scored by a trial key, the percent overlap for each of the three pairs of distributions determined by the key was computed. The objective was to identify the key that yielded the minimum percent overlap between the distribution of the program group the key was made for, and each of the other two program groups.

The statistical significance of the differences between the means of the several distributions was then determined by use of the "t" statistic so that the stated hypotheses of the study could be tested. Once the

Table 1. Tilton percent overlap table[a]

Q	Percent overlap	Q	Percent overlap	Q	Percent overlap	Q	Percent overlap
0.00	100	0.63	75	1.35	50	2.30	25
0.02	99	0.66	74	1.38	49	2.35	24
0.05	98	0.69	73	1.41	48	2.40	23
0.08	97	0.72	72	1.44	47	2.45	22
0.10	96	0.74	71	1.48	46	2.51	21
0.12	95	0.77	70	1.51	45	2.56	20
0.15	94	0.80	69	1.54	44	2.62	19
0.18	93	0.82	68	1.58	43	2.68	18
0.20	92	0.85	67	1.61	42	2.74	17
0.23	91	0.88	66	1.65	41	2.81	16
0.25	90	0.91	65	1.68	40	2.88	15
0.28	89	0.94	64	1.72	39	2.95	14
0.30	88	0.96	63	1.76	38	3.03	13
0.33	87	0.99	62	1.79	37	3.11	12
0.35	86	1.02	61	1.83	36	3.20	11
0.38	85	1.05	60	1.87	35	3.29	10
0.40	84	1.08	59	1.91	34	3.39	9
0.43	83	1.11	58	1.95	33	3.50	8
0.46	82	1.14	57	1.99	32	3.62	7
0.48	81	1.17	56	2.03	31	3.76	6
0.51	80	1.20	55	2.07	30	3.92	5
0.53	79	1.23	54	2.12	29	4.11	4
0.56	78	1.26	53	2.16	28	4.34	3
0.58	77	1.29	52	2.21	27	4.65	2
0.61	76	1.32	51	2.25	26	5.15	1

[a]From J. W. Tilton (11).

variances were checked for equality by the "F" test, the value of "t" for equal variances was computed by the pooled model

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{\Sigma x_1^2 + \Sigma x_2^2}{n_1 + n_2 - 2}\right)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

and for unequal variances by the separate model

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\Sigma x_1^2}{n_1(n_1 - 1)} + \frac{\Sigma x_2^2}{n_2(n_2 - 1)}}}$$

where $\bar{X}$ = sample mean

Σx^2 = summation of squared deviations from $\bar{X}$

n = sample size

Entering Students

Once the decision had been made as to which items should be included in each scoring key, the responses of the entering students were scored on all keys and the "t" statistic was computed for the three pairs of differences between the means of the three distributions (C.Tch, E.Tch and M.Tch) for each key to check that the keys were discriminating between new students (by program) as they had done between graduates.

The entering students in each program were then grouped according to the score they received for their response to the questionnaire as determined by the scoring key for that program. Those with scores above the mean for all entering students in a given program were considered to have the "more accurate conceptions" of future job activities and those with scores below the mean were considered to have the "less accurate conceptions". For each of these two groupings, the numbers and proportions who did and who did not graduate were obtained. Using the total number of students among both groups (above and below the mean score) who graduated, chi-square values were computed to test the statistical significance of any difference in the tendency to graduate between entering students scoring above the mean for their program and those scoring below the mean. The "observed" values for the chi-square calculations were the numbers of students who actually graduated in the above mean group and in the below mean group for each program. The "expected" value for each group in a given program was obtained by multiplying the total number of students (graduated and not-graduated) in each group (above the mean and below the mean) by the proportion of all entering students in a given program who graduated.

FINDINGS

Introduction

To keep the function of the graduates responses to the Job Characteristics Inventory separate from the function of the entering students responses, the results of the study are grouped into a section on Scoring Key Development and a section on Analysis of Student Persistence.

Scoring Key Development

In Trambley's study (15) there were 80 graduates from Construction Technology, 135 graduates from Electronics Technology and 100 graduates from Mechanical Technology. Before any calculations were made, the sizes of the three groups were randomly equalized to n=80 to allow future analysis of the percent overlap between various distributions on trial scoring keys to be based on equal sized samples. Results of preliminary calculations to identify questionnaire items producing different strengths of "Yes" - "No" response between programs of study are presented in Table 2. For example, 134 of the 240 graduates in the criterion group responded "Yes" - meaning, "I perform this activity", to Item 1 (Analysis") on the questionnaire. One would therefore "expect" one-third, or 44.7 (134 divided by 3), of the graduates of each program, C.Tch, E.Tch, and M.Tch, to have responded "Yes" to Item 1, based on the hypotheses that there are no differences between the job activities of C.Tch, E.Tch, and M.Tch graduates. Actually, there were 38 C.Tch, 54 E.Tch, and 42 M.Tch graduates who responded "Yes" - these were the "observed" values. Looking at only the C.Tch graduates for the moment, the chi-square value for "Yes" responses to Item 1, was obtained by squaring the difference between the "expected" and the "observed" values and dividing by the "expected" value [$\frac{(44.7-38)^2}{44.7}$ = 1.01]. The procedure was repeated for the C.Tch "No" responses to Item 1, and the two values obtained (1.01 and 1.24) were summed for the total chi-square statistic of 2.25. The value of chi-square from Table 2 for one degree of freedom at the 0.05 level of significance is 3.84. Comparing the C.Tch value of 2.25 for Item 1 to the 0.05 significance level value of 3.84, one could say that the rate at which C.Tch graduates perform "Analysis" does not vary from the rate for the criterion group (C.Tch, E.Tch, and M.Tch together) enough to be statistically significant, although their rate is obviously less than the criterion group and a chi-square value of 2.25 is certainly higher than the pure chance chi-square value of 0.45 for one degree of freedom. For the entire questionnaire, thirty-four of the fifty-three items showed a significant chi-square value for at least one of the programs of study.

From these thirty-four items, a trial set of scoring keys was selected with scoring weights of plus one, zero, or minus one assigned as previously described. The items used in the first set of scoring keys are shown in Table 3. The 80 graduates in each program group were then scored on each of the three keys, and the percent overlap (the extent to which scores on one distribution were matched by scores on another) was computed for each comparison available - (C.Tch vs. E.Tch), (E.Tch vs. M.Tch), and (C.Tch vs. M.Tch) by Tilton's method and by actual count of matched scores. These initial overlaps and the overlaps for a total of nine different scoring keys are presented in Table 4. The lack of

Table 2. Yes-no responses to job activities by program of study

Item	Job activity	C.Tch Yes/No	C.Tch χ^2	E.Tch Yes/No	E.Tch χ^2	M.Tch Yes/No	M.Tch χ^2	Total Yes/No	Total χ^{2a}
1	Analysis	38 42	2.25	54 26	4.42*	42 38	0.36	134 106	7.03*
2	Build Things	6 74	22.79*	45 35	20.57*	27 53	0.06	78 162	43.42*
3	Calibration and Adjustment	29 51	2.47	51 29	11.37*	28 52	3.23	108 132	17.07*
4	Check Drawings	48 32	1.61	36 44	2.02	43 37	0.02	127 113	3.65
5	Communications	40 40	0.45	35 45	0.20	36 44	0.05	111 129	0.70
6	Coordination	59 21	0.33	54 26	0.43	57 23	0.01	170 70	0.77
7	Company Training	29 51	2.03	42 38	2.25	35 45	0.01	106 134	4.29

[a]Chi-square with 1 degree of freedom equals 3.84 at the 0.05 level of significance; with 2 degrees of freedom it equals 5.99 at the 0.05 level.

*Value significant at or beyond the 0.05 level.

Table 2. Continued

Item	Job activity	C.Tch Yes	C.Tch No	C.Tch χ^2	E.Tch Yes	E.Tch No	E.Tch χ^2	M.Tch Yes	M.Tch No	M.Tch χ^2	Total Yes	Total No	Total χ^{2a}
8	Cost Estimating	49	31	8.10*	30	50	2.02	30	50	2.02	109	131	12.14*
9	Customer Service	35	45	0.84	29	51	0.21	29	51	0.21	93	147	1.26
10	Data Recording	24	56	10.77*	56	24	15.04*	36	44	0.35	116	124	26.16*
11	Derivation	6	74	3.22	18	62	4.02*	11	69	0.05	35	205	7.29*
12	Design	38	42	2.25	45	35	0.01	51	29	2.03	134	106	4.29
13	Design Assistance	34	46	1.60	41	39	0.09	44	36	0.94	119	121	2.63
14	Drafting-Design	39	41	0.05	31	49	4.05*	50	30	5.00*	120	120	9.10*
15	Drafting-Detail	34	46	0.47	14	66	15.23*	45	35	10.32*	93	147	26.02*

Table 2. Continued

Item	Job activity	C.Tch Yes No	C.Tch χ^2	E.Tch Yes No	E.Tch χ^2	M.Tch Yes No	M.Tch χ^2	Total Yes No	Total χ^{2a}
16	Drafting-Layout	23 57	1.95	23 57	1.95	41 39	7.78*	87 153	11.68*
17	Evaluation	20 60	8.72*	45 35	7.43*	34 46	0.05	99 141	16.20*
18	Expediting	42 38	4.18*	30 50	0.46	27 53	1.86	99 141	6.50*
19	Experimentation	7 73	5.96*	15 65	0.03	25 55	6.92*	47 193	12.91*
20	Inspection-Maintenance	24 56	0.45	25 55	0.86	15 65	2.57	64 176	3.88
21	Inspection-Quality Control	42 38	9.66*	22 58	2.42	22 58	2.42	86 154	14.50*
22	Installation	16 64	0.04	21 59	2.59	9 71	3.23	46 194	5.86
23	Instrumentation	5 75	15.50*	31 49	7.50*	25 55	1.44	61 179	24.44*

Table 2. Continued

Item	Job activity	C.Tch Yes	C.Tch No	C.Tch χ^2	E.Tch Yes	E.Tch No	E.Tch χ^2	M.Tch Yes	M.Tch No	M.Tch χ^2	Total Yes	Total No	Total χ^{2a}
24	Manufacturing	3	77	3.14	11	69	1.60	9	71	0.26	23	217	5.00
25	Mapping	26	54	31.39*	1	79	8.83*	2	78	6.93*	29	211	47.15*
26	Marketing and Sales	8	72	0.48	4	76	0.93	7	73	0.08	19	221	1.49
27	Materials Testing	25	55	6.92*	5	75	9.03*	17	63	0.14	47	193	16.09*
28	Methods-Production	6	74	9.46*	13	67	1.38	33	47	18.08*	52	188	28.92*
29	Methods-Quality Control	3	77	5.23*	15	65	3.35	11	69	0.21	29	211	8.79*
30	Operating	10	70	3.96*	28	52	8.38*	14	66	0.82	52	188	13.16*
31	Perform Modifications	4	76	19.20*	44	36	32.84*	16	64	1.82	64	176	53.86*

