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THE INFLUENCE OF INDUSTRIAL ARTS EXPERIENCE ON GRADES EARNED IN POST-HIGH SCHOOL TRADE AND TECHNICAL CURRICULUMS.

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A SAMPLE OF 363 FULL-TIME ENROLLEES IN FOUR CURRICULUMS (AUTOMOTIVE, DRAFTING, ELECTRICAL, AND MACHINE SHOP) AT WILLIAM HOOD DUNWOODY INDUSTRIAL INSTITUTE WAS SELECTED TO TEST THE "PREVOCATIONAL EFFECTIVENESS" OF SENIOR HIGH INDUSTRIAL ARTS. THIRTY-FIVE VARIABLES WERE USED IN MEASURING THE EFFECT OF THE FOLLOWING ON ACADEMIC ACHIEVEMENT--(1) THE AMOUNT OF INDUSTRIAL ARTS TAKEN, (2) GRADES IN THOSE COURSES, (3) THEIR CONTENT, AND (4) THEIR OBJECTIVES. THE POST-SECONDARY COURSES LASTED EIGHTEEN 4-WEEK TRAINING PERIODS. NO DIFFERENCES IN SCHOLASTIC ACHIEVEMENT COULD BE ATTRIBUTED TO DIFFERENCES IN THE AMOUNT OF SENIOR HIGH SCHOOL INDUSTRIAL ARTS EXPERIENCE, OR ABSENCE OF THIS EXPERIENCE, GRADES IN INDUSTRIAL ARTS, OR DIFFERENCES IN CONTENT OR OBJECTIVES OF INDUSTRIAL ARTS CLASSES. (EM)

THE INFLUENCE OF INDUSTRIAL ARTS EXPERIENCE ON GRADES EARNED IN POST-HIGH SCHOOL TRADE AND TECHNICAL CURRICULUMS

COOPERATIVE RESEARCH PROJECT NO.

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Minnesota Research Coordination Unit in Occupational Education
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HIGHLIGHTS

from the

CONCLUSIONS AND IMPLICATIONS

"This study raises serious questions about the unique prevocational value of senior high school industrial arts. After taking into consideration other relevant variables, it found that differences in amount, content, and objectives of industrial arts experience had no observable influence on the scholastic achievement of students in four different clusters of post-high school trade and technical curriculums. The study showed that academic courses, particularly the physical sciences, were apparently as effective in preparing the students who took them, as industrial arts was for the students who enrolled in it. The results, therefore, indicate that industrial arts educators should be a great deal more conservative in the future than they have been in the past about justifying senior high school industrial arts on the basis of its greater prevocational value for all youth who intend to enter post-high school trade and technical curriculums."

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Exceedingly few studies are done in education that do not require the cooperation of a considerable number of people. This one was no exception. While it is not practical to enumerate the entire list of persons to whom the investigator is indebted, the following deserve special recognition:

Messrs. John Butler, Leon Swedlund and Allen Johnson of the William Hood Dunwoody Industrial Institute for their cooperation and assistance in the data gathering stages of the study.

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Mr. Marvin Bloom, research assistant, who worked as a colleague in all phases of the study.

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INTRODUCTION

The Problem

Industrial arts educators are currently in the throes of re-examing the ends and means of their curriculum at all educational levels. Many persuasions are evident in the literature of the field. Unfortunately, the dialogue has been forced to remain almost entirely at the speculative level. There is an obvious need for evidence that will improve the quality of the critical decisions that must be made.

Many educators have attempted to justify senior high school industrial arts on the basis of its special "prevocational" value. That is, they assume that the experiences provided in these courses will uniquely facilitate subsequent trade and technical training through positive transfer of appropriate psychomotor and cognitive skills. While the assumption may appear reasonable at first inspection, careful investigation has revealed negligible existing evidence to support it. Further, the efficacy of industrial arts cannot be considered realistically in isolation. The selection of any substantial amount of industrial arts in the senior high school is likely to decrease the time devoted to other types of study. It is the relative prevocational value of each of these possible patterns of preparation that is of prime educational significance. And, as the cognitive component of skilled and technical occupational requirements increases, it can also be logically argued that greater amounts of "academic" courses are of more benefit than industrial arts experiences.

This study, therefore, is an attempt to estimate the relative effectiveness of industrial arts experience, as part of a pattern of senior high school preparation, on success in certain post-high school trade and technical curriculums.

The Objectives

There are many aspects of senior high school industrial arts experiences which might have a differential effect on its prevocational value. A realistic and maximally useful evaluation of industrial arts should therefore investigate the several aspects of the experience which appear to have the greatest potential relevance to subsequent success in trade and technical training. This study has examined the effect of differences in a) amount of industrial arts taken, b) grades earned in those courses, c) content of the industrial arts courses in relation to the post-high school curriculum in which the student enrolled, and d) the primary purpose for which the industrial arts courses were offered.

Similarly, the nature of the post-high school curriculum is a significant variable in estimating the influence of prior industrial arts experience. Consequently, the study has examined the effect of each of the above four aspects of industrials arts on four separate clusters of trade and technical curriculums: automotive, drafting, electrical, and machine shop.

The primary criterion for "prevocational effectiveness" utilized in the study was scholastic achievement, defined as the average of all the grades earned by a student while enrolled in a particular post-high school trade and technical curriculum. It was selected in preference to the criterion of completion rate because of its consistency with the definition of "prevocational" value, its psychometric characteristics, and because completion rate is not a very valid measure of student performance. However, since completion rate is of concern to many educators, it has been used as a secondary criterion.

In light of these considerations, the major questions to be answered by the study for each of the four clusters of post-high school trade and technical curriculums are as follows:

1. Are there differences in the post-high school scholastic achievement of students attributable to the effect of three patterns of senior high school coursework containing a) no industrial arts, b) one to five semesters of industrial arts, and c) six or more semesters of industrial arts?
2. Are there differences in the post-high school scholastic achievement of students attributable to a) high (A, B grades) or b) low (C-F grades) achievement in senior high school industrial arts courses as compared with those students who took no industrial arts?
3. Are there differences in the post-high school scholastic achievement of students attributable to the a) direct or b) indirect relationship between the content of senior high school industrial arts courses taken and the content of the post-high school trade and technical curriculums in which they were enrolled as compared with students who took no industrial arts?
4. Are there differences in the post-high school scholastic achievement of students attributable to a) above or b) below average emphasis on "prevocational" or "vocational" objectives in the senior high school industrial arts courses taken as compared with students who took no industrial arts?

This study raises questions only about the prevocational value of senior high school industrial arts. Within that limited domain it cannot answer the value question of should we subscribe to such a propose, nor can it reveal what industrial arts could accomplish. The evidence accumulated can only disclose the actual prevocational value of certain existing industrial arts courses as they have effected a limited group of students who subsequently elected to undertake a specific set of trade and technical curriculums. As such, however, the results of the study should be significant to industrial arts curriculum planners and guidance personnel as they evaluate the feasibility of attaining maximally beneficial prevocational outcomes from proposed senior high school educational experiences.

The Design

The ideal approach to the solution of the research problem and objectives posed would require an experimental design. This procedure, however, was not practical under existing conditions. In lieu of the more technically desirable approach, a causal-comparative procedure was employed. Data was collected from a sample of students who had already graduated from high school and who had elected to enroll in certain trade and technical curriculums in a particular post-high school institution. Thus, the assignment of students to categories based upon differing high school experiences could not be done randomly, but was determined by the history of the student. The major methodological problem, therefore, was to isolate the effect of specific senior high school preparation on post-high school achievement.

The rationale of the procedure employed stated that if specific kinds of high school preparation have no differential effect, then post-high school achievement in a given trade and technical curriculum can best be predicted by other factors. Should the actual regression lines for various high school experience groups differ, causing systematic differences between earned and predicted grades, the systematic differences are attributable to a diversity in the influence of those high school experiences. A comparison of the residuals (earned minus predicted grades) among groups with dissimilar kinds of high school preparation would therefore reveal whether or not the assumption of no differential effect was true.

Twenty-seven variables (later called "controlled" variables), potentially related to post-high school achievement but not a part of specific kinds of high school preparation, were used to develop four multiple linear regression equations to predict grades earned in each of four clusters of post-high school trade and technical curriculums. The predicted grades were then subtracted from the earned grades and the differences (residuals) were used as a criterion measure of achievement attributable to the effect of variations in specific high school preparation.

Implicit in the procedure were the assumptions that a) the most significant, measurable, predictive (controlled) factors were taken into account and that these did not explain any of the valid variance due to differences in the specific kinds of high school preparation studied, b) other factors not accounted for, including errors of measurement, were randomly distributed, and c) the effect of differences in kinds of high school preparation would be great enough to reveal themselves in the unexplained variance (residuals) of post-high school achievement.

Students in each trade and technical curriculum cluster were then classified according to each of the following aspects of their senior high school industrial arts experiences (later called "independent" variables): a) amount of industrial arts taken, b) average grades earned in those courses, c) content of the industrial arts courses in relation to the post-high school curriculum in which the student was enrolled, and d) the primary purpose for which the industrial arts courses taken were offered. The four independent variables were analyzed for each trade and technical curriculum cluster (single-factor ANOVA) using residual grades (the principal "dependent" variable) as the criterion measure.

Statistically significant differences among average residual scores were interpreted in terms of the relative influence of each of these independent variables upon performance in the various trade and technical curriculum clusters. As a matter of secondary interest, the relationships between completion rate and each of the above four aspects of industrial arts experience were determined for each curriculum cluster by means of the chi-square statistic.

The number of semesters of various non-industrial arts senior high school courses taken by students (later called "descriptive" variables) was employed as a criterion measure and analyzed by categories of amount of senior high school industrial arts taken (single-factor ANOVA) in order to relate that independent variable to possible dissimilarites in total patterns of senior high school preparation.

Chapter II

DATA COLLECTION

The Sample

The sample utilized in the study consisted of all the high school graduates (except those previously enrolled in high school vocational-industrial courses) who entered William Hood Dunwoody Industrial Institute between September 4 and November 26, 1963 as full-time students in the automotive body and fender, automotive electrical, general automotive, electronic, general electrical, mechanical drafting, drafting and estimating, and machine shop preparatory curriculums, and who completed at least one grading period (one month) at the Institute in one of those curriculums.

Because the numbers of students who entered each of the eight curriculums noted above were insufficient to permit adequate application of the proposed statistical methodology, the sample was grouped into four curriculum clusters for purposes of analysis.[1] The groupings utilized were based upon a high degree of commonality of subject matter content and activities within each cluster as judged by the administration and faculty of Dunwoody Institute. The "automotive" cluster consisted of the body and fender, general automotive, and automotive electrical curriculums; " ifting" cluster was made up of mechanical drafting and the drafting and estimating curriculums; "electrical" cluster contained the general electrical and electronics curriculums; the machine shop curriculum was treated as a separate cluster.

Thirteen members of the sample transferred between relevant curriculum clusters after their first month of attendance at Dunwoody Institute. These students were retained in the sample, but were assigned to the cluster from which they eventually graduated, or in which they spent the majority of their time.

Table 1 summarizes the sample size by curriculum cluster.

Table 1

SAMPLE SIZE

Curriculum Cluster	Not Included in Sample by Definition					Adjustments Within the Sample		Net Adjusted Sample Size
	Number Enrolled	Number Dropping or Leaving Before One Month	Number Not High School Graduates	Number With H.S. Voc.-Ind. Courses	Net Sample At End of One Month	Transferred Out	Transferred In	
Automotive	136	15	9	9	103	6	7	104
Drafting	88	4	2	5	77	2	4	79
Electrical	146	6	2	8	130	3	2	129
Machine Shop	74	11	3	7	53	2	0	51
TOTAL	444	36	16	29	363	13	13	363

The sample was not drawn at random from any larger predetermined, finite population. It is possible, however, that the sample is representative of many other groups of students who enroll in similar post-high school trade and technical curriculums. Data describing characteristics of the sample are provided in Chapter III so that comparisons can be made by the reader. In making these comparisons it should be remembered that the sample is the net result of a series of selection processes. First, the applicants for admission to the school were self-selected; not the least of the influences bearing upon their decision was their perception of institutional standards. Second, after reviewing high school records and recommendations, and administering the Army General Classification Test where considered necessary, the school found a group of the applicants unsuitable. Third, in order to make the study feasible, the sample, by definition, excluded those who did not remain in a relevant curriculum long enough to receive at least one grade, as well as those with inappropriate high school backgrounds. This final screening probably served to increase further the homogeneity of the sample on motivational and ability characteristics.

Dunwoody Institute is an endowed, non-profit organization located in Minneapolis, Minnesota. It is one of the largest schools of its kind in the world, drawing students from all over the state and nation. The Institute enjoys an enviable reputation for preparing competent employees in all its curricula; the criterion of academic success is therefore potentially meaningful in terms of subsequent performance on the job.

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[1]The use of curriculum clusters rather than separate curriculums also provided a more stable, conservative prediction of earned grades based on the "controlled" variables.

All the curriculums included in the study consisted of eighteen, four-week training periods. Students attended school ve days per week for 6 3/4 hours per day. A typical daily schedule included three hours of "shopwork", forty-five inutes of instruction in "job knowledge" (how, why, demonstrations, safety, applications, regulations, etc.), 1½ ours of "trade knowledge and applied subjects" (materials, processes, equipment, trade literature, definitions, calcu- tions, sketching, science, etc.), and 1½ hours of "general subjects" and library-study assignments (business actices, mathematics, communications, worker-foreman relations, etc.). Each curriculum, of course, differed in the pecific nature of its instructional content, but there was a great deal of similarity among the "general subjects" fferings. Also, most curriculums tended to increase the complexity of and emphasis on technical knowledge as stu- ents progressed through them. A more detailed description of the various curriculums is available from Dunwoody stitute (16).

Controlled Variables

Measures were obtained on twenty-seven variables considered to be potentially related to post-high school achieve- ent, but not a part of specific kinds of high school preparation. These measures were later utilized to develop multiple near regression equations to predict the grade point average of students in each of the four trade and technical cur- iculum clusters included in the study. The predicted grades then served as the "base line" from which systematic dif- erences in average residuals could be attributed to differences in high school preparation.

MVII Score (X_1): Although measured interest has rarely proven to be good predictor of scholastic achievement 14, 15), the recently developed Minnesota Vocational Interest Inventory [2] has shown an appreciable relation to success n trade and technical curriculums (1,3). The MVII was therefore administered by the investigator to members of the sam- le during the first day of their attendance at Dunwoody Institute.

The MVII consists of 190, three-alternate choice items. For each item the respondent indicates the most desirable nd the least desirable alternative; each alternative is a statement of an activity which is presumed to be related to one r more occupations. About fifty minutes is required to administer the instrument.

Twenty scoring keys were available for a range of semi-skilled, skilled, and technical occupations. With the advice f the author of the inventory and his co-workers, the most relevant keys were selected on which to score the students n each of the four curriculum clusters: mechanic key was applied to students in the automotive cluster; electrician ey was used for the electrical cluster; machinist key was used with the machine shop students; stock clerk key was pplied to students in the drafting cluster. While the selection of the first three keys was rather self-evident, the stock lerk key was chosen for the drafting cluster because there was no drafting key available and because both stock lerks and draftsmen were hypothesized to reject the mechanical, "dirty-hand" syndrome and accept "white collar" etailed, individualized activites.

Clark (4) has reported the following MVII stability coefficients, using about one hundred post-high school trade nd technical students tested thirty days apart: Mechanic, .88; electrician, .86; machinist, .83; stock clerk, .73.

The inventory was hand-scored and checked for clerical accuracy. The data were utilized in raw score form, ex- ept that a constant of twenty-five was added to the scores of students in the drafting cluster.

Aptitudes (X_2-X_{10}) : Since aptitudes could be expected to affect achievement, the twelve tests comprising the J.S. Department of Labor's complete General Aptitude Test Battery, B–1002, Form B (8) were administered by the nvestigator and assistants to all students in the sample on the first day of their attendance at Dunwoody Institute. The twelve tests were machine scored (Docu Tran) and the following nine standardized measures of aptitude were btained: G–Intelligence (X_2); V–Verbal Aptitude (X_3); N– Numerical Aptitude (X_4); S–Spatial Aptitude (X_5); P-Form Perception (X_6); Q-Clerical Perception (X_7); K-Motor Coordination (X_8); F–Finger Dexterity (X_9); M–Manual Dexterity (X_{10}).

The GATB was designed for persons and occupations similar to those in the study. The factors measured include virtually all the vocationally significant aptitudes isolated to date, and permit adaptation to a variety of occupations nd occupational clusters through optimal weighting of valid variances. Published reports tend to show a high relation- hip between test results and the time needed to train persons with no previous job experience (5, 6, 15).

The results of prior investigations utilizing the GATB with a variety of high school, college, and adult populations ndicate test-retest reliabilities of the nine aptitude measures to range from .80 to .90 when test intervals were from one week to one year (9).

Approximately one-third of the sample reported having taken the GATB previously, with intervals ranging from two o eighty-six months. With the cooperation of the Minnesota Department of Employment Security, scores from the initial

[2] This is an unpublished instrument developed by Kenneth E. Clark and was used with his permission.

testing were secured for a sub-sample of forty-two persons and an attempt was made to determine the possible effect of practice induced by the prior test administration (13). No practice effect was clearly discerned, and it was therefore concluded that no adjustment should be made for practice on the scores derived from the second administration.

Similarly, thirty-eight students in the sample had taken the Army General Classification Test from four to six months prior to the GATB administered during the study. Since the practice effect of the GATB on itself is very small, even negligible, at that interval, and the correlation coefficients between the G, V and N aptitude measures and AGCT scores are only about .50, no adjustment was made in the GATB scores.

High School Percentile Rank (X_{11}): High school percentile rank was used as a measure of general scholastic achievement; prior performance has usually proven to be a significant predictor of subsequent performance as well as an indirect measure of motivation (12). As a part of the study, official high school transcripts were collected for every member of the sample, and percentile rank was computed from recorded information on class size and rank in the class at graduation. The percentile ranks of students were then converted to normalized standard scores ($\overline{X}$=50, S.D. =10) within each curriculum cluster.

Semesters Taken of Junior High School Industrial Arts (X_{12}): Interviews with Minnesota secondary school personnel indicated that the kind of academic preparation provided in the junior high school grades throughout the State could be considered reasonably equal. It also appeared that the nature of the industrial arts experiences, when provided, could be assumed to be equivalent, but that the amount of industrial arts taken would probably vary. Since it was anticipated that the greatest proportion of sample members would have received their junior high school education in the State, it was decided to collect data only on amount of industrial arts taken in the seventh, eighth and ninth grades.

A five-page "General Information Form" [3] was designed by the investigator and completed by the sample members within one week after their enrollment at Dunwoody Institute. One item on the form served to secure the necessary information about the number of semesters of junior high school industrial arts taken (maximum range of 0-6); this information was partially checked by a comparison with those high school transcripts which included a record of seventh, eighth and/or ninth grades.