Table 2. Continued

Item	Job activity	C.Tch Yes	C.Tch No	C.Tch χ^2	E.Tch Yes	E.Tch No	E.Tch χ^2	M.Tch Yes	M.Tch No	M.Tch χ^2	Total Yes	Total No	Total χ^{2a}
32	Performance Testing	8	72	30.00*	53	27	22.97*	35	45	0.47	96	144	53.44*
33	Planning and Scheduling	31	49	4.27*	18	62	1.34	19	61	0.83	68	172	6.44*
34	Plant Layout	9	71	0.05	11	69	0.21	9	71	0.05	29	211	0.31
35	Process Control	5	75	0.02	5	75	0.02	6	74	0.09	16	224	0.13
36	Programming	7	73	0.66	17	63	7.13*	4	76	3.45	28	212	11.24*
37	Purchasing	19	61	0.20	16	64	0.13	17	63	0.01	52	188	0.34
38	Quantity Estimating	42	38	4.51*	24	56	3.89*	32	48	0.02	98	142	8.42*
39	Recommend Modifications	28	52	14.68*	50	30	1.27	57	23	7.31*	135	105	23.26*

Table 2. Continued

Item	Job activity	C.Tch Yes	C.Tch No	C.Tch χ^2	E.Tch Yes	E.Tch No	E.Tch χ^2	M.Tch Yes	M.Tch No	M.Tch χ^2	Total Yes	Total No	Total χ^{2a}
40	Reliability	2	78	14.83*	20	60	1.49	25	55	6.91	47	193	23.23*
41	Repair	9	71	8.88*	39	41	21.93*	14	66	2.90	62	178	33.71*
42	Report Writing	30	50	4.67*	50	30	5.34*	39	41	0.02	119	121	10.03*
43	Specification Writing	10	70	1.82	11	69	1.12	23	57	5.80*	44	196	8.74*
44	Supervising	39	41	8.05*	17	63	5.59*	25	55	0.22	81	159	13.86*
45	Surveying-Instrument Man	45	35	60.84*	2	78	16.30*	3	77	14.16*	50	190	91.30*
46	Surveying-Rodman	23	57	26.59*	0	80	9.72*	3	77	4.15*	26	214	40.46*
47	Technical Publications	5	75	3.16	21	59	12.65*	5	75	3.16	31	209	18.97*

Table 2. Continued

Item	Job activity	C.Tch Yes/No	C.Tch χ^2	E.Tch Yes/No	E.Tch χ^2	M.Tch Yes/No	M.Tch χ^2	Total Yes/No	Total χ^{2a}
48	Training	25 55	0.01	29 51	0.78	22 58	0.64	76 164	1.42
49	Troubleshooting	24 56	16.86*	62 18	19.41*	41 39	0.09	127 113	36.36*
50	Verbal Reports	36 44	3.24	49 31	1.26	47 33	0.45	132 108	4.95
51	Write Proposals	19 61	0.70	16 64	0.00	13 67	0.70	48 192	1.40
52	Writing Change Notices	14 66	7.42*	23 57	0.31	39 41	10.79*	76 164	18.52*
53	Writing Standard Practices	8 72	3.12	14 66	0.00	20 60	3.12	42 198	6.24*

Table 3. Initial scoring keys, by program

Item	Job activity	Scoring weights C.Tch Yes	C.Tch No	E.Tch Yes	E.Tch No	M.Tch Yes	M.Tch No
1	Analysis	0	0	+1	-1	0	0
2	Build Things	-1	+1	+1	-1	0	0
3	Calibration and Adjustment	0	0	+1	-1	0	0
4	Check Drawings	0	0	0	0	0	0
5	Communications	0	0	0	0	0	0
6	Coordination	0	0	0	0	0	0
7	Company Training	0	0	0	0	0	0
8	Cost Estimating	+1	-1	0	0	0	0
9	Customer Service	0	0	0	0	0	0
10	Data Recording	-1	+1	+1	-1	0	0
11	Derivation	0	0	+1	-1	0	0
12	Design	0	0	0	0	0	0
13	Design Assistance	0	0	0	0	0	0
14	Drafting-Design	0	0	-1	+1	+1	-1
15	Drafting-Detail	0	0	-1	+1	+1	-1
16	Drafting-Layout	0	0	0	0	+1	-1
17	Evaluation	-1	+1	+1	-1	0	0
18	Expediting	+1	-1	0	0	0	0
19	Experimentation	-1	+1	0	0	+1	-1
20	Inspection-Maintenance	0	0	0	0	0	0

Table 3. Continued

Item	Job activity	Scoring weights C.Tch Yes	C.Tch No	E.Tch Yes	E.Tch No	M.Tch Yes	M.Tch No
21	Inspection-Quality Control	+1	-1	0	0	0	0
22	Installation	0	0	0	0	0	0
23	Instrumentation	-1	+1	+1	-1	0	0
24	Manufacturing	0	0	0	0	0	0
25	Mapping	+1	-1	-1	+1	-1	+1
26	Marketing and Sales	0	0	0	0	0	0
27	Materials Testing	+1	-1	-1	+1	0	0
28	Methods-Production	-1	+1	0	0	+1	-1
29	Methods-Quality Control	-1	+1	0	0	0	0
30	Operating	-1	+1	+1	-1	0	0
31	Perform Modifications	-1	+1	+1	-1	0	0
32	Performance Testing	-1	+1	+1	-1	0	0
33	Planning and Scheduling	+1	-1	0	0	0	0
34	Plant Layout	0	0	0	0	0	0
35	Process Control	0	0	0	0	0	0
36	Programming	0	0	+1	-1	0	0
37	Purchasing	0	0	0	0	0	0
38	Quantity Estimating	+1	-1	-1	-1	0	0
39	Recommend Modifications	-1	+1	0	0	+1	-1
40	Reliability	-1	+1	0	0	+1	-1

Table 3. Continued

Item	Job activity	Scoring weights C.Tch Yes	C.Tch No	E.Tch Yes	E.Tch No	M.Tch Yes	M.Tch No
41	Repair	-1	+1	+1	-1	0	0
42	Report Writing	-1	+1	+1	-1	0	0
43	Specification Writing	0	0	0	0	+1	-1
44	Supervising	+1	-1	-1	+1	0	0
45	Surveying-Instrument Man	+1	-1	-1	+1	-1	+1
46	Surveying-Rodman	+1	-1	-1	+1	-1	+1
47	Technical Publications	0	0	+1	-1	0	0
48	Training	0	0	0	0	0	0
49	Troubleshooting	-1	+1	+1	-1	0	0
50	Verbal Reports	0	0	0	0	0	0
51	Write Proposals	0	0	0	0	0	0
52	Writing Change Notices	-1	+1	0	0	+1	-1
53	Writing Standard Practices	0	0	0	0	+1	-1

Table 4. Comparison of scoring key discrimination by percent overlap using ±1 scoring weights

Key	No. items on key	C.Tch vs. E.Tch Computed	C.Tch vs. E.Tch Observed	C.Tch vs. M.Tch Computed	C.Tch vs. M.Tch Observed	E.Tch vs. M.Tch Computed	E.Tch vs. M.Tch Observed
C.Tch	21	23	20	36	29	84	66
C.Tch[a]	26	24	23[b]	35	26[b]	67	58
C.Tch	31	26	26	38	30	80	62
E.Tch	23	31	26	66	58	59	55
E.Tch	26	29	21	63	55	58	54
E.Tch[a]	30	30	26[b]	66	65	57	51[b]
M.Tch	12	64	61	42	44	69	66
M.Tch	15	75	66	41	38	61	60
M.Tch[a]	18	87	75	42	41[b]	54	54[b]

[a]Key selected to score entering students.

[b]Major comparisons on selected keys.

agreement between the "computed" values (Tilton method) of percent overlap and the "actual count" values is attributable to the distributions involved. The Tilton method assumes that both distributions being compared are normal and that they have equal standard deviations, whereas the actual count method makes no such assumptions. Since these distributions are not normal, the percent overlaps based on actual count were used to evaluate the relative effectiveness of the trial scoring keys. A total of nine keys were constructed to find a key which minimized the amount of overlapping between the three programs when scored on a given key.

Table 5 shows the results of attempts to reduce overlap by using scoring weights other than plus or minus one. In the expectation that weighting items receiving very strong "Yes" or "No" responses more heavily than items receiving weaker responses might reduce the percent overlap, the actual chi-square values for the selected items were used as the scoring weights for several M.Tch keys. Although the scores themselves changed considerably, the actual results, in terms of discrimination, were essentially unchanged. Since the use of chi-square scoring weights would make hand scoring of future responses to the questionnaire much more difficult, the method was discarded in favor of plus and minus one, and zero, as the scoring weights, such as used by Strong (11).

The maximum extent to which two distributions can overlap and still be considered as sufficiently different so that membership in one distribution can be interpreted as being meaningfully different from membership in the other distribution is not fixed. Strong (11) reports usable values

Table 5. Comparison of M.Tch scoring key discrimination by percent overlap using $\pm \chi^2$ scoring weights

No. items	Comparison[a]					
	C.Tch vs. E.Tch		C.Tch vs. M.Tch		E.Tch vs. M.Tch	
on key	±1	χ^2	±1	χ^2	±1	χ^2
12	64	62	42	40	69	67
15	75	65	41	38	61	63
18	81	67	42	39	62	64
20	78	66	40	37	62	61
22	73	65	44	37	61	63

[a]All values computed by Tilton's method.

of overlap between criterion and general groups for SVIB scales from 15 to 52 percent on men's scales with a median of 31 percent and from 16 to 42 percent on women's scales with a median of 34 percent. For the keys selected to score entering students, the overlaps of major interest on the C.Tch key as shown in Table 4 were 20 (C.Tch vs. E.Tch) and 26 (C.Tch vs. M.Tch), on the E.Tch key they were 21 (E.Tch vs. C.Tch) and 51 (E.Tch vs. M.Tch), and on the M.Tch key they were 38 (M.Tch vs. C.Tch) and 54 (M.Tch vs. E.Tch). Table 6 shows the item makeup of the final keys.

The first three hypotheses stated in the study were concerned with determining the statistical significance of a particular scoring key's ability to discriminate between the responses of the graduates of the

Table 6. Final scoring keys, by program

Item	Job activity	Scoring weights C.Tch Yes	C.Tch No	E.Tch Yes	E.Tch No	M.Tch Yes	M.Tch No
1	Analysis	0	0	+1	-1	0	0
2	Build Things	-1	+1	+1	-1	0	0
3	Calibration and Adjustment	0	0	+1	-1	-1	0
4	Check Drawings	0	0	-1	+1	0	0
5	Communications	0	0	0	0	0	0
6	Coordination	0	0	0	0	0	0
7	Company Training	0	0	+1	-1	0	0
8	Cost Estimating	+1	-1	-1	+1	0	0
9	Customer Service	0	0	0	0	0	0
10	Data Recording	-1	+1	+1	-1	0	0
11	Derivation	0	0	+1	-1	0	0
12	Design	0	0	0	0	0	0
13	Design Assistance	0	0	0	0	0	0
14	Drafting-Design	0	0	-1	+1	+1	-1
15	Drafting-Detail	0	0	-1	+1	+1	-1
16	Drafting-Layout	0	0	-1	+1	+1	-1
17	Evaluation	-1	+1	+1	-1	0	0
18	Expediting	+1	-1	0	0	0	0
19	Experimentation	-1	+1	0	0	+1	-1
20	Inspection-Maintenance	0	0	0	0	0	0

Table 6. Continued

Item	Job activity	C.Tch Yes	C.Tch No	E.Tch Yes	E.Tch No	M.Tch Yes	M.Tch No
21	Inspection-Quality Control	+1	-1	-1	+1	0	0
22	Installation	0	0	+1	-1	-1	+1
23	Instrumentation	-1	+1	+1	-1	0	0
24	Manufacturing	0	0	0	0	0	0
25	Mapping	+1	-1	-1	+1	-1	+1
26	Marketing and Sales	0	0	0	0	0	0
27	Materials Testing	+1	-1	-1	+1	0	0
28	Methods-Production	-1	+1	0	0	+1	-1
29	Methods-Quality Control	-1	+1	+1	-1	0	0
30	Operating	-1	+1	+1	-1	0	0
31	Perform Modifications	-1	+1	+1	-1	0	0
32	Performance Testing	-1	+1	+1	-1	0	0
33	Planning and Scheduling	+1	-1	0	0	0	0
34	Plant Layout	0	0	0	0	0	0
35	Process Control	0	0	0	0	0	0
36	Programming	0	0	+1	-1	-1	+1
37	Purchasing	0	0	0	0	0	0
38	Quantity Estimating	+1	-1	-1	+1	0	0
39	Recommend Modifications	-1	+1	0	0	+1	-1
40	Reliability	-1	+1	0	0	+1	-1

Table 6. Continued

Item	Job activity	Scoring weights C.Tch Yes	C.Tch No	E.Tch Yes	E.Tch No	M.Tch Yes	M.Tch No
41	Repair	-1	+1	+1	-1	-1	+1
42	Report Writing	-1	+1	+1	-1	0	0
43	Specification Writing	0	0	0	0	+1	-1
44	Supervising	+1	-1	-1	+1	0	0
45	Surveying-Instrument Man	+1	-1	-1	+1	-1	+1
46	Surveying-Rodman	+1	-1	-1	+1	-1	+1
47	Technical Publications	0	0	+1	-1	-1	+1
48	Training	0	0	0	0	0	0
49	Troubleshooting	-1	+1	+1	-1	0	0
50	Verbal Reports	0	0	0	0	0	0
51	Write Proposals	0	0	0	0	0	0
52	Writing Change Notices	-1	+1	0	0	+1	-1
53	Writing Standard Practices	0	0	0	0	+1	-1

three programs, page 6. These hypotheses were tested by the "t" statistic which was computed for each of the nine possible pairs of differences between group means (three pairs per key) and presented in Table 7 along with the mean score and standard deviation for each group of graduates on each scoring key. It is noteworthy that all nine comparisons were statistically significant, with eight of them being beyond the 0.01 level.

Figures 1, 2, and 3 show graphically the distributions of graduates scores and their relative overlaps on the scoring keys selected for use with the entering student responses. The locations of the respective mean scores for each group serve as visual indications of the discrimination afforded by the scoring keys.

Analysis of Student Persistence

The second three hypotheses were concerned with determining the statistical significance of the same scoring key's ability to discriminate between the responses of entering students, by program, pages 6 and 7. These were also tested by the "t" statistic which was computed for each of the nine possible pairs of differences between group means (three pairs per key) and presented in Table 8 along with the mean score and standard deviation for each group of entering students on each scoring key. Discrimination was again quite high, with eight comparisons significant beyond the 0.01 level. The single insignificant comparison. C. Tch-E.Tch on the M.Tch key, was not one of the major comparisons.

Figures 4, 5, and 6 show graphically the distribution of entering students scores and their relative overlaps on the three scoring keys.

Table 7. Program means, standard deviations, and values of "t" for graduates scored on final scoring keys, all n=80

Scoring Key		Graduates, by Program C.Tch	E.Tch	M.Tch	"t" C.Tch-E.Tch	C.Tch-M.Tch	E.Tch-M.Tch
C.Tch	$\bar{X}$	10.10	-5.00	-1.28	14.6**[a]	11.6**[a]	3.2**[b]
	S.D.	5.16	7.66	7.12			
E.Tch	$\bar{X}$	-10.05	6.17	-3.17	8.9**[b]	2.0*[b]	6.9**[b]
	S.D.	7.41	8.46	8.02			
M.Tch	$\bar{X}$	-1.72	-0.45	5.25	2.9**[b]	6.7**[a]	5.0**[b]
	S.D.	3.62	4.44	4.95			

* "t" significant beyond 0.05 level; t_{05} with 158 d.f. = 1.96, with 79 d.f. = 1.99.

** "t" significant beyond 0.01 level; t_{01} with 158 d.f. = 2.62, with 79 d.f. = 2.64.

[a] Pooled variance "t" model used.

[b] Separate variance "t" model used.

Table 8. Program means, standard deviations and values of "t" for entering students scored on final scoring keys, C.Tch n=65, E.Tch n=138, M.Tch n=69

Scoring Key		Students, by Program C.Tch	E.Tch	M.Tch	"t"[a] C.Tch-E.Tch	C.Tch-M.Tch	E.Tch-M.Tch
C.Tch	$\overline{X}$	7.97	-9.35	1.48	16.68**	11.09**	3.78**
	S.D.	7.29	6.60	5.11			
E.Tch	$\overline{X}$	-9.12	10.38	1.10	21.02**	10.82**	7.44**
	S.D.	5.58	5.40	5.28			
M.Tch	$\overline{X}$	-5.54	3.30	4.93	0.49	4.25**	5.64**
	S.D.	6.79	6.93	4.23			

[a]All "t" computed using separate variance model.

*"t" significant beyond 0.05 level; t_{05} with 64 and 68 d.f. = 1.99, with 137 d.f. = 1.96.

**"t" significant beyond 0.01 level; t_{01} with 64 and 68 d.f. = 2.65, with 137 d.f. = 2.61.

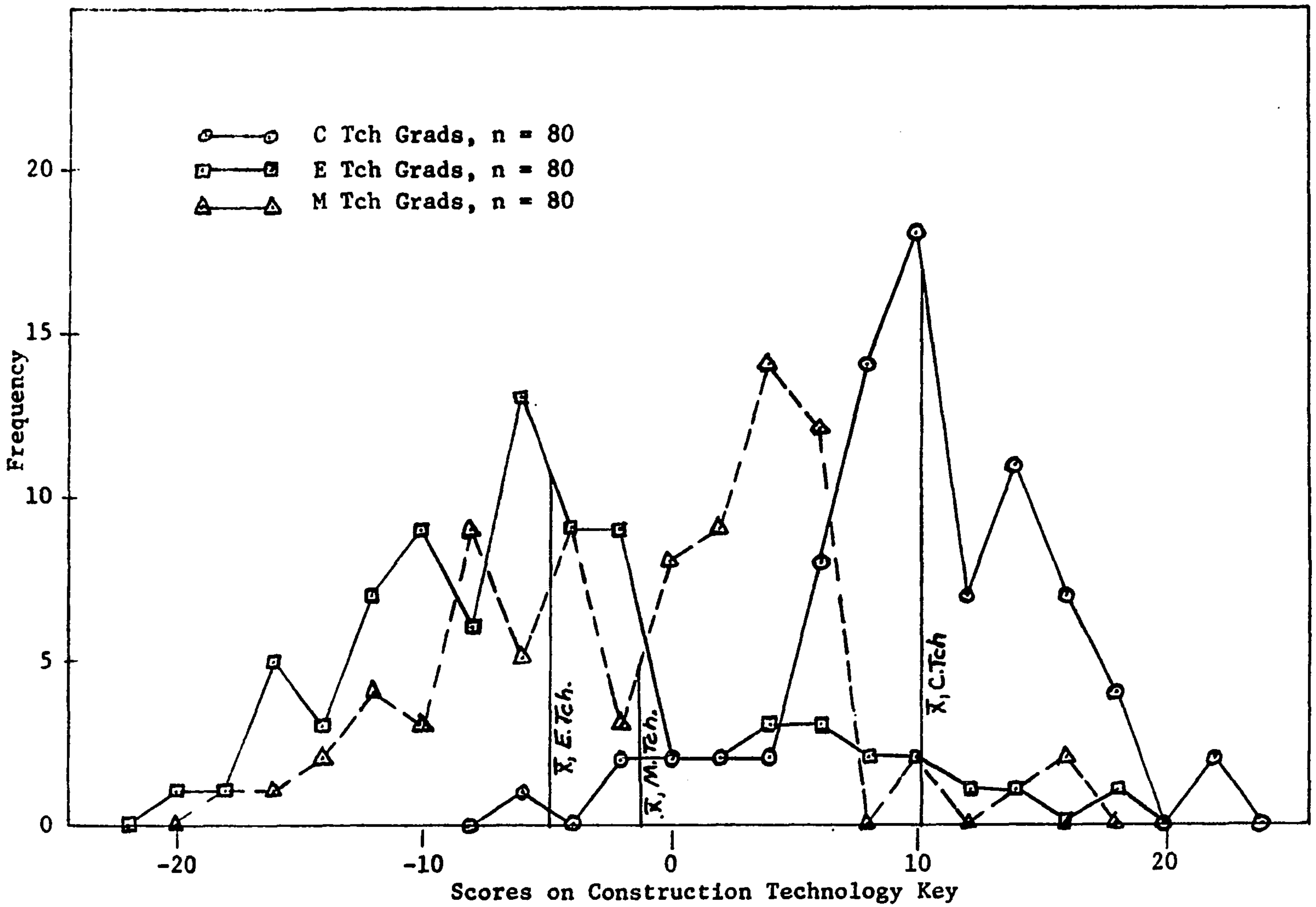


Figure 1. Distribution of graduates' responses on construction technology key, by program.