Weeks of Directly Related (X_{13}) and Not Directly Related (X_{14}) Prior Vocational Instruction at the Post-High School Level: Preliminary discussions with the Dunwoody staff revealed that about 15% of the students enrolled at that time had undertaken some form of post-high school training prior to entrance. Because it was logical to anticipate that different kinds and amounts of such experience might influence achievement at Dunwoody, the "General Information Form" contained items designed to secure this information.

One tabular item on the form concerned itself with prior post-high school vocational instruction. Sample members supplied data about the areas of content of all of the vocational courses taken since leaving high school in vocational-technical schools, junior colleges, the Armed Forces, in-plant training programs, apprenticeship classes, and correspondence programs. They also supplied information about the number of courses taken in each content area, hours attended each week per course, and the number of weeks per course. The content areas of the courses taken were then classified by the investigator as directly related or not directly related to the Dunwoody curriculum cluster in which the student had enrolled. The amount of time spent in directly and not directly related courses was computed in hours, and the hours converted to twenty-hour weeks (to the nearest whole week).

Whether or Not Prior Post-High School Courses Were Taken in Physical Science (X_{15}), Mathematics (X_{16}), English (X_{17}), Social Studies (X_{18}): The prior post-high school academic preparation of Dunwoody students might have been as influential in their success as prior vocational education. Consequently, an item on the "General Information Form" asked whether students had or had not taken courses since leaving high school, at a junior college, business college, college or university, vocational-technical school, in the Armed Forces, or through correspondence, in the physical sciences, mathematics, English (composition, speech, literature, etc.), and social studies.

Months Elapsed Since Last Formal Schooling (X_{19}): The study habits needed for maximum learning and the retention of relevant substantive content could be affected by the interval between periods of formal education. The "General Information Form" therefore asked members of the sample to indicate when they last attended school (classes), other than their present enrollment at Dunwoody. Responses were converted to the nearest whole month of elapsed time between the date provided and the entry date at Dunwoody.

Months of Prior Full-Time Directly Related (X_{20}) and Not Directly Related (X_{21}) Work Experience[4]: The general or specific competencies that may have been gained from work experiences could influence school achievement, partic-

[3]Because of space limitations, the "General Information Form" has not been included in the Appendix material.

[4]The Dunwoody counseling staff indicated that their recent, unreported investigation showed no significant relationship between amount and kind of work experience during attendance at Dunwoody and grades earned.

ularly in vocational-technical programs. Hence, the "General Information Form" requested brief descriptions of major duties of all the wage earning jobs (part-time and full-time) which sample members held during and since high school attendance. Information on the length of employment and average number of hours worked per week on each job was also secured. Time spent in the Armed Forces did count as work experience.

The investigator evaluated each wage earning job as directly or not directly related to the curriculum cluster in which the student was enrolled. Hours worked on each job were converted to equivalent full-time months by considering 160 working hours as one month.

Age in Half Years (X_{22}): Chronological age was considered a gross, indirect indication of social and/or vocational maturity, and thus was potentially related to motivation and achievement. Students were asked to indicate their date of birth on the "General Information Form".

Number of Partial Dependents (X_{23}) : An item on the "General Information Form" requested members of the sample to supply the number of persons, including themselves, who were presently partially dependent and/or wholly dependent upon their income for support. One wholly dependent person was equated with two partial dependents. It was believed that this measure might reflect, among other things, motivation and time for study.

Whether or Not Active in a Directly Related Hobby (X_{24}): Competencies developed outside of the formal school or work situation could transfer to the learning situation at Dunwoody. An item on the "General Information Form" therefore asked the sample members to list the one, two or three hobbies at which they had spent the greatest amount of time during and since leaving high school. If any one of the hobbies listed was judged by the investigator to be directly related to the curriculum cluster in which the student was enrolled, that student was considered to have an active, directly related hobby.

Highest School Grade Completed By Father (X_{25}) and By Mother (X_{26}): As an indication of home influence on attitudes and aspirations related to formal education, the "General Information Form" secured data on the highest school grade completed by each parent.

Whether or Not Holding a Financial Scholarship (X_{27}): It was anticipated that a reasonable number of students in the sample would receive some financial support from governmental or private agency scholarships. Invariably, continuing support was contingent upon satisfactory scholastic achievement and attendance. In light of the motivational, financial and other implications of these awards, the records at Dunwoody were reviewed to identify each sample member who held a scholarship.

It is recognized that health factors and personality traits have not been measured directly by any of the twenty-seven variables listed above. During the administration of the manipulative tests of the GATB, no students were observed to have physical handicaps which would militate against success in the occupational programs of their choice. In the case of prolonged sickness, students dropped-out temporarily and then reentered the same instructional unit; while this delayed graduation, it did not necessitate missing or making-up instructional units.

Personality traits may have affected adjustments in the training situation, but measurement and diagnosis have thus far been most effective in screening severe problem cases rather than in predicting the extent of interference or non-interference with success in specific types of educational or vocational endeavor.

Independent Variables

The independent variables in the study were used to classify the sample in relevant categories descriptive of their Dunwoody programs and of the four different aspects of their prior senior high school industrial arts experience. These variables were dictated by the objectives of the study, and provided the basis for forming sample sub-groups which could then be used in the analysis of criterion measures.

Dunwoody Curriculum Cluster (Y_1): As previously noted in the section of the report dealing with the sample, four curriculum clusters were used to indicate the nature of the students' experience at Dunwoody: automotive, drafting, electrical and machine shop. Once a student qualified as a member of the sample, he was assigned to the curriculum cluster from which he eventually graduated, or if he didn't graduate, to the cluster in which he spent the majority of his time. This information was obtained from each student's permanent record card kept by Dunwoody Institute. Since thirteen members of the sample transferred between relevant curriculum clusters during the period of their enrollment, measures on the controlled variables which depended upon curriculum (X_1, X_{13}, X_{14}, X_{20}, X_{21}, X_{24}) were adjusted accordingly.

Amount of Senior High School Industrial Arts Taken (Y_2): Official high school transcripts were used to determine the total number of semesters of industrial arts taken by each member of the sample in the tenth, eleventh, and twelfth grades. Each student was then assigned to one of the three following categories: a) No industrial arts, b) one to five semesters of industrial arts, and c) six and over semesters of industrial arts. Only three categories were utilized in order to maintain adequate numbers of students in each category. The dividing points between categories were selected because a "no industrial arts" group was considered essential for the study, and because the most nearly equal numbers of remaining students fell into the other two categories.

Average Grade Earned in Senior High School Industrial Arts (Y_3): By assigning numbers to the letter grades recorded on transcripts (A=5, B=4, etc.) an average industrial arts grade was computed for each sample member who had taken one or more senior high school industrial arts courses. Those students who had earned A or B averages (3.50 and up) were placed in one category, and those who had earned C-F averages (less than 3.50) were placed in a second category. A third category was composed of those students who had taken no senior high school industrial arts.

Directly or Not Directly Related Industrial Arts Experience (Y_4): If, according to the high school transcript, one or more of the senior high school industrial arts courses taken by a sample member was directly related to the Dunwoody curriculum cluster from which he graduated, or in which he spent the most time, the student was placed in the "Directly Related" category. Otherwise, the student was assigned to the "Not Directly Related" category or to the "No Industrial Arts" category, depending upon whether or not he had taken any industrial arts. The following list indicates those high school industrial arts courses considered directly related to Dunwoody curriculums.

Dunwoody Course	Industrial Arts Course
Automotive, general	Automotive
Automotive, body and fender	Automotive
Automotive, electrical	Automotive or electricity
Drafting, mechanical	Drawing or drafting
Drafting and estimating	Drawing or drafting
Electrical, general	Electricity or electronics
Electronic	Electricity or electronics
Machine Shop	Machine shop or advanced metals

Above or Below Average "Vocational" or "Prevocational" Emphasis in Senior High School Industrial Arts (Y_5): Using information collected by an item on the "General Information Form", as well as information available on transcripts and in published directories, a list was compiled of all the teachers who had taught one or more senior high school industrial arts courses to the members of the sample. Each teacher was sent a questionnaire containing statements of ten common industrial arts objectives compiled by the investigator, together with the name(s) of his former student(s) in the sample, the course(s) they had taken, and the date(s) the courses were taken. The teachers were requested to rank the objectives consecutively (one to ten) to indicate the priority which they had actually placed on each objective at the dates indicated for each of the courses specified. A rank of one was considered most important. Although space was provided at the bottom of the list for "write-in" objectives, none were received. The following randomly ordered objectives were included in the questionnaire:

1. Develop marketable skills for employment after high school.
2. Provide exploratory experiences to help students learn about occupations and discover their industrial-technical talents.
3. Provide preparation for college-bound youth entering the mathematical and physical sciences, architecture, engineering, etc.
4. Develop an interest in and an understanding of contemporary industry -- its processes, organization, and social significance.
5. Develop creative talents and problem-solving abilities.
6. Provide preparation for youth who will enter post-high school vocational and technical programs (prevocational).
7. Develop consumer-oriented skills, information, and appreciations.
8. Develop leisure time, recreational interests and skills.
9. Provide realistic opportunities to apply the content learned in high school academic courses.
10. Develop habits and attitudes leading to safe, orderly, and satisfying work practices.

Opinionnaires and the necessary orienting information were sent to 356 teachers of 283 students in the sample (eighty of the 363 total sample had not taken any industrial arts). Four of the teachers were deceased. Despite two follow-ups and telephone calls, thirty-five teachers were not located and twenty-three others failed to respond. Returns were received from 294 teachers. About fifty percent of the respondents taught industrial arts in the Minneapolis-St. Paul metropolitan area; nearly twenty-five percent taught in other parts of Minnesota, approximately fifteen percent were located outside of Minnesota but in the Upper Midwest region, and the remaining ten percent were scattered over the country. The industrial arts experience of the sample was fairly recent; close to forty percent of the students had graduated from high school within the year, another forty percent had graduated between one and two years previously, nearly fifteen percent were out of high school between two and three years, and the remaining five percent had been graduated for more than three years.

The total of sixty-two non-responding teachers reflected themselves in the final "vocational" or "prevocational" emphasis measure in two ways. First, no responses were received for thirty-one students who had taken some senior high school industrial arts, consequently these students had to be eliminated from the analysis using this independent variable. Second, forty-four students were retained for the analysis although rankings of objectives were not received for all of the industrial arts courses they had taken. Including these forty-four students, rankings of objectives were received for an average of ninety-two percent of all courses taken by each of the 252 students (283 minus 31) used in the final analysis involving relative "vocational" or "prevocational" emphasis.

Objective one on the opinionnaire was considered "vocational", and objective six, "prevocational". Utilizing only the higher of the two teacher rankings on objective one or six for each industrial arts course taken, an average rank was computed for all the courses taken by each of the 252 usable members of the sample. This average rank represented a single measure of the relative "vocational" or "prevocational" emphasis of the industrial arts courses taken by each student. The mean of the distribution of average ranks for the 252 students was found to be 3.86 (one being top priority); the median was almost identical to the mean. The sample was therefore divided into two groups, using the mean (3.86) as the division point; those students with average rankings at or less than 3.86 were considered to have "above average vocational or prevocational" emphasis. The mean of the "above average" group was 2.25 and the mean of the "below average" group was 5.49. It appears that the sample as a whole took industrial arts courses which had a relatively high "vocational" or "prevocational" emphasis in relation to other possible, common industrial arts objectives.

Descriptive Variables

The descriptive variables in the study served to report amounts of pertinent kinds of academic, non-industrial arts senior high school preparation. Data from these variables were analyzed so that different amounts of industrial arts experience could be related to variations in amount of other kinds of high school preparation.

Total Number of Semesters Taken in Senior High School Biological Sciences (Z_1), Physical Sciences (Z_2), Mathematics (Z_3), English (Z_4), Social Studies (Z_5), and Foreign Language (Z_6): The number of semesters taken by each member of the sample in each of these subject matter areas was obtained from official high school transcripts. No attempt was made to distinguish among specific courses within each subject area (e.g. physical sciences combined chemistry, physics and general science, mathematics included algebra as well as general mathematics, etc., English was comprised of literature, composition and speech, etc.). The same amount of credits toward graduation was awarded per semester for each of the subjects by all of the high schools represented.

Total Number of Semesters of "Academic" Courses Taken (Z_7): This figure was the sum of all of the semesters taken in the six subject matter areas (variables Z_1 - Z_6) noted above.

Total Number of Senior High School Credits Earned (Z_8): In order to assess the total amount of preparation of each high school graduate, high school transcripts were used to record total number of credits earned during the tenth, eleventh and twelfth grades. This total included industrial arts courses, "academic" subjects, and a miscellaneous group of courses including business, distributive, and agricultural subjects, health, personal typing, music, arts, religion, and driver training (where the high school gave credit for these subjects). The total did not include physical education or military science.

Dependent Variables

The dependent variables are indicative of "success" in post-high school trade and technical curriculums. They include both scholastic achievement and completion rate.[5]

Average Earned Grade (D_1): The average post-high school grade earned by each member of the sample was used as the dependent variable in the development of multiple linear regression equations to predict scholastic achievement (D_1') in each of the four curriculum clusters.

Various members of the Dunwoody instructional staff assigned each student a grade for "shopwork", a grade for "job knowledge", a grade for "trade knowledge and applied subjects", and a grade for "general subjects" in each four-week training period completed by the student. Thus, over the full eighteen training period curriculum, seventy-two separate grades were accumulated on the student's permanent record card. Each grade was based on a five-point interval scale. For the purpose of the study, a numerical value of five represented the highest achievement and one the lowest achievement.

Average earned grade was defined as the unweighted mean of all the individual grades received by a student that counted toward his graduation from one of the curriculums included in the study. The curriculum used was the one from which the stu-

[5]The investigator also considered utilizing numbers of transfers as a dependent variable, but there were an insufficient number of transfers actually made by members of the sample to permit a meaningful analysis. Of the thirteen transfers that did occur after the first month, all were within the eight curriculums selected for the study.

dent graduated, or the one in which he spent the majority of his time. In cases where students had to repeat certain training periods in a subject area, both grades were included in the average. The unweighted mean was selected for use because the Dunwoody staff felt that it a) best estimated overall success at the Institute, b) best predicted future success on the job, and c) accurately reflected the Dunwoody probation and dismissal policy.

Because these measures were used as the dependent variable in developing multiple linear regression equations, the frequency distribution of average grades in each curriculum cluster was tested for "goodness of fit" with the chi-square statistic. In no case were any of the four distributions found to be significantly different (.05 level) from a normal distribution.

Table 2 presents the mean numbers of four-week training periods on which the average grades earned by sample members were based.

Table 2

MEANS AND STANDARD DEVIATIONS OF THE NUMBER OF FOUR-WEEK TRAINING PERIODS ON WHICH AVERAGE EARNED GRADES WERE BASED*

Curriculum Cluster	No Industrial Arts	1-5 Semesters of Industrial Arts	6 and Over Semesters of Industrial Arts
Automotive	n = 23 $\bar{X}$ = 12.39 S = 6.50	43 12.21 6.50	38 11.18 6.69
Drafting	n = 11 $\bar{X}$ = 11.64 S = 6.71	32 13.16 6.17	36 12.36 6.72
Electrical	n = 36 $\bar{X}$ = 12.06 S = 7.06	54 12.13 7.35	39 11.90 6.74
Machine Shop	n = 10 $\bar{X}$ = 14.40 S = 5.40	16 12.13 6.96	25 9.96 7.15

*No significant differences (.05 level) were found between the means or variances within each curriculum cluster.

Residual Grade (D_2): This variable represents that portion of scholastic achievement presumed attributable to the effect of variations in specific high school preparation. It was computed rather than gathered from Dunwoody records. The residual grade is the difference between actual earned average post-high school grade (D_1) and predicted average grade (D_1') with a constant added to eliminate negative residuals ($D_2 = D_1 - D_1' + 2.00$). The distributions of residual grades within each curriculum cluster were found not to differ significantly (.05 level) from a normal distribution.

Completion Rate (D_3): The permanent record cards at Dunwoody were examined two months after the sample members were scheduled to graduate to determine who had succeeded in graduating and who had left school before graduating and had not returned. Thirty-one of the 363 members of the total sample were still in school as the result of lost time due to transfer, sickness, etc. These thirty-one students were not included in the analysis to determine differences in completion rate.

Chapter III

RESULTS

Characteristics of the Sample

The function of this section is to describe the sample in terms of the twenty-seven controlled variables considered potentially related to scholastic achievement in post-high school trade and technical curriculums but not a part of specific kinds of senior high school preparation. The description can be used to compare the sample with other populations as well as to make internal comparisons among groups with different amounts of senior high school industrial arts experience; the latter information will assist in interpreting the results of subsequent analyses.

Table 3 presents the means and standard deviations of the twenty-seven controlled variables (X_1-X_{27}) for the total sample and for three sub-groups in the sample classified according to amount of prior industrial arts experience (Y_2). Since the trends of the means of groups within each of the four curriculum clusters were similar to the means shown for the sample as a whole, individual curriculum cluster data have not been given in the table. However, differences among curriculum clusters will be discussed later in the section.

Table 3 reveals that the mean intelligence (G) of the sample (X=114, S=12) is well above the mean of the general working population (X=100, S=20) on which the test norms were based. A detailed comparison of the students enrolled in each curriculum cluster with the norm group actually working in directly related occupations (not shown in Table 3) showed that the students had consistently higher mean scores on all of the GATB aptitudes considered critical to those occupations. Further, the selection process leading to membership in the sample resulted in eliminating almost all of the persons who would have been considered inappropriate for the occupation according to GATB aptitude cut-off scores.

The mean high school percentile rank (not normalized) of the sample was thirty-eight. This is almost identical with the mean percentile rank of the total 1964 male population in the public area vocation-technical schools of Minnesota, but is lower than the mean male high school percentile rank (fifty) of Junior College and State College freshmen, as well as the University of Minnesota male freshman high school percentile rank of sixty-two (11).

Except for students in the drafting curriculum cluster (where the stock clerk key was used), the MVII scores indicated that the mean of the measured interests of students in each of the other three curriculum clusters was very similar to the interests of persons employed in directly related occupations (not shown in Table 3).

The comparisons in Table 3 among groups in the sample having different amounts of senior high school industrial arts experience showed that those students without industrial arts had higher intelligence (G), verbal aptitude (V), numerical aptitude (N), and form perception (P) than the students with industrial arts experience. On the other hand, students with one to five semesters of industrial arts were not different on any of the aptitude measures from students with six and over semesters of industrial arts. For these reasons, the conclusions of the study which involve the "no industrial arts" group must be interpreted in terms of the prevocational effectiveness of different senior high school course patterns for students who actually took those particular patterns; because of differences in aptitudes, it is not possible to assume that all students could benefit equally from the various high school course patterns. However, since the students with some, but different, amounts of industrial arts had similar aptitudes, it is possible to assume that they could have benefited equally from the different patterns of courses they may have taken.

Table 3 also reveals significant relationships between amounts of senior high school industrial arts taken and whether or not prior post-high school level courses had been taken in a) physical sciences, b) mathematics, c) English, and d) social studies. In each case, there was a tendency for a higher proportion of students to have had one or more of these post-high school courses as the amount of their senior high school industrial arts experience decreased. Conversely, there was a significant trend for those with increasing amounts of senior high industrial arts to have taken increasing amounts of junior high school industrial arts.