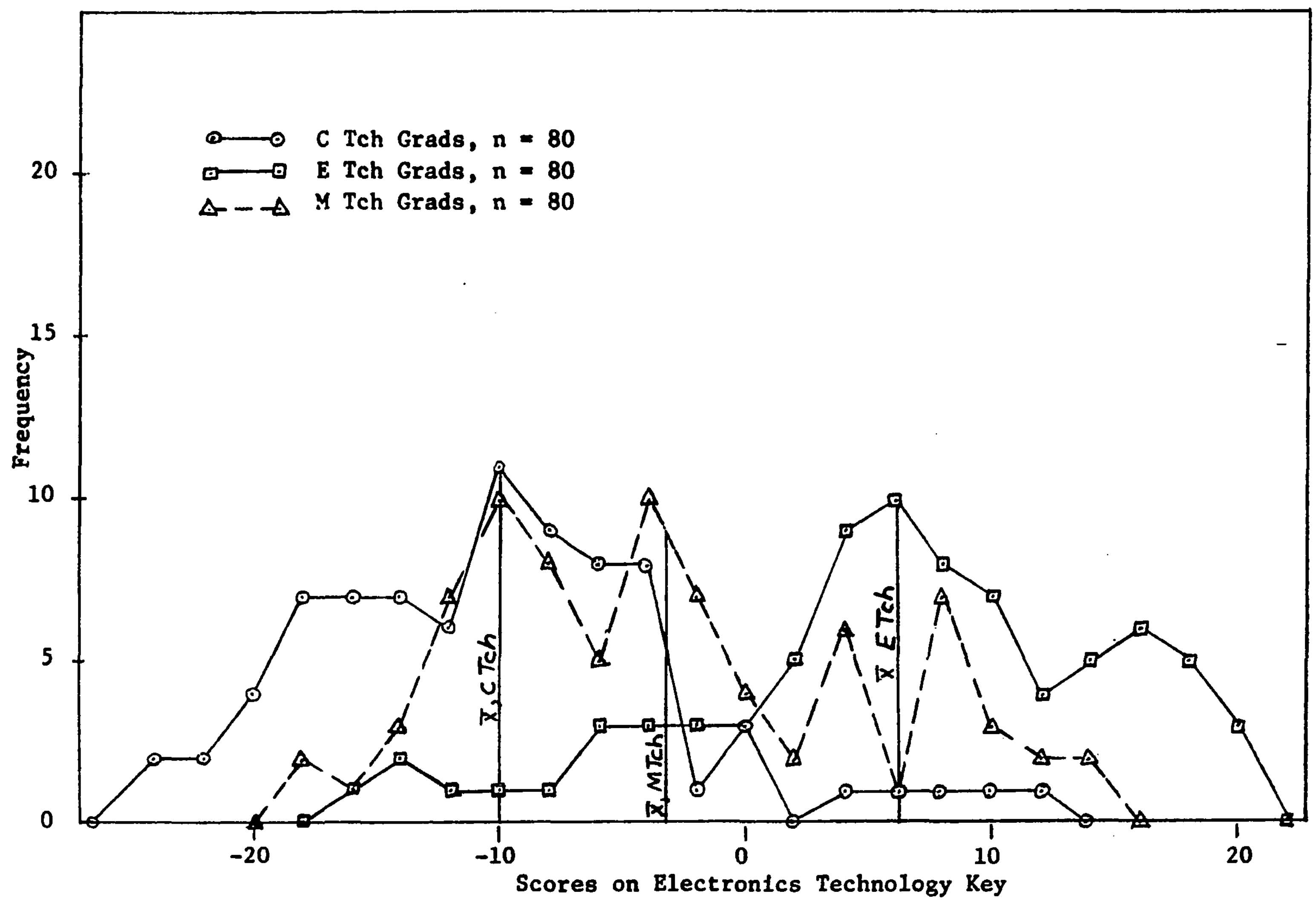


Figure 2. Distribution of graduates' responses on electronics technology key, by program.

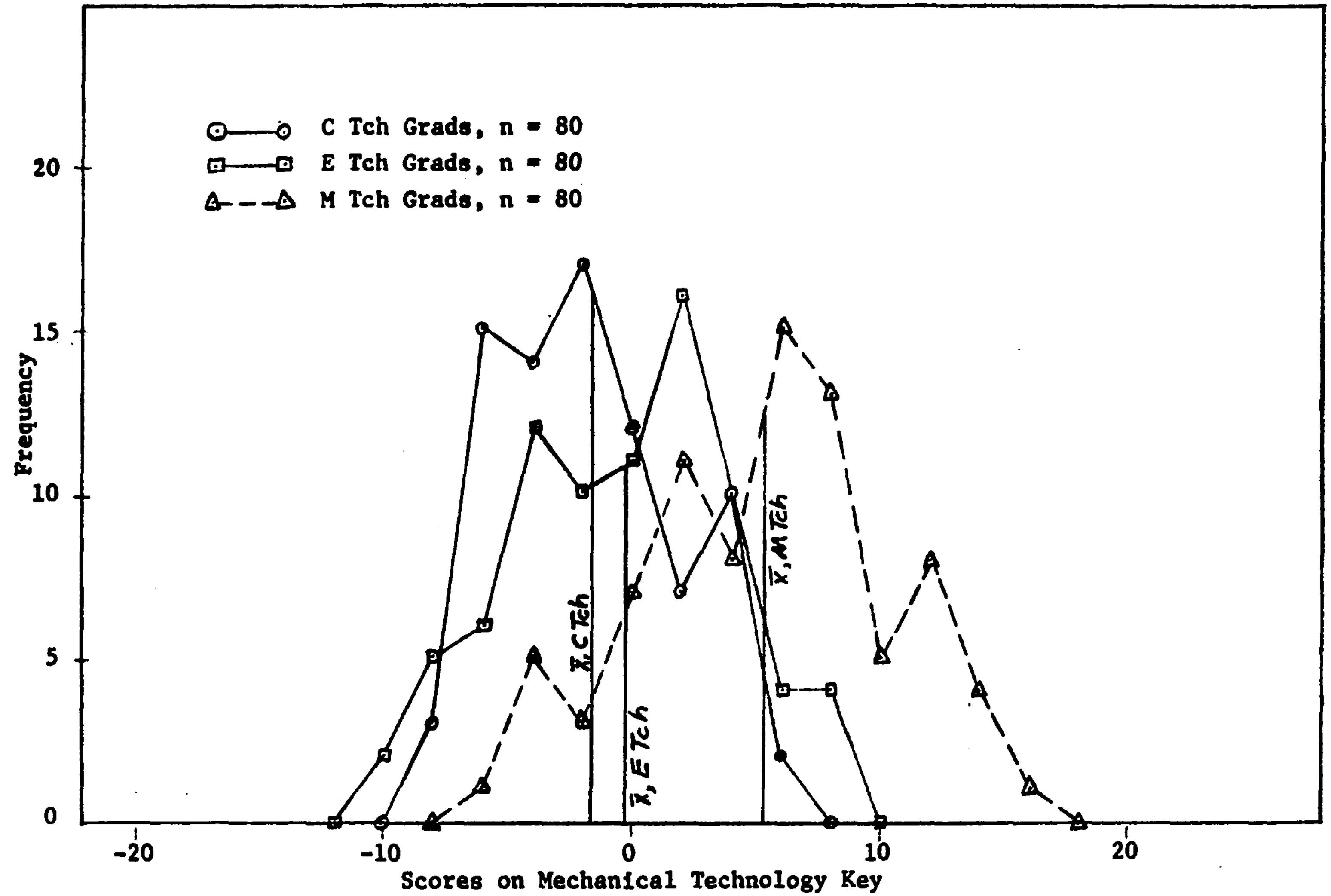


Figure 3. Distribution of graduates' responses on mechanical technology key, by program.