Contrasts between curriculum clusters within the sample (not shown in Table 3) indicated that for the cognitive and motor GATB measures the general order of decreasing aptitude was drafting, electrical, machine shop and automotive; automotive was, in most cases, significantly lower than drafting and electricity. There was no difference, however, among the mean high school percentile ranks (not normalized) of the four curriculum clusters.

Prediction of Average Grades

The twenty-seven controlled variables (X_1-X_{27}), potentially related to post-high school achievement but not a part of specific kinds of high school preparation, were used to develop four multiple linear regression equations to predict grades earned (D_1') in each of the four clusters of post-high school trade and technical curriculums. The predicted grades were then subtracted from the earned grades (D_1-D_1') and the differences (plus a constant) were used as a criterion mea-

Table 3

MEANS[1] AND STANDARD DEVIATIONS OF THE TWENTY-SEVEN CONTROLLED VARIABLES BY AMOUNT OF SENIOR HIGH SCHOOL INDUSTRIAL ARTS

Controlled Variable (X)	No Industrial Arts (n = 80)	1-5 Semesters of Industrial Arts (n = 145)	6 and Over Semesters of Industrial Arts (n = 138)	Total Sample (N = 363)	Value of Test Statistics[2]
MVII Score (X_1)	$\bar{X}$ = (Total sample means are not meaningful since different scoring keys were used for the various curriculum clusters) S =				
G – Intelligence (X_2)	$\bar{X}$ = 118.6(a) S = 12.1	113.8 (b) 12.2	112.0 (b) 11.6	114.2 12.2	F = 7.54* Fmax = 4.39
V – Verbal aptitude (X_3)	$\bar{X}$ = 110.2 (a) S = 13.6	105.6 (b) 12.6	102.9 (b) 12.0	105.6 12.4	F = 5.84* Fmax = 3.25
N – Numerical aptitude (X_4)	$\bar{X}$ = 109.8 (a) S = 12.9	105.0 (b) 12.5	102.7 (b) 12.2	105.2 12.8	F = 7.19* Fmax = 4.83
S – Spatial aptitude (X_5)	$\bar{X}$ = 125.7 S = 15.4	124.9 15.3	126.6 14.8	125.7 15.1	F = .44 Fmax = 9.57
P – Form perception (X_6)	$\bar{X}$ = 116.0 (a) S = 15.0	110.1 (b) 15.3	110.4 (b) 15.1	111.5 15.3	F = 4.25** Fmax = 2.46
Q – Clerical perception (X_7)	$\bar{X}$ = 106.4 (a) S = 13.1	104.4 (a) 11.6	102.8 (a) 12.6	104.2 12.4	F = 2.67 Fmax = 2.91
K – Motor coordination (X_8)	$\bar{X}$ = 101.9 (a) S = 13.5	100.1 (a) 15.7	97.1 (a) 14.5	99.4 14.9	F = 1.61 Fmax = 2.95
F – Finger dexterity (X_9)	$\bar{X}$ = 107.5 (a) S = 19.1	102.8 (a) 18.2	104.6 (a) 18.3	104.5 18.5	F = .50 Fmax = 2.47
M – Manual dexterity (X_{10})	$\bar{X}$ = 114.5 (a) S = 19.7	112.6 (a) 21.3	109.8 (a) 19.6	112.0 20.4	F = .60 Fmax = 2.81
High School percentile rank (normalized within curriculum clusters) (X_{11})	$\bar{X}$ = 50.8 (a) S = 10.3	50.6 (a) 9.2	49.0 (a) 10.5	50.0 10.0	F = .83 Fmax = 1.80
Semesters, Junior High Industrial Arts (X_{12})	$\bar{X}$ = 2.2 (c) S = 2.2	3.2 (b) 2.3	3.8 (a) 2.0	3.2 2.2	F = 15.55** Fmax = 1.93

[1]Means which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level, e.g. ab = a, a ≠ b, ab = b. The Newman-Keuls method was used to test for differences between pairs of means.

[2]F ratios for means and variances on each of the controlled variables result from two-way ANOVA using curriculum clusters as one factor and amount of industrial arts as the second factor. Single asterisk (*) F ratios for means signify significant differences at the .05 level and double asterisk (**) ratios signify significant differences at the .01 level after allowances have been made for Fmax variance ratios over 2.99 in accordance with the following rationale. There is some agreement (2,7,10) that the ANOVA test for differences in means is quite insensitive to differences in cell variances or non-normality of distributions in cell populations when cell frequencies are "large enough" and the differences in cell frequencies are not "too great". In this study, therefore, where the variances of the smaller frequency cells were not consistently and greatly different from the variances of the larger frequency cells, and where the ratios of the largest to the smallest cell variances did not exceed 2.99 (Fmax = 3.00 at .01 level), the effect of differences in variance were considered negligible on the test of means; where Fmax ratios of 3.00 to 8.00 were found, the .01 level of significance for mean differences was arbitrarily required before the means were considered different at the .05 level; with Fmax ratios over 8.00, it was considered impossible to place any known degree of confidence in the test of means.

Table 3 (Continued)

Controlled Variable (X)	No Industrial Arts (n = 80)	1-5 Semesters of Industrial Arts (n = 145)	6 and Over Semesters of Industrial Arts (n = 138)	Total Sample (N = 363)	Value of Test Statistics
Weeks, directly related prior post-high school vocational instruction (X_{13})	$\bar{X}$ = 3.3 S = 13.1	2.4 9.1	2.3 8.0	2.6 9.8	F = .03 Fmax = 361.0
Weeks, not directly related prior post-high school vocational instruction (X_{14})	$\bar{X}$ = 5.8 S = 17.6	2.6 10.5	3.5 15.3	3.6 14.2	F = 4.69 Fmax = 1296.0
Whether or not had prior post-high school courses in physical sciences (X_{15})	Yes = 18 No = 62	13 132	8 130	39 324	Chi-square = 15.49**
Whether or not had prior post-high school courses in mathematics (X_{16})	Yes = 20 No = 60	19 126	17 121	56 307	Chi-square = 7.34*
Whether or not had prior post-high school courses in English (X_{17})	Yes = 24 No = 56	23 122	17 121	64 299	Chi-square = 11.30**
Whether or not had prior post-high school courses in social studies (X_{18})	Yes = 19 No = 61	18 127	12 126	49 314	Chi-square = 10.05**
Months elasped since last formal schooling (X_{19})	$\bar{X}$ = 19.0 S = 26.2	15.2 21.9	16.9 24.8	16.7 24.1	F = 1.27 Fmax = 40.2
Months directly related prior full-time work experience (X_{20})	$\bar{X}$ = 3.6 S = 12.3	2.6 10.0	2.5 9.2	2.8 10.3	F = .13 Fmax = 1960.0
Months not directly related prior full-time work experience (X_{21})	$\bar{X}$ = 26.8 (a) S = 30.7	20.6 (a) 27.4	23.1 (a) 25.9	22.9 27.7	F = .88 Fmax = 6.04
Age in half-years (X_{22})	$\bar{X}$ = 41.5 S = 5.6	40.1 6.2	40.2 5.0	40.5 5.7	F = 3.32 Fmax = 12.54
Number of partial dependents (X_{23})	$\bar{X}$ = 1.2 (a) S = 1.3	1.2 (a) 1.4	1.0 (a) 1.3	1.1 1.4	F = .20 Fmax = 2.89
Whether or not active in a directly related hobby (X_{24})	Yes = 19 No = 61	37 108	23 115	79 284	Chi-square = 3.45
Highest school grade completed by Father (X_{25})	$\bar{X}$ = 10.3 (a) S = 2.9	10.8 (a) 2.7	10.6 (a) 2.6	10.6 2.7	F = .62 Fmax = 2.94
Highest school grade completed by Mother (X_{26})	$\bar{X}$ = 11.3 (a) S = 2.3	11.4 (a) 2.2	11.4 (a) 2.0	11.4 2.2	F = .01 Fmax = 2.33
Whether or not holds financial scholarship (X_{27})	Yes = 8 No = 72	16 129	7 131	31 332	Chi-square = 3.51

sure (D_2) of achievement attributable to the effects of variations in specific high school preparation. This section describes the results of the procedure used to develop the four multiple linear regression equations.

Table 4 presents the means and standard deviations of average grades actually earned by students in each post-high school trade and technical curriculum cluster. The numerical value of five represents the highest possible earned grade. Note the trend for those with greater amounts of senior high school industrial arts to earn lower grades. However, in light of the differences in aptitudes reported in the previous section, this finding is not unexpected.

A weighted regression analysis was used to develop the multiple linear regression equations. The analysis first used all twenty-seven variables in the equation, then it dropped the variable contributing the least to the prediction. It recomputed the equation for the remaining twenty-six variables and then dropped the least efficient predictor, and so on, until all the variables in the equation had a probability equal to or greater than .90 of contributing significantly to the prediction. Appendix A contains the zero order intercorrelation matrices for the four curriculum clusters. Table 5 gives the ordinary multiple linear equations resulting from the weighted regression analysis to predict average earned grades.

By inspection, no two equations are alike; different factors and/or weightings apparently predict best for different occupational curriculum clusters. On the basis of the number of times they appear in the equations and on their relative contributions to the prediction (standard partial regression coefficients are not shown in Table 5), the most efficient overall predictors of average earned grade were a) high school percentile rank (normalized) and b) intelligence (G). All other predictor (controlled) variables appeared either in only one equation or not at all.