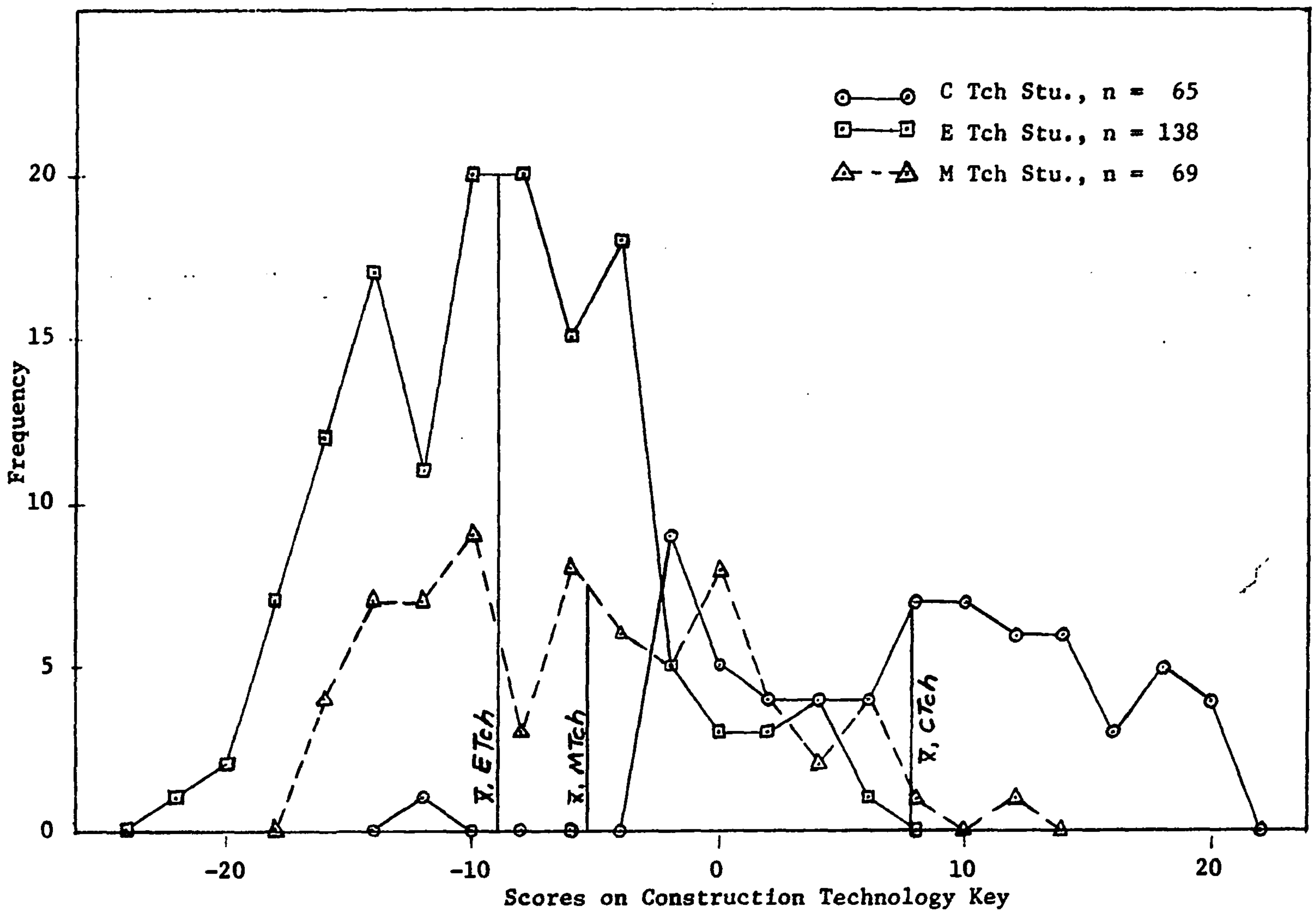
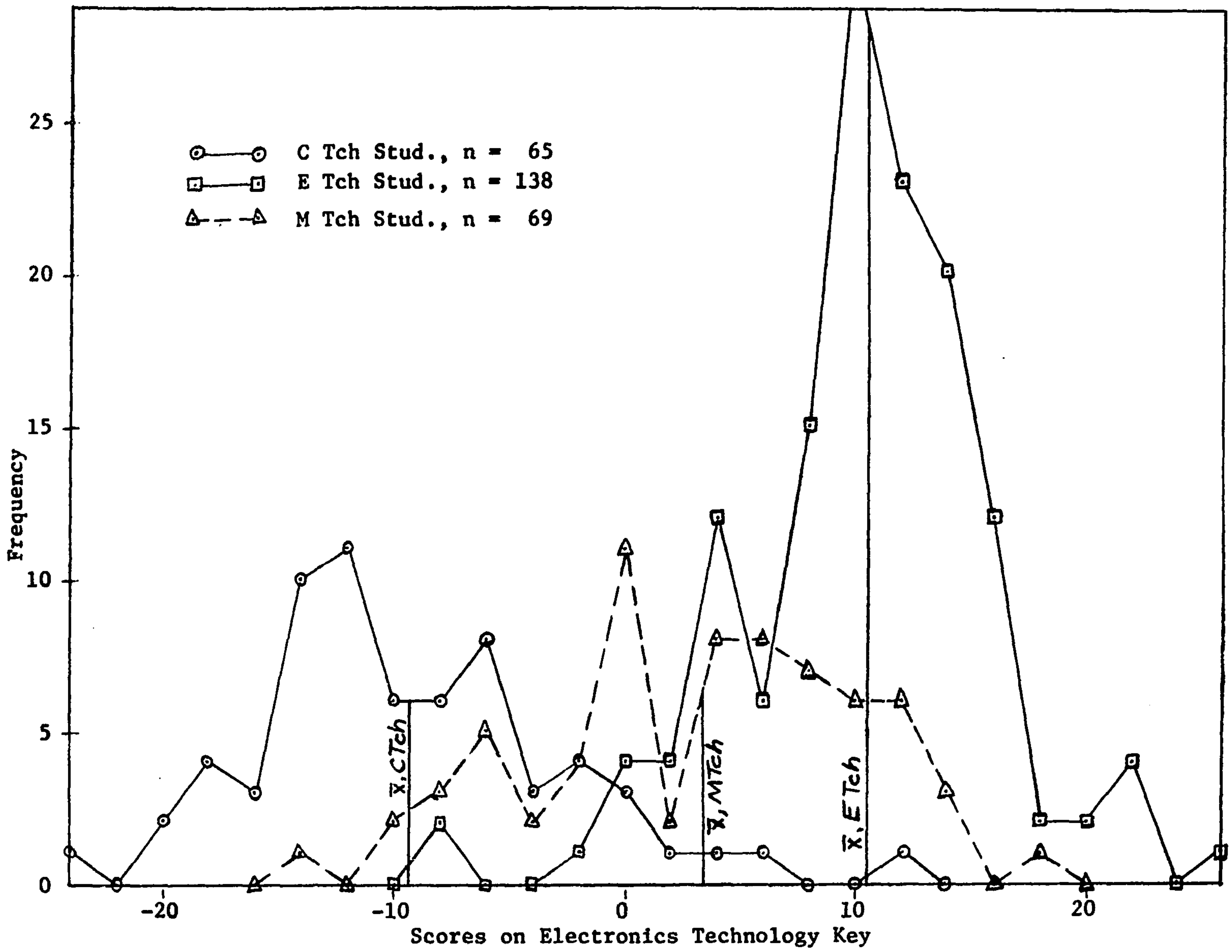


Figure 4. Distribution of entering students' responses on construction technology key, by program.

Figure 5. Distribution of entering students' responses on electronics technology key, by program.


C Tch Stud., n = 65
E Tch Stud., n = 138
M Tch Stud., n = 69
Frequency
0
5
10
15
20
25
-20
-10
0
10
20
Scores on Electronics Technology Key
x̄, CTch
x̄, MTch
x̄, ETch

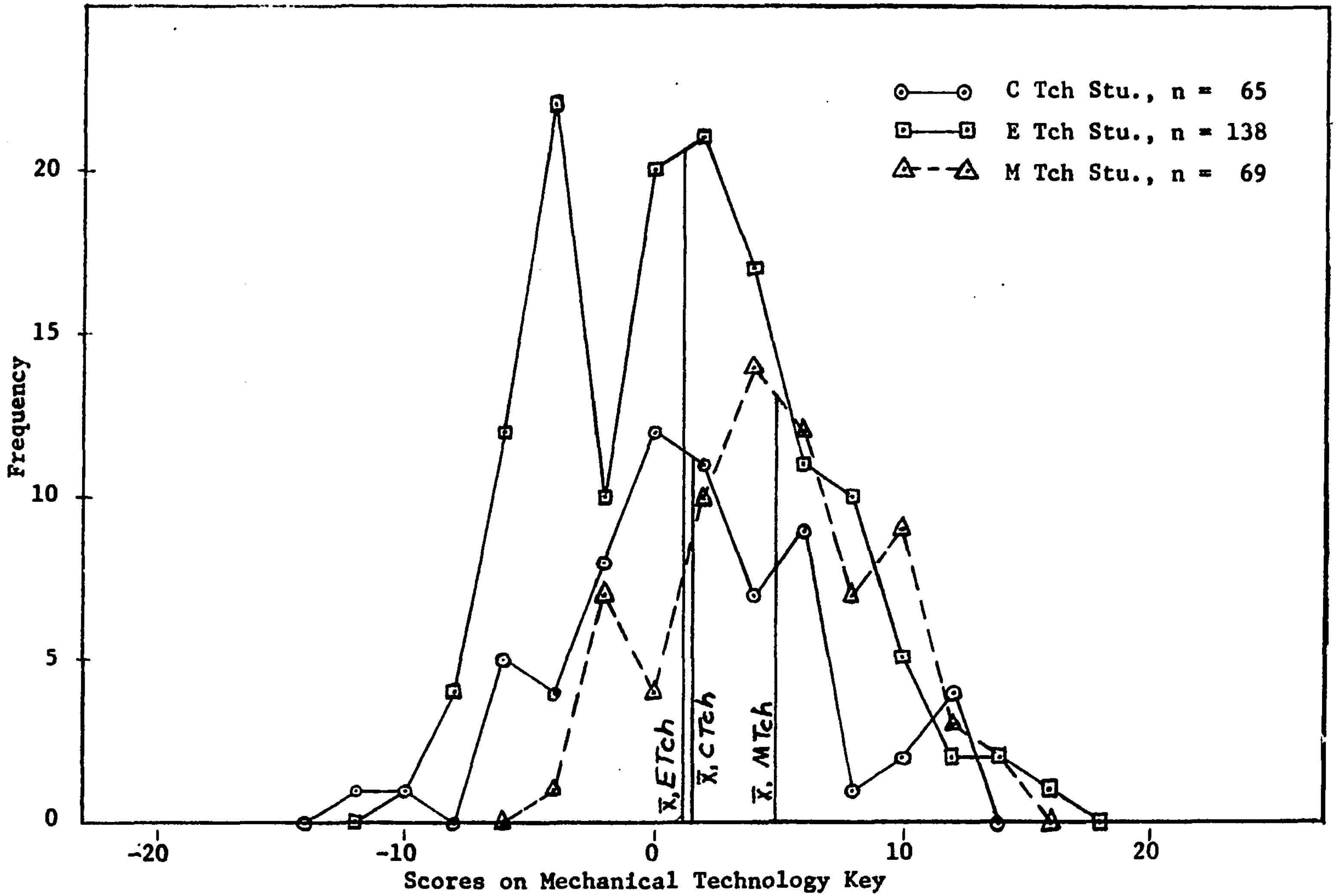


Figure 6. Distribution of entering students' responses on mechanical technology key, by program.

The last three hypotheses were concerned with differences in the tendency (of entering students in a given program) to graduate between those students with "more accurate conceptions" of future job activities and those with "less accurate conceptions", page 7. These hypotheses were tested by the chi-square statistic with results shown in Table 9 wherein the "Above $\overline{X}$" category was synonymous to "more accurate conception" and "Below $\overline{X}$" was synonymous to "less accurate conception", and the chi-square is based on the difference in the proportion of students in those two groupings who graduate. The "observed" value for each group was the actual number who graduated (for C.Tch's "Above $\overline{X}$" and "Graduated" the value is 18). The "expected" value was the total number, "Graduated" plus "Not-Graduated" in a group, multiplied by the proportion of all students who entered a program and graduated. The proportions were C.Tch, 49.2%; E.Tch, 55.0%; and M.Tch, 43.5% with a combined proportion of 51.4% of all entering students graduating from a program. The "expected" value for C.Tchs "Above $\overline{X}$" and "Graduated" was, 18 plus 13, multiplied by 0.492 which equals 15.25. The "expected" value for C.Tchs "Below $\overline{X}$" and "Graduated" was, 14 plus 20, multiplied by 0.492 which equals 16.75. Chi-square was then computed as $(18-15.25)^2 \div 15.75$ plus $(14-16.75)^2 \div 16.75$, which equals 0.95. None of the reported values of chi-square were statistically significant. In two of the programs, C.Tch and M.Tch, the greater proportion of graduates did occur in those students whose scores indicated they possessed the "more accurate conceptions" of future job activities; but in the case of the E.Tchs, it was

Table 9. Percentage of entering students who graduated and scored above and below the mean, by program, with chi-square

Students' Program		Percent Graduated		Percent Not-graduated		χ^{2a}
C.Tch	Above $\overline{X}$	58	n=18	42	n=13	0.95
	Below $\overline{X}$	41	n=14	59	n=20	
E.Tch	Above $\overline{X}$	53	n=34	47	n=30	0.09
	Below $\overline{X}$	57	n=42	43	n=32	
M.Tch	Above $\overline{X}$	45	n=15	55	n=18	0.06
	Below $\overline{X}$	42	n=15	58	n=21	

[a]Chi-square at 0.05 level with 1 d.f. = 3.84.

the group having the "less accurate conceptions" that graduated in the greater proportion.

A slightly different view of the same situation yielded Table 10, wherein the mean score, standard deviation and "t" statistic were calculated for those entering students in each program who were graduated and for those who were not, as scored on their respective keys. The "t" statistic was computed for the difference between the mean scores of the "Graduated" and the "Not-Graduated" students as scored on their respective scoring keys. Again, no statistically significant results were observed; all values of "t" reported being above the 0.50 level. Here we observe

Table 10. Mean scores, standard deviations and "t" for graduated and not-graduated students, by program

Students' Program		Mean score		Standard deviation	"t"[a]
C.Tch	Graduated	7.81	n=32	7.77	0.17
	Not-graduated	8.12	n=33	6.78	
E.Tch	Graduated	10.21	n=76	5.28	0.40
	Not-graduated	10.58	n=62	5.53	
M.Tch	Graduated	4.67	n=39	3.93	0.58
	Not-graduated	5.27	n=30	4.57	

[a]All "t" computed using separate variance model.

that for all three programs, the entering students who did not graduate had higher mean scores on their respective key than did their classmates who graduated.

In reaction to these discouraging developments, alternatives to the stated conditions of comparing the tendency to graduate of students scoring "Above $\overline{X}$" to those scoring "Below $\overline{X}$" were tried. To check the possibility that students scoring near their respective group means could be obscuring useful differences that might still exist between students whose scores were some distance above or below the mean, the "Above $\overline{X}$" group was replaced by those students who had scored in the upper one-third of their original group and the "Below $\overline{X}$" group was replaced by

Table 11. Percentage of entering students who graduated and scored in upper one-third and lower one-third, by program, with chi-square

Students' Program		Percent Graduated		Not-graduated		χ^{2a}
C.Tch	Upper 1/3	50	n=12	50	n=12	0.15
	Lower 1/3	44	n=10	56	n=13	
E.Tch	Upper 1/3	54	n=22	46	n=19	0.05
	Lower 1/3	57	n=25	43	n=19	
M.Tch	Upper 1/3	52	n=11	48	n=10	0.44
	Lower 1/3	41	n=9	59	n=13	

[a]Chi-square at 0.05 level with 1 d.f. = 3.84.

those who had scored in the lower one-third. Chi-square values were obtained as before with results shown in Table 11. Again, no statistically significant differences were found, and again, the E.Tchs who scored low on their key had a greater tendency to graduate than did those who scored well.

Next the students were grouped according to their rank in their high school class - the best single indicator of academic performance that was available for all students in the study group. In this grouping, students from all three programs were combined and regrouped into those who had entered a technology program in the upper one-third, middle one-third, or

Table 12. Percentages of entering students who graduated and scored above and below the mean, by high school rank, with chi-square

Students, by High school rank		Percent Graduated		Not-graduated		χ^{2a}
Upper 1/3	Above $\bar{X}$	50	n=24	50	n=24	1.42
	Below $\bar{X}$	33	n=13	67	n=26	
Middle 1/3	Above $\bar{X}$	50	n=24	50	n=24	0.90
	Below $\bar{X}$	64	n=27	36	n=15	
Lower 1/3	Above $\bar{X}$	56	n=20	44	n=16	0.02
	Below $\bar{X}$	54	n=29	46	n=25	

[a]Chi-square at 0.05 level with 1 d.f. = 3.84.

lower one-third of the sample. Table 12 shows values of chi-square computed for differences between "Graduated" students who scored "Above $\bar{X}$" or "Below $\bar{X}$" on their own program scoring key. The proportions of students in the three groupings by high school rank who graduated were needed to compute chi-square and were determined to be 42.5% for those in the upper one-third, 56.7% for the middle one-third, and 54.5% for the lower one-third. These percentages were applied to the total number of students scoring "Above $\bar{X}$" (and "Below $\bar{X}$") to determine the "expected" number of graduates for each case. In the "Upper 1/3" and "Lower 1/3"

Table 13. Percentages of entering students who graduated and scored above a minus one-half standard deviation and below a minus one-half standard deviation, by high school rank, with chi-square

Students, by High school rank		Percent Graduated		Not-graduated		χ^{2a}
Upper 1/3	Above -1/2 S.D.	45	n=29	55	n=36	0.28
	Below -1/2 S.D.	36	n=8	64	n=14	
Middle 1/3	Above -1/2 S.D.	54	n=37	46	n=32	0.48
	Below -1/2 S.D.	67	n=14	33	n=7	
Lower 1/3	Above -1/2 S.D.	57	n=35	43	n=26	0.27
	Below -1/2 S.D.	48	n=14	52	n=15	

[a]Chi-square at 0.05 level with 1 d.f. = 3.84.

groups we find a higher proportion of students graduating who scored well, while in the "Middle 1/3" the students scoring below their program means graduated in the greater proportion.

Table 13 shows similarly obtained results wherein students who "Graduated" either scored above a minus one-half standard deviation from the mean score for their own program or scored below that level - the "Above -1/2 S.D." group corresponds to Strong's (11) "A" category in his SVIB analysis. Again, no statistically significant results are noted, and again, the "Middle 1/3" group shows the higher proportion of graduates among the lower scores while the "Upper 1/3" and "Lower 1/3" are as before.

Table 14. Percentages of entering students who graduated and scored above a minus one standard deviation and below a minus one standard deviation, by high school rank, with chi-square

Students, by High school rank		Percent Graduated		Not-graduated		χ^{2a}
Upper 1/3	Above -1 S.D.	40	n=29	60	n=43	0.48
	Below -1 S.D.	53	n=8	47	n=7	
Middle 1/3	Above -1 S.D.	54	n=43	46	n=36	0.59
	Below -1 S.D.	73	n=8	27	n=3	
Lower 1/3	Above -1 S.D.	56	n=38	44	n=30	0.10
	Below -1 S.D.	50	n=11	50	n=11	

[a]Chi-square at 0.05 level with 1 d.f. = 3.84.

Table 14 was, again, similarly obtained; but the grouping by score was changed to above or below a minus one standard deviation from the mean score for the students own program - the "Above -1 S.D." group includes Strong's (11) "A" category and the "B+" category. There are still no statistically significant results and now two groups, "Upper 1/3" and "Middle 1/3", show their larger proportion of graduates coming from those students who scored low.

Lastly, those entering students who had college experience prior to entering one of the programs were removed from the sample and the

Table 15. Percentage of entering students, less transfers, who graduated and scored above and below the mean, by program, with chi-square

Students' Program		Percent Graduated		Not-graduated		χ^{2a}
C.Tch	Above $\bar{X}$	59	n=16	41	n=11	0.17
	Below $\bar{X}$	50	n=14	50	n=14	
E.Tch	Above $\bar{X}$	49	n=25	51	n=26	0.18
	Below $\bar{X}$	55	n=33	45	n=27	
M.Tch	Above $\bar{X}$	46	n=12	54	n=14	0.81
	Below $\bar{X}$	31	n=10	69	n=22	

[a] Chi-square at 0.05 with 1 d.f. = 3.84.

proportions graduating were determined for those scoring "Above $\bar{X}$" and "Below $\bar{X}$" and the two groups compared. These results, with chi-squares are shown in Table 15.

To compute the chi-square values reported in the preceding tables, the proportions (percentages) of students graduating in various categories were needed. These values were not reported as results as such; but are of interest to most anyone concerned with academic success and several such rates of completion are listed in Table 16 for that reason. Some rates are based on scores received by certain groupings of students;

Table 16. Graduation rates for various categories of entering engineering technology students

Category	Percent graduated
All entering students	51
All transfer students	58
All non-transfer students	49
All entering C.Tch	49
All entering E.Tch	55
All entering M.Tch	44
All in Upper 1/3 (HSR)	42
All in Middle 1/3 (HSR)	57
All in Lower 1/3 (HSR)	54
All scoring Above $\overline{X}$	52
All scoring Below $\overline{X}$	49
All scoring in Upper 1/3	52
All scoring in Lower 1/3	49
All scoring in "A" category	52
All scoring in "B+" category	38

others are based on academic characteristics of groups of students - all tend to illustrate the small differences between groups regardless of how they were classified.

DISCUSSION

Introduction

This study was undertaken to discover whether or not there was a tendency for an entering engineering technology student's concept of his future job activities to influence his likelihood of graduation from his chosen program of study. The discussion describes the fate of the hypotheses proposed as tests of the success or failure to meet the objective and contains suggestions as to the direction of further activity in this area.

Hypotheses

The first group of hypotheses proposed:

1. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Construction Technology scale.
2. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Electronics Technology scale.
3. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and

Mechanical Technology graduates as measured by the Mechanical Technology scale.

were intended to test the ability of selected scoring keys to differentiate between the questionnaire responses of the graduates of Construction Technology, Electronics Technology and Mechanical Technology from Iowa State University. The amount of overlap between the several distributions of scores on the final scoring keys reported in Table 4, page 42, and shown in Figures 1, 2, and 3, pages 51 to 53, were not unlike values of overlap used by others (11). Values of "t" computed for the differences between the mean scores of various groups on these same scoring keys were highly significant (beyond 0.01 level) for all major comparisons: e.g. C.Tch vs. E.Tch and C.Tch vs. M.Tch on the C.Tch key (E.Tch vs. M.Tch on the C.Tch key was a minor comparison). The first three hypotheses were rejected by this evidence and the conclusion reached that there are statistically significant differences between the responses of groups of engineering technicians to the questionnaire as measured by the constructed scoring keys.

The second group of hypotheses proposed:

4. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Construction Technology scale.
5. There is no statistically significant difference between the mean responses to the job characteristics inventory by

Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Electronics Technology scale.

6. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Mechanical Technology scale.

were intended to test the ability of the selected scoring keys to differentiate between the questionnaire responses of students entering the three programs. The "t" statistic was again used to determine the statistical significance of differences between the mean scores of the program groups, see Table 8, page 56 and the distributions shown in Figures 4, 5, and 6, pages 54 to 57. All major comparisons were highly significant and the hypotheses were rejected. There are statistically significant differences between the mean scores of program groups of entering engineering technology students as determined by the scoring keys.

The remaining hypotheses:

7. There is no statistically significant difference between the proportion of entering Construction Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Construction Technology scale.

8. There is no statistically significant difference between the proportion of entering Electronic Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Electronics Technology scale.
9. There is not statistically significant difference between the proportion of entering Mechanical Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Mechanical Technology scale.

were intended to test the major objective of the study - do entering students with the "more accurate conceptions" of future job activities tend to graduate from their program in greater proportions than do their classmates with the "less accurate conceptions"? The values of chi-square presented in Table 9, page 59 were used to test these hypotheses. None of the values reported are statistically significant and, therefore, the hypotheses cannot be rejected. The implications of the preceding statement are that, based on the evidence gathered in this study, one cannot tell whether or not there is a relationship (of any kind) between score on the questionnaire and tendency to graduate. One can only conclude that the hypotheses: "There is no statistically significant difference....", cannot be rejected.

General

As one wondered why no significant differences were found for the three major hypotheses, only two categories of possibilities occurred.

One was that, perhaps, there actually were no differences to be found. Some investigators, previously mentioned, have reached that conclusion based on their own studies. If so, one should not be concerned that these non-existent differences were not found. Also, the values of chi-square reported, all of which pertained to the major hypotheses, ranged in significance from about 0.2 to 0.9 which suggests that if the study were to be replicated 100 times, from 20 to 90 of these replications (depending on the specific differences being tested by a given chi-square), would also fail to reject a hypothesis of "...no statistically significant difference...".