Except for intelligence (G), the GATB aptitudes recommended by the U.S. Bureau of Employment Security as critical in the selection of trainees were not among the most important predictors of average grades, nor were the aptitudes that did contribute significantly to the prediction necessarily the recommended critical aptitudes for that curriculum cluster. It must be remembered, however, that the sample already contained a very high proportion of students who had scores well above the minimum for B.E.S. recommended aptitudes.

It was not considered necessary or advisable to employ a cross-validation procedure; the equations were not to be used for selection and their absolute efficiency was not of direct concern. Maximizing the stability of the equations to obtain the best estimate of the generalizable effect of the controlled variables appeared to be more important. Therefore, in light of the relatively small numbers within curriculum clusters and the large number of variables being considered, all the students in each cluster were used to develop the equations to make them as stable as possible. For the same reason, to reduce the number of predictors unique to the sample, a high (.90) probability level was selected to admit variables to the equation.[6] As shown in Table 5, the estimates of the multiple correlation coefficients for the hypothetical universes from which the sub-samples were drawn indicate that the equations developed are reasonably stable.

The relatively small amount of variance explained by the "stable" variables in the equations implies that factors which were not considered among the twenty-seven controlled variables used in the study have an important influence on average earned grades. In addition to the less stable variables, and the effect of factors to be tested in this study, there are several other factors which might influence the prediction of post-high school scholastic achievement. Some of these follow: a) Differences within each curriculum cluster; b) errors of measurement; c) content of the specific senior high school courses taken; d) amount actually learned by students in the specific courses taken (as opposed to the general achievement measure of high school percentile rank); e) motivation and aspirations to succeed (which were only indirectly measured by many of the factors included in the study, e.g. election of a curriculum, staying at least one month, scholarship or not, prior general scholastic achievement, number of dependents, age, educational background at home, and hobbies).

Senior High School Course Patterns

The following section reports on the descriptive variables (Z) which assess the amount of different kinds of non-industrial arts senior high school preparation (primarily academic) of the sample. Since the amount of industrial arts taken is likely to influence the amount of time devoted to academic subjects, and thus result in different patterns of senior high school preparation, comparisons of the descriptive variables were made among groups with different amounts of industrial arts within every curriculum cluster. Eight descriptive variables (Z1-Z8) were tested in each curriculum cluster (one-way ANOVA), Tables 6, 7, 8, and 9 present the results.

It is apparent from Tables 6-9 that the students within each of the four curriculum clusters did not differ significantly in the total amount of senior high school credits earned regardless of differences in the amount of industrial arts taken. On the other hand, there was a definite tendency for those with increasing amounts of industrial arts to have taken

[6] When all twenty-seven variables were used in the regression equations, the following coefficients of multiple correlation were found: Automotive, .69; drafting, .72; electrical, .63; machine shop, .83.

Table 4

MEANS AND STANDARD DEVIATIONS[1] [2] OF AVERAGE EARNED GRADES BY CURRICULUM CLUSTER AND AMOUNT OF SENIOR HIGH SCHOOL INDUSTRIAL ARTS

Curriculum Cluster		No Industrial Arts	1-5 Semesters of Industrial Arts	6 and Over Semesters of Industrial Arts	Total Sample
Automotive	n	23	43	38	104
	$\bar{X}$	2.96	2.92	2.70	2.85(b)
	S	.46	.59	.63	.59
Drafting	n	11	32	36	79
	$\bar{X}$	3.28	3.04	3.00	3.05(a,b)
	S	.59	.58	.51	.55
Electrical	n	36	54	39	129
	$\bar{X}$	3.02	2.83	2.81	2.88(b)
	S	.65	.88	.72	.77
Machine Shop	n	10	16	25	51
	$\bar{X}$	3.57	3.05	3.00	3.12(a)
	S	.33	.47	.43	.47
Total	n	80	145	138	363
	$\bar{X}$	3.11(a)	2.93(a,b)	2.86(b)	2.94
	S	.59	.70	.60	.65

[1]Column and row means which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level.

[2]Values of test statistics found in this two-way analysis were as follows: Fmax, 7.11; Fcol., 5.65*; Frow, 4.61*; F interaction, .59. (The single asterisks indicate an estimate of significant differences reduced to the .05 level to account for possible effects of heterogeneity in variance.)

Table 5

ORDINARY MULTIPLE LINEAR REGRESSION EQUATIONS FOR PREDICTING AVERAGE EARNED GRADES (D'_1) BY CURRICULUM CLUSTER

Curriculum Cluster	N	Equation***	R*	cR**	S.E. of Estimate
Automotive	104	$D'_1 = 2.364 + .009X_2 + .023X_{11} + .012X_{19} - .046X_{22}$	.58	.55	.48
Drafting	79	$D'_1 = 1.115 + .011X_3 + .014X_{11} + .728X_{17} - .551X_{18}$	.58	.55	.45
Electrical	129	$D'_1 = -.699 + .023X_2 + .018X_{11}$	.47	.46	.68
Machine Shop	51	$D'_1 = .698 + .011X_2 + .009X_6 + .014X_{11} + .392X_{17} + .107X_{23} - .065X_{25}$	.72	.68	.32

***Where X_2 = Intelligence (G); X_3 = Verbal aptitude (V); X_6 = Form perception (P); X_{11} = High School percentile rank (normalized); X_{17} = Prior post-high school courses in English (Yes – No); X_{18} = Prior post-high school courses in social studies (Yes – No); X_{19} = Months elapsed since last formal schooling; X_{22} = Age in half years; X_{23} = Number of partial dependents; X_{25} = Highest school grade completed by Father.

*All multiple correlation coefficients are significantly different from zero at the .01 level.

**Estimate of the correlation coefficient for the universe from which the sample was drawn (correction for shrinkage). From J. P. Guilford, Fundamentals of Statistics in Psychology and Education, 2d.ed., New York, McGraw-Hill, 1950.

Table 6 SEMESTERS OF SENIOR HIGH SCHOOL ACADEMIC SUBJECTS TAKEN (Z) BY AMOUNT OF INDUSTRIAL ARTS EXPERIENCE[1]: AUTOMOTIVE

Subject Matter Area	No Industrial Arts (n = 23)	1-5 Semesters of Industrial Arts (n = 43)	6 and Over Semesters of Industrial Arts (n = 38)	Value of Test Statistics[2]
Biological Sciences (Z_1)	$\bar{X}$ = 2.09 (a) S = .73	1.63 (b) .90	1.53 (b) .86	F = 3.31* Fmax = 1.51
Physical Sciences (Z_2)	$\bar{X}$ = 2.00 (a) S = 1.60	2.12 (a) 1.55	1.21 (b) 1.28	F = 4.25* Fmax = 1.56
Mathematics (Z_3)	$\bar{X}$ = 3.61 (a) S = 1.95	3.26 (a,b) 1.65	2.42 (b) 1.70	F = 3.97* Fmax = 1.40
English (Z_4)	$\bar{X}$ = 5.87 (a) S = .63	5.93 (a) .74	6.05 (a) .87	F = .47 Fmax = 1.92
Social Studies (Z_5)	$\bar{X}$ = 5.83 (a) S = 1.23	5.81 (a) 1.07	5.84 (a) 1.00	F = .01 Fmax = 1.51
Foreign Languages (Z_6)	$\bar{X}$ = .57 (a) S = .90	.42 (a) 1.12	.47 (a) 1.27	F = .13 Fmax = 2.00
Total Semesters of Academic Courses (Z_7)	$\bar{X}$ = 19.96 (a) S = 3.62	19.16 (a, b) 3.30	17.58 (b) 3.28	F = 4.09* Fmax = 1.22
Total Senior High School Credits Earned (Z_8)	$\bar{X}$ = 13.17 (a) S = 1.34	13.72 (a) 1.30	13.87 (a) 1.19	F = 2.25 Fmax = 1.26

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

Table 7 SEMESTERS OF SENIOR HIGH SCHOOL ACADEMIC SUBJECTS TAKEN (Z) BY AMOUNT OF INDUSTRIAL ARTS EXPERIENCE[1]: DRAFTING

Subject Matter Area	No Industrial Arts (n = 11)	1-5 Semesters of Industrial Arts (n = 32)	6 and Over Semesters of Industrial Arts (n = 36)	Value of Test Statistics[2]
Biological Sciences (Z_1)	$\bar{X}$ = 1.64 (a) S = .84	1.53 (a) .84	1.17 (a) .97	F = 1.91 Fmax = 1.44
Physical Sciences (Z_2)	$\bar{X}$ = 2.73 (a) S = 1.62	1.63 (b) 1.72	1.19 (b) 1.37	F = 4.12* Fmax = 1.58
Mathematics (Z_3)	$\bar{X}$ = 3.91 (a) S = 1.92	4.03 (a) 1.66	3.36 (a) 1.38	F = 1.64 Fmax = 1.95
English (Z_4)	$\bar{X}$ = 6.14 (a) S = .60	6.06 (a) .56	5.97 (a) .61	F = .58 Fmax = 1.17
Social Studies (Z_5)	$\bar{X}$ = 4.64 (b) S = 1.57	5.84 (a) .92	5.50 (a) 1.00	F = 5.30* Fmax = 2.90
Foreign Languages (Z_6)	$\bar{X}$ = 1.27 (a) S = 2.05	.34 (b) .90	.00 (b) .00	F = 7.72**
Total Semesters of Academic Courses (Z_7)	$\bar{X}$ = 20.36 (a) S = 4.13	19.44 (a) 2.55	17.19 (b) 2.04	F = 9.35** Fmax = 4.10*
Total Senior High School Credits Earned (Z_8)	$\bar{X}$ = 12.82 (a) S = 1.25	12.88 (a) 1.26	13.28 (a) 1.17	F = 1.18 Fmax = 1.24