On the other hand, the sought after differences could, in fact, exist but the study failed to find them. This study may have been one of those in which false hypotheses were not rejected - this situation can and does occur although one does not expect it to happen in his study; failure to reject false hypotheses is the type of occurrence that happens only in other people's studies.

The sample itself contained little room for error, since the entire population available was used - three students whose responses were incomplete were the only ones excluded from the group. Likewise, the classification of a student as "Graduated" or "Not-Graduated" is not a likely source of error in that faculty advisors were periodically asked to update their predictions and actual disposition of students up to the time that entering student data was analyzed on a "Graduated" versus "Not-Graduated" basis.

Sample size is a contributor to statistical significance and if a replication were made with a sample seven or eight (or more) times as large, a few values of chi-square would become statistically significant if the same proportions held as in the present case. Even so, it is unlikely that any of the major hypotheses could be rejected.

There is little evidence to question that the Job Characteristics Inventory and the scoring keys herein developed for its use as a counseling device could effectively indicate the program of study of an entering student - in other words, membership within a given group could be indicated. Likely success or failure while a member of that group (as defined as whether or not a student graduated) could not be so indicated. The interest a person has in a particular field of work seems to influence his choice of field and/or program of study; but once committed to a course of action, other factors, not revealed here, seem to predominate in the determination of success or failure for an individual.

Attempts to view the assembled data from vantage points other than that prescribed by the procedure of the study were likewise unsuccessful. Excluding students who were scoring near the mean of their group failed to uncover significant differences. Neither did attempts to segregate students by prior college experience or lack thereof, nor by standing in their high school classes. Scores at two levels below their group means were considered to indicate "more accurate conceptions" without changing the results of 'no difference'. There is a possibility that some manner of subgrouping the entering students prior to comparing "more accurate conceptions" to "less accurate conceptions" would have resulted in findings of statistical significance. From the auxiliary data collected from the respondents (see Appendix) and from their records (ACT composite, ACT math, H.S.R., G.P.A. at Iowa State University), numerous subgroups were available. However, the intent of the study was to look for major differences in success based solely on the students responses to the questionnaire. If found, these differences could have been used by guidance counselors in a meaningful manner. If differences were non-existent or apparent only after extensive grouping and regrouping, the value, if any, of the questionnaire as a counseling device becomes an academic question and of negligable practical value.

The author suspects that the level of interest needed for a prospective student to voluntarily complete the questionnaire is great enough that the questionnaire and scoring keys cannot further define that interest as a predictor of whether or not the student is likely to complete his program of study. If we consider the following: 72% of all the entering students scored in the "A" category (a score equal to or above a minus one-half standard deviation) on their key and 52% of them graduated; that 9% scored in the "B+" category (at or above a minus one standard deviation but below a minus one-half) and 38% of them graduated; and that 19% scored as "B" and below (below a minus one standard deviation) and 53% of them graduated - one is led to suspect that there are no significant differences as measured by this technique. That this study was unsuccessful in finding the differences sought cannot, however, be construed as proving that these differences are non-existent. Since the major hypotheses were not rejected, no conclusions can be reached concerning their existence.

This study is but one bit of negative evidence that may be supported or refuted in the future.

Suggested Research

It is customary, in the course of a dissertation, for the author to include a series of suggestions to others as to additional investigations in the same vein that appear promising. In light of some discouraging results obtained in this study, the author finds himself somewhat reluctant to encourage others to pursue the same, or a similar path.

Yet, some of the objectives of this study were convincingly reached. Persons interested in a quantitative differentiation between various programs of study in engineering technology could likely find the inventory of job activities most useful. The scoring keys developed in this study demonstrated an ability to differentiate between programs and suggest that successful scoring keys could be developed for other engineering technology programs and, perhaps, for engineering programs. The questionnaire by itself is still a useful instrument to collect information for curriculum development and for informing others of the job activities of engineering technicians and, as such, its utilization could be profitably expanded to other programs of study.

Any suggestion that others replicate this study in an attempt to discover significant differences between the responses to this type of questionnaire by entering students who will later graduate and by those who will not must include a recommendation to exercise due caution. Such a replication appears to involve considerable risk, as did this study, and anyone considering such a study should be forewarned. If the small differences found between the responses of those who graduate and those who do not were to hold steady in a replication, a sample several times larger than the one examined here would be needed to yield even a few statistically significant differences. And even if differences were found, this study indicates that they can as easily be unfavorable as they can be favorable to the intent of the study, i.e. students who will graduate tend to score higher on their key than do their classmates who will not graduate from that program. Even if favorable differences that were statistically significant could be found, they would have to be quite large in a practical sense before the technique would be acceptable to a counselor and his clients. A graduation rate of, say, 51% for students scoring well on a given key versus 49% for those scoring poorly would not be accepted by potential users, even if the difference was statistically significant. The graduation rates would probably need to be at least 20 percentage points apart, say, 60% graduating who scored well versus 40% of those who scored poorly, before high school counselors would be likely to accept the technique.

SUMMARY

The rate at which college students fail to complete their program of study indicates a serious waste of human and financial resources. An attempt to help students improve their prospects of selecting a program they would complete was believed to be worthwhile. Since a person's famil- familiarity (or lack thereof) with various occupations seems to influence his eventual choice of work, a technique involving the scoring of entering engineering technology students' responses to an inventory of specific job activities was developed which utilized responses of engineering technicians employed by industry as the criterion group.

It was the intent of the study to determine whether or not an entering student's ability to foresee his probable job activities upon graduation as measured by the questionnaire and summated by the scoring keys has a significant bearing on his tendency to complete his program of education.

The specific objectives of the study were:

1. Develop scoring scales from existing responses of practicing engineering technicians to an inventory of job activities which are capable of differentiating between the technologies involved.
2. Secure a measure of future job conceptions from entering engineering technology students.
3. Score entering student responses and categorize scores as to accuracy of conception.
4. Determine proportions of those students who graduate with the more accurate and the less accurate conceptions of

future job activities.

5. Test for statistical significance the differences between the proportions who graduate in the more accurate versus the less accurate conception groups.

To determine whether or not the objectives were met, the following hypotheses were tested (with results following each):

1. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Construction Technology scale. (Rejected)
2. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Electronics Technology scale. (Rejected)
3. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology graduates as measured by the Mechanical Technology scale. (Rejected)
4. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Construction Technology scale. (Rejected)

5. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Electronics Technology scale. (Rejected)
6. There is no statistically significant difference between the mean responses to the job characteristics inventory by Construction Technology, Electronics Technology and Mechanical Technology entering students as measured by the Mechanical Technology scale. (Rejected)
7. There is no statistically significant difference between the proportion of entering Construction Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Construction Technology scale. (Failed to reject)
8. There is no statistically significant difference between the proportion of entering Electronic Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Electronics Technology scale. (Failed to reject)
9. There is no statistically significant difference between the proportion of entering Mechanical Technology students with "more accurate conceptions" who graduate than those with the "less accurate conceptions" as measured by the Mechanical Technology scale. (Failed to reject)

From these hypotheses it was concluded that scoring keys could be constructed that would differentiate between engineering technicians (by program) and between entering students (by program). Since the hypotheses concerned with tendency to graduate could not be rejected, no conclusions regarding such a relationship (or lack thereof) could be reached.

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APPENDIX

BACKGROUND INFORMATION

Name____
Last First Middle

Social Security Number____________________

(A) What year were you born?______________

(B) Are you a transfer student? Yes☐ No☐

(C) What program are you enrolled in at Iowa State University?__________

____

(D) What was the principle influence in your choice of this program?

____

(E) What is (was) your father's occupation?____________________

(F) Have you been in the military service? Yes☐ No☐

(G) Do you have work experience related to your occupational goal? Yes☐ No☐ If yes, doing what?______________________________ ______________________________ and for how long?______________

(H) Approximately what grade were you in when you decided on your present occupational goal?

(1) 1-6
(2) 7
(3) 8
(4) 9
(5) 10
(6) 11
(7) 12
(8) decided after leaving high school

(I) While deciding on your present occupational goal, approximately how many conferences did you have with a high school guidance counselor?

(0) None
(1) 1
(2) 2
(3) 3
(4) 4
(5) 5
(6) 6
(7) more than 6

(J) Approximately what percentage of your educational expenses will you pay through savings and part-time work?

(1) 0 - 25%
(2) 25 - 50%
(3) 50 - 75%
(4) more than 75%

JOB CHARACTERISTICS INVENTORY

INSTRUCTIONS

The Job Characteristics Inventory includes statements and descriptions of work activities. We are interested in those activities which you believe will be characteristic of your job after you complete your studies at Iowa State University. Your responses will be studied statistically and the results will help us in developing sound guidance programs. It is therefore essential that you complete the inventory in a thoughtful and careful manner.

Responding to the inventory is accomplished in two steps.

STEP 1 Read straight through all activities and check YES for those you believe will be characteristics of your future job. Otherwise check NO.

NOTE: If you believe there are characteristics of your future job which are not described in the inventory, add them after item 55.

STEP 2 When you have completed step 1, go back to the YES checked activities. These are the activities you have estimated will be characteristics of your future job. Now estimate how frequently these job activities will occur according to the following scale.

You may use any of the numbers between 0 and 100. DO NOT attempt to rank activities. DO NOT attempt to make your estimates total 100. Several job activities may require equal amounts of time or several activities may be accomplished in a single day. Simply look at each YES checked activity and estimate the frequency of occurrence independent of all other estimates.

I estimate my future job will require me to engage in this YES checked activity at least two hours daily during _____ days out of 100 working days.

0 10 20 30 40 50 60 70 80 90 100

No days in 100 — Roughly half the days — Every day

EXAMPLES

✓ YES 10 — TROUBLESHOOTING: You will determine why a machine, circuit, piece of equipment, or structure is not performing like it should.

____ NO

This means that you estimate your future job will require you to engage in troubleshooting at least two hours daily during 10 days out of 100 working days.

✓ YES 0 — SUPERVISING: You will tell others what to do and evaluate their performance.

____ NO

This means that you estimate your future job will require you to engage in supervising, but you do not believe you will spend two or more hours during any working day engaged in this activity.

____ YES ____ — REPAIR: You will replace bad or worn parts and assemblies in instruments, machines, or equipment.

✓ NO

This means you do not expect repair to be a characteristic of your future job.

TAKE YOUR TIME! READ EACH ENTRY CAREFULLY!

1. ____ YES ______ — ANALYSIS: You will use mathematical expressions for predicting characteristics of machines, equipment, circuits, structures, or materials.

   ____ NO

2. ____ YES ______ — BUILD THINGS: You will build models, experimental machines, structures, circuits, equipment, cables, parts, or components using a variety of hand and machine tools.

   ____ NO

3. ____ YES ______ — CALIBRATION AND ADJUSTMENT: You will calibrate or adjust instruments, machines, or equipment in order to obtain acceptable limits of operation.

   ____ NO

4. ____ YES ______ — CHECK DRAWINGS: You will examine drawings done by others, checking for errors.

   ____ NO

I estimate my future job will require me to engage in this YES checked activity at least two hours daily during _____ days out of 100 working days.

0	10	20	30	40	50	60	70	80	90	100
No days in 100					Roughly half the days					Every day

5. _____ YES _______ COMMUNICATIONS: You will observe and report pertinent activities from one area of your company to another, keeping each area informed of the other's activities.
   _____ NO

6. _____ YES _______ COORDINATION: You will assist in the solution of problems which are shared by two or more activities, such as engineering department and assembly line or construction site and home office.
   _____ NO

7. _____ YES _______ COMPANY TRAINING: You will attend training sessions or special schools as part of your job.
   _____ NO

8. _____ YES _______ COST ESTIMATING: You will estimate costs for materials, labor, equipment, equipment installation, and general expenses for a job.
   _____ NO

9. _____ YES _______ CUSTOMER SERVICE: You will follow-up on complaints and attempt to satisfy the customer.
   _____ NO

10. _____ YES _______ DATA RECORDING: You will copy test data into a notebook possibly including a sketch of the test set-up, or you will use special data sheets for recording the test data.
    _____ NO

11. _____ YES _______ DERIVATION: You will derive mathematical expressions for predicting characteristics of machines, equipment, circuits, structures, or materials.
    _____ NO

12. _____ YES _______ DESIGN: You will plan, make calculations, and provide sketches for a structure, machine, piece of equipment, circuit, component, part, or tool to satisfy specifications like size, weight, function, conditions of operation, or performance characteristics.
    _____ NO

13. _____ YES _______ DESIGN ASSISTANCE: You will assist the design leader by performing calculations, obtaining handbook data, determining which components and parts are standard, making sketches, or doing other duties as directed.
    _____ NO

14. _____ YES _______ DRAFTING - DESIGN: You will develop and draw plans including layout, assembly, dimensions, tolerances, and materials for a structure, process, machine, piece of equipment, component, part, or tool knowing specifications like size, weight, function, conditions of operation, or performance characteristics.
    _____ NO

I estimate my future job will require me to engage in this YES checked activity **at least two hours daily** during _____ days out of 100 working days.

0	10	20	30	40	50	60	70	80	90	100

No days in 100 — Roughly half the days — Every day

15. _____ YES _______ DRAFTING - DETAIL: You will prepare or modify drawings from design or layout drawings and sketches or from actual equipment, machines, or structures.
_____ NO

16. _____ YES _______ DRAFTING - LAYOUT: You will plan and draw the arrangement of parts, determining dimensions, tolerances, or component values from design sketches or calculations.
_____ NO

17. _____ YES _______ EVALUATION: You will interpret test data by making calculations to compare actual performance characteristics with desired or expected performance characteristics.
_____ NO

18. _____ YES _______ EXPEDITING: You will keep records which show the progress of a job, and you will schedule the arrival of materials, equipment, or tools so the job can progress without delay.
_____ NO

19. _____ YES _______ EXPERIMENTATION: Using fundamental physical laws and relationships, you will determine new materials or methods that can be used to improve technological practices.
_____ NO

20. _____ YES _______ FIRST LEVEL MAINTENANCE: You will clean and lubricate machines or parts of machines.
_____ NO

21. _____ YES _______ INSPECTION - MAINTENANCE: You will inspect machines, equipment, or structures to determine need for maintenance such as oiling, painting, adjusting, calibrating, repair, or replacement.
_____ NO

22. _____ YES _______ INSPECTION - QUALITY CONTROL: You will inspect materials, components, machines, equipment, circuits, or structures in order to verify the quality or conformance with specifications.
_____ NO

23. _____ YES _______ INSTALLATION: You will install machines, equipment, or structures according to layout and assembly drawings and installation instructions.
_____ NO

24. _____ YES _______ INSTRUMENTATION: You will specify the test equipment, fixtures, and procedures required for testing machines, structures, circuits, equipment, components, parts, or materials.
_____ NO

I estimate my future job will require me to engage in this YES checked activity <u>at least two hours daily</u> during _____ days out of 100 working days.

0	10	20	30	40	50	60	70	80	90	100

No days in 100 — Roughly half the days — Every day

25. _____ YES _______ <u>MANUFACTURING</u>: You will make, process, or assemble parts in the manufacturing of structures, machines, circuits, or equipment.
_____ NO

26. _____ YES _______ <u>MAPPING</u>: You will make topographical maps from survey data or from aerial photographs.
_____ NO

27. _____ YES _______ <u>MARKETING AND SALES</u>: You will consult with potential customers, showing the capability of your equipment, machine, or product in solving their problems.
_____ NO

28. _____ YES _______ <u>MATERIALS TESTING</u>: You will test samples of materials such as metals, plastics, ceramics, wood, concrete, asphalt, sand, or rock according to standard procedures.
_____ NO

29. _____ YES _______ <u>METHODS - ANALYSIS</u>: You will observe production operations in order to determine lengths of time required for making or assembling parts of a machine, structure or piece of equipment.
_____ NO

30. _____ YES _______ <u>METHODS - PRODUCTION</u>: You will determine how parts of a machine, structure, or piece of equipment should be made and assembled.
_____ NO

31. _____ YES _______ <u>METHODS - QUALITY CONTROL</u>: You will develop methods for inspection, testing, and evaluation of materials, components, circuits, equipment, machines or structures, either manufactured or purchased by your company.
_____ NO

32. _____ YES _______ <u>OPERATING</u>: You will operate complex equipment or machines which require a special operator because of their complexity.
_____ NO

33. _____ YES _______ <u>PERFORM MODIFICATIONS</u>: You will alter machines, structures, circuits, equipment, or components using a variety of hand or machine tools.
_____ NO

34. _____ YES _______ <u>PERFORMANCE TESTING</u>: You will test machines, structures, circuits, equipment, or components.
_____ NO

I estimate my future job will require me to engage in this YES checked activity <u>at least two hours daily</u> during _____ days out of 100 working days.

0	10	20	30	40	50	60	70	80	90	100

No days in 100 — Roughly half the days — Every day

35. _____ YES _______ PLANNING AND SCHEDULING: You will plan and schedule the work of others considering factors like availability of materials and manpower, capacity of facilities, sequence of operations, and reasonable time limits.
_____ NO

36. _____ YES _______ PLANT LAYOUT: You will plan and draw the arrangement of spaces, equipment, or machines for a building, portion of a building, or process.
_____ NO

37. _____ YES _______ PROCESS CONTROL: You will adjust controls to regulate a continuous flow process in order to meet quality and safety standards.
_____ NO

38. _____ YES _______ PROGRAMMING: You will translate mathematical expressions or numerical data into program language statements, electrical equivalents, or coded information in order to operate tape controlled machines, computers, or data processing equipment.
_____ NO

39. _____ YES _______ PURCHASING: You will purchase materials, equipment, standard parts, or special items, specifying the exact requirements the company you are buying from must meet.
_____ NO

40. _____ YES _______ QUANTITY ESTIMATING: You will estimate the quantity of the various materials required to build a component, piece of equipment, machine, or structure.
_____ NO

41. _____ YES _______ RECOMMEND MODIFICATIONS: You will make recommendations for changes in the design of a machine, structure, circuit, piece of equipment, or component.
_____ NO

42. _____ YES _______ RELIABILITY: You will determine reliability data, such as life expectancy or dependability, for structures, machines, circuits, equipment, components, or parts.
_____ NO

43. _____ YES _______ REPAIR: You will replace bad or worn parts and assemblies in instruments, machines, or equipment.
_____ NO

I estimate my future job will require me to engage in this YES checked activity **at least two hours daily** during _____ days out of 100 working days.

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100

No days in 100 — Roughly half the days — Every day

44. _____ YES _______ REPORT WRITING: You will write an account or summary of your activities; for instance, a report on a test could include test set-up used, procedure followed, test data, calculations comparing actual with expected performance, curves, and charts.
_____ NO

45. _____ YES _______ SPECIFICATION WRITING: You will prepare documents which specify the materials and components satisfactory for use in products or structures produced by your company.
_____ NO

46. _____ YES _______ SUPERVISING: You will tell others what to do and evaluate their performance.
_____ NO

47. _____ YES _______ SURVEYING - INSTRUMENT MAN: You will set-up and operate surveying equipment, such as an alidade, engineer's level, or transit, and keep notes, sketches, and records of work performed.
_____ NO

48. _____ YES _______ SURVEYING - RODMAN: You will hold a surveying rod at points designated by the instrument man, mark points with elevations, make measurements, and perform miscellaneous duties as directed.
_____ NO

49. _____ YES _______ TECHNICAL PUBLICATIONS: You will write or revise instruction manuals that include information like theory of operation, maintenance procedures, and troubleshooting techniques.
_____ NO

50. _____ YES _______ TRAINING: You will instruct others in the use or maintenance of machines, instruments, or equipment or in fundamental concepts relating to these machines, instruments, or equipment.
_____ NO

51. _____ YES _______ TROUBLESHOOTING: You will determine why a machine, circuit, piece of equipment, or structure is not performing like it should.
_____ NO

52. _____ YES _______ VERBAL REPORTS: You will describe your activities; for instance, a report on a test could include test set-up used, procedure followed, results obtained, and problems encountered.
_____ NO

I estimate my future job will require me to engage in this YES checked activity **at least two hours daily** during _____ days out of 100 working days.

0	10	20	30	40	50	60	70	80	90	100
No days in 100					Roughly half the days					Every day

53. _____ YES _______ **WRITE PROPOSALS**: You will prepare written descriptions and cost estimates of ways to satisfy needs expressed by customers.
    _____ NO

54. _____ YES _______ **WRITING CHANGE NOTICES**: You will write instructions which show design modifications to machines, structures, circuits, or equipment.
    _____ NO

55. _____ YES _______ **WRITING STANDARD PRACTICES**: You will prepare written descriptions of methods, processes, or procedures in order to establish standard practices.
    _____ NO

ADDITIONAL JOB CHARACTERISTICS

56. _____ YES _______ ________________________________
    _____ NO ________________________________
    ____
    ____

57. _____ YES _______ ________________________________
    _____ NO ________________________________
    ____
    ____

58. _____ YES _______ ________________________________
    _____ NO ________________________________
    ____
    ____

59. _____ YES _______ ________________________________
    _____ NO ________________________________
    ____
    ____

Items 21 (Inspection-Maintenance) and 29 (Methods-Analysis) were added to the questionnaire by Trambley (15) after his analysis of the responses to the original form by practicing engineering technicians. These items were deleted from the present study since there were no criterion group responses to them from which scoring weights could be determined.

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