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

Table 8 **SEMESTERS OF SENIOR HIGH SCHOOL ACADEMIC SUBJECTS TAKEN (Z) BY AMOUNT OF INDUSTRIAL ARTS EXPERIENCE[1]: ELECTRICAL**

Subject Matter Area	No Industrial Arts (n = 36)	1-5 Semesters of Industrial Arts (n = 54)	6 and Over Semesters of Industrial Arts (n = 39)	Value of Test Statistics[2]
Biological Sciences (Z_1)	$\bar{X}$ = 1.44 (a) S = .91	1.37 (a) 1.00	1.23 (a) 1.09	F = .45 Fmax = 1.43
Physical Sciences (Z_2)	$\bar{X}$ = 3.22 (a) S = 1.53	2.44 (b) 1.60	1.69 (c) 1.49	F = 9.15** Fmax = 1.15
Mathematics (Z_3)	$\bar{X}$ = 4.11 (a) S = 1.85	3.63 (a) 1.81	3.28 (a) 2.03	F = 1.81 Fmax = 1.24
English (Z_4)	$\bar{X}$ = 6.11 (a) S = .67	6.13 (a) .67	5.88 (a) .57	F = 2.08 Fmax = 1.40
Social Studies (Z_5)	$\bar{X}$ = 5.86 (a) S = 1.07	5.85 (a) 1.04	5.59 (a) .94	F = .93 Fmax = 1.31
Foreign Languages (Z_6)	$\bar{X}$ = .94 (a) S = 1.69	.39 (b) 1.13	.10 (b) .64	F = 4.65* Fmax = 6.94
Total Semesters of Academic Courses (Z_7)	$\bar{X}$ = 21.69 (a) S = 3.18	19.85 (b) 2.88	17.77 (c) 3.26	F = 15.24** Fmax = 1.27
Total Senior High School Credits Earned (Z_8)	$\bar{X}$ = 13.08 (a) S = 1.36	13.43 (a) 1.21	13.69 (a) 1.13	F = 2.31 Fmax = 1.45

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

Table 9 **SEMESTERS OF SENIOR HIGH SCHOOL ACADEMIC SUBJECTS TAKEN (Z) BY AMOUNT OF INDUSTRIAL ARTS EXPERIENCE[1]: MACHINE SHOP**

Subject Matter Area	No Industrial Arts (n = 10)	1-5 Semesters of Industrial Arts (n = 16)	6 and Over Semesters of Industrial Arts (n = 25)	Value of Test Statistics[2]
Biological Sciences (Z_1)	$\bar{X}$ = 2.40 (a) S = 1.26	1.25 (b) 1.00	1.20 (b) 1.00	F = 5.05* Fmax = 1.59
Physical Sciences (Z_2)	$\bar{X}$ = 2.60 (a) S = 1.90	1.88 (a) 1.71	.96 (b) 1.17	F = 4.71* Fmax = 2.62
Mathematics (Z_3)	$\bar{X}$ = 4.20 (a) S = 2.57	2.69 (a) 1.74	2.88 (a) 1.74	F = 2.16 Fmax = 2.19
English (Z_4)	$\bar{X}$ = 6.20 (a) S = .63	6.13 (a) .50	6.20 (a) 1.04	F = .04 Fmax = 4.34
Social Studies (Z_5)	$\bar{X}$ = 5.80 (a) S = 1.14	6.12 (a) .62	5.80 (a) 1.35	F = .45 Fmax = 4.78
Foreign Languages (Z_6)	$\bar{X}$ = .60 (a) S = 1.35	.31 (a) .70	.24 (a) 1.20	F = .38 Fmax = 3.68
Total Semesters of Academic Courses (Z_7)	$\bar{X}$ = 21.80 (a) S = 3.71	18.37 (b) 3.05	16.60 (b) 3.97	F = 7.26** Fmax = 1.69
Total Senior High School Credits Earned (Z_8)	$\bar{X}$ = 13.[illegible]0 (a) S = 1.45	13.37 (a) 1.02	13.28 (a) 2.78	F = .05 Fmax = 7.34

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

ecreasing numbers of semesters of academic courses. With respect to specific academic subject areas, there were no ignificant differences among groups with various amounts of industrial arts in the number of semesters of English aken in any of the curriculum clusters. In three of the four curriculum clusters amount of mathematics and social studes were also unrelated to amount of industrial arts taken. However, in every curriculum cluster there were significant ifferences among two or more groups in the mean amount of physical sciences taken; in each case, those with less inustrial arts had a significantly greater amount of physical sciences. Also, in two of the four curriculum clusters, those vith industrial arts were found to have taken significantly fewer semesters of biological sciences and foreign languages.

An inspection of the non-academic, non-industrial arts courses taken by the sample, e.g. health, personal typing, usiness, etc., did not indicate that they were unequally distributed among groups with various amounts of industrial arts xperience. Thus, the prevocational effectiveness of amount of senior high school industrial arts courses taken may be ompared primarily with the prevocational value of different amounts of physical sciences, and also, for certain curricuum clusters, different amounts of biological sciences and foreign languages.

Prevocational Effectiveness : Scholastic Achievement

The residual grade (D_2) represented that portion of each student's scholastic achievement in a post-high school rade and technical curriculum cluster which was presumed attributable to the effect of variations in his specific high school preparation. It was computed by subtracting predicted average grade (D_1') from average earned grade (D_1) and adding a constant of 2.00. The residual grade was then used as the criterion measure in one-way ANOVA designs to determine whether there were significant differences within each curriculum cluster among the average residuals of groups hat varied according to the four industrial arts related independent variables (Y): a) Amount of senior high school industrial arts (Y_2); b) average grade earned in senior high school industrial arts (Y_3); c) directly or not directly related industrial arts experience (Y_4); d) above or below average "vocational" or "prevocational" emphasis in senior high school industrial arts (Y_5). This series of tests provided answers to the major questions posed by the study.

The means, standard deviations and results of the tests of hypotheses concerning groups with varying amounts of senior high school industrial arts are given in Table 10. In all four curriculums, no significant differences were found among the mean residual grades of the groups with no industrial arts, 1-5 semesters of industrial arts, and 6 and over semesters of industrial arts.

Table 11 presents the means, standard deviations and results of the tests of hypotheses concerning groups with varying average grades earned in senior high school industrial arts: a) No industrial arts, b) A, B industrial arts grades, c) C-F industrial arts grades. While no significant differences were found among the mean residual grades of the three groups in the automotive and machine shop curriculum clusters, significant differences were found among mean residual grades in the drafting and electrical curriculum clusters. In the latter two clusters there were no differences between the group with no industrial arts and the group with A, B industrial arts grades. However, significantly lower mean residuals were found in the drafting cluster for the group with C-F industrial arts grades as compared with the group with no industrial arts; in the electrical cluster the group with C-F industrial arts grades had significantly lower mean residuals than both the no industrial arts and the A, B industrial arts grades groups.

In order to better interpret the significant results depicted in Table 11, the three groups within the drafting and electrical curriculum cluster were compared in the bases of intelligence (G) and senior high school course patterns. It was found that, consistent with the results shown in Table 3, the A, B industrial arts grade group and the C-F grade group were not significantly different in intelligence in either curriculum cluster, but that both groups had a significantly lower mean G score than the no industrial arts group in both curriculum clusters. Within the drafting and electrical clusters the A, B and the C-F industrial arts grade groups took approximately the same number of total academic courses as well as equal amounts of specific academic subject matter courses. Both groups, however, took significantly fewer total academic courses, and significantly fewer courses in the physical sciences and foreign languages, than did the no industrial arts group.

Table 12 shows the means, standard deviations and results of the tests of hypotheses concerning groups with no industrial arts experience, directly related industrial arts experience, and not directly related industrial arts experience. In all four curriculum clusters, no significant differences were found among the mean residual grades of the three groups.

The means, standard deviations and results of the tests of hypotheses concerning groups with no industrial arts experience, below average vocational or prevocational emphasis in their industrial arts experience, and above average vocational or prevocational emphasis in their industrial arts experience are shown in Table 13. In all four curriculum clusters, no significant differences were found among the mean residual grades of the three groups.

Table 10

MEANS AND STANDARD DEVIATIONS OF RESIDUAL GRADES (D_2) BY CURRICULUM CLUSTER AND AMOUNT OF SENIOR HIGH SCHOOL INDUSTRIAL ARTS[1]

Curriculum Cluster	No Industrial Arts	1-5 Semesters of Industrial Arts	6 and Over Semesters of Industrial Arts	Value of Test Statistics[2]
Automotive	n = 23 $\bar{X}$ = 2.05 (a) S = .45	43 2.01 (a) .40	38 1.95 (a) .58	F = .35 Fmax = 2.06
Drafting	n = 11 $\bar{X}$ = 2.13 (a) S = .39	32 1.99 (a) .48	36 1.97 (a) .45	F = .55 Fmax = 1.49
Electrical	n = 36 $\bar{X}$ = 2.01 (a) S = .63	54 2.00 (a) .76	39 2.00 (a) .64	F = .01 Fmax = 1.40
Machine Shop	n = 10 $\bar{X}$ = 2.15 (a) S = .27	16 1.95 (a) .27	25 1.96 (a) .36	F = 1.47 Fmax = 1.88

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

Table 11

MEANS AND STANDARD DEVIATIONS OF RESIDUAL GRADES (D_2) BY CURRICULUM CLUSTER AND AVERAGE GRADE EARNED IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS[1]

Curriculum Cluster	No Industrial Arts	Average A,B Grade	Average C-F Grade	Value of Test Statistics[2]
Automotive	n = 23 $\bar{X}$ = 2.05 (a) S = .45	43 2.07 (a) .47	38 1.89 (a) .50	F = 1.55 Fmax = 1.28
Drafting	n = 11 $\bar{X}$ = 2.13 (a) S = .39	51 2.05 (a,b) .43	17 1.77 (b) .48	F = 3.13* Fmax = 1.51
Electrical	n = 36 $\bar{X}$ = 2.01 (a) S = .63	58 2.16 (a) .65	35 1.73 (b) .72	F = 4.56* Fmax = 1.31
Machine Shop	n = 10 $\bar{X}$ = 2.15 (a) S = .27	21 1.96 (a) .38	20 1.95 (a) .27	F = 1.47 Fmax = 1.98

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

Table 12

MEANS AND STANDARD DEVIATIONS OF RESIDUAL GRADES (D_2) BY CURRICULUM CLUSTER AND DIRECTLY OR NOT DIRECTLY RELATED SENIOR HIGH SCHOOL INDUSTRIAL ARTS EXPERIENCE[1]

Curriculum Cluster	No Industrial Arts	Directly Related	Not Directly Related	Value of Test Statistics[2]
Automotive	n = 23 $\bar{X}$ = 2.05 (a) S = .45	15 1.98 (a) .45	66 1.99 (a) .50	F = .19 Fmax = 1.23
Drafting	n = 11 $\bar{X}$ = 2.13 (a) S = .39	57 2.01 (a) .43	11 1.83 (a) .57	F = 1.23 Fmax = 2.14*
Electrical	n = 36 $\bar{X}$ = 2.01 (a) S = .63	20 2.14 (a) .55	73 1.96 (a) .74	F = .52 Fmax = 1.81
Machine Shop	n = 10 $\bar{X}$ = 2.15 (a) S = .27	23 1.94 (a) .36	18 1.98 (a) .29	F = 1.56 Fmax = 1.78

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

Table 13

MEANS AND STANDARD DEVIATIONS OF RESIDUAL GRADES (D_2) BY CURRICULUM CLUSTER AND RELATIVE VOCATIONAL OR PREVOCATIONAL EMPHASIS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS[1]

Curriculum Cluster	No Industrial Arts	Below Average Emphasis	Above Average Emphasis	Value of Test Statistics[2]
Automotive	n = 23 $\bar{X}$ = 2.05 (a) S = .45	30 1.97 (a) .51	41 1.95 (a) .49	F = .37 Fmax = 1.28
Drafting	n = 11 $\bar{X}$ = 2.13 (a) S = .39	28 1.96 (a) .46	32 2.01 (a) .49	F = .56 Fmax = 1.58
Electrical	n = 36 $\bar{X}$ = 2.01 (a) S = .63	48 2.08 (a) .69	37 1.93 (a) .67	F = .54 Fmax = 1.20
Machine Shop	n = 10 $\bar{X}$ = 2.15 (a) S = .27	19 1.89 (a) .23	17 1.99 (a) .38	F = 2.48 Fmax = 2.73

[1]Means within rows which do not have a common letter following them are considered significantly different from each other at or beyond the .05 level. The Newman-Keuls method was used to test for differences between pairs of means.

[2]A single asterisk (*) indicates an F value significant at the .05 level; a double asterisk (**) indicates significance at the .05 level.

Prevocational Effectiveness: Completion

The secondary criterion of prevocational effectiveness used in the study was completion — whether the student graduated or whether he left school before graduating. Unlike the criterion of residual grades, which attempted to attribute a part of scholastic achievement to aspects of senior high school preparation, the criterion of completion was used only to investigate the possible existence of relationships. Because of the design of the study, relationships that were revealed using the criterion of completion cannot be interpreted as indicating cause and effect; differences in one or more aspects of prior industrial arts experience, for example, cannot be said to have caused differences in the proportion of students who graduated or dropped.

Beginning with a sample of 363 students, who had already completed one grading period (month), thirty-one were eliminated from this phase of the analysis because they were still in school at the time of final data collection. Data from the remaining 332 students were used in a series of chi-square contingency tables to test the independence of graduating or dropping out and each of the four industrial arts related independent variables (Y) in the four curriculum clusters.

Table 14 shows that, except for the machine shop curriculum where the expected frequencies were small, there were no significant relationships between graduating from or dropping out of the post-high school trade and technical curriculum clusters and having taken no senior high school industrial arts, 1-5 semesters of industrial arts, or 6 and over semesters of industrial arts.

Again with the exception of the machine shop curriculum, Table 15 reveals significant relationships between graduating from or dropping out of the curriculum clusters and having taken no senior high school industrial arts, earning A, B average grades in senior high school industrial arts, or earning C-F average industrial arts grades. Those students with no prior industrial arts experience and those with A, B average grades tended to have a higher proportion of graduates than those students with C-F average industrial arts grades.

Tables 16 and 17 show there were no significant relationships between students graduating or dropping out and (a) directly or not directly related senior high school industrial arts experience, and (b) relative vocational or prevocational emphasis in prior industrial arts.

Thus, the results of the tests of hypotheses with completion as the criterion are similar to the results obtained when residual grade was used as the criterion.

Table 14

FREQUENCY OF STUDENTS GRADUATING (G) AND DROPPING OUT (D) BY CURRICULUM CLUSTER AND AMOUNT OF SENIOR HIGH SCHOOL INDUSTRIAL ARTS

Curriculum Cluster	No Industrial Arts	1-5 Semesters of Industrial Arts	6 and Over Semesters of Industrial Arts	Obtained Chi-square Values[1]
Automotive	G = 11	19	15	
	D = 11	22	22	.47
Drafting	G = 4	18	19	
	D = 4	10	16	.83
Electrical	G = 18	30	18	
	D = 17	21	18	.80
Machine Shop	G = 4	7	2	
	D = 2	7	17	9.07*[2]
Total	G = 37	74	54	
	D = 34	60	73	4.40

[1]A single asterisk (*) indicates a chi-square value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

[2]Based on an expected frequency of two in one cell.

Table 15

FREQUENCY OF STUDENTS GRADUATING (G) AND DROPPING OUT (D) BY CURRICULUM CLUSTER AND AVERAGE GRADE EARNED IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS

Curriculum Cluster	No Industrial Arts	Average A,B Grades	Average C-F Grades	Obtained Chi-square Values[1]
Automotive	G = 11 D = 11	23 17	11 27	6.71*
Drafting	G = 4 D = 4	33 15	4 11	8.62*
Electrical	G = 18 D = 17	36 18	12 21	7.71*
Machine Shop	G = 4 D = 2	6 10	3 14	5.07[2]
Total	G = 37 D = 34	98 60	30 73	27.24**

[1]A single asterisk (*) indicates a chi-square value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

[2]Based on an expected frequency of two in one cell.

Table 16

FREQUENCY OF STUDENTS GRADUATING (G) AND DROPPING OUT (D) BY CURRICULUM CLUSTER AND DIRECTLY OR NOT DIRECTLY RELATED SENIOR HIGH SCHOOL INDUSTRIAL ARTS EXPERIENCE

Curriculum Cluster	No Industrial Arts	Directly Related	Not Directly Related	Obtained Chi-square Values[1]
Automotive	G = 11 D = 11	5 7	28 37	.33
Drafting	G = 4 D = 4	34 20	3 6	2.97
Electrical	G = 18 D = 17	10 8	38 31	.14
Machine Shop	G = 4 D = 2	3 15	6 9	5.55[2]
Total	G = 37 D = 34	53 50	75 83	.59

[1]A single asterisk (*) indicates a chi-square value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

[2]Based on an expected frequency of two in one cell.

Table 17

FREQUENCY OF STUDENTS GRADUATING (G) AND DROPPING OUT (D) BY CURRICULUM CLUSTER AND RELATIVE VOCATIONAL OR PREVOCATIONAL EMPHASIS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS[1]

Curriculum Cluster	No Industrial Arts	Below Average Emphasis	Above Average Emphasis	Obtained Chi-square Values[2]
Automotive	G = 11 D = 11	11 18	19 20	1.01
Drafting	G = 4 D = 4	11 13	19 11	2.07
Electrical	G = 18 D = 17	27 17	19 16	.83
Machine Shop	G = 4 D = 2	5 10	3 11	3.65[3]
Total	G = 37 D = 34	54 58	60 58	.32

[1]The sample of 332 was further reduced in this analysis due to the thirty-one students for whom no information was received regarding the relative emphasis of their industrial arts experience.

[2]A single asterisk (*) indicates a chi-square value significant at the .05 level; a double asterisk (**) indicates significance at the .01 level.

[3]Based on an expected frequency of two in one cell.

Chapter IV

CONCLUSIONS AND IMPLICATIONS

Conclusions

Within the limitations imposed by the definitions employed, the characteristics, high school and post-high school experience of the sample, and subject to the validity of the assumptions required by the methodology utilized, the following conclusions to the four major questions posed by the study seem warranted:

1. Are there differences in the post-high school scholastic achievement of students attributable to the effect of three patterns of senior high school coursework containing a) no industrial arts, b) one to five semesters of industrial arts, and c) six or more semesters of industrial arts?

There were no differences in the scholastic achievement of students enrolled in any of the four post-high school trade and technical curriculum clusters studied attributable to differences in amount of senior high school industrial arts experience. Since increasing amounts of industrial arts tended to be accompanied by decreasing amounts of academic courses in the high school patterns of preparation of students in all curriculum clusters, the additional academic coursework had as much apparent prevocational value for the students who took them as industrial arts had for the students who took it. The physical sciences, and, to a less generalizable degree, the biological sciences and foreign languages, were the specific subject matter areas which accounted for most of the variation in amount of academic courses undertaken.

The assumption should not be made, however, that the physical sciences, biological sciences, and foreign languages are as effective as industrial arts for all students. Because of differences in the aptitudes of the students who took the various course patterns, there is no assurance that those with more industrial arts background could have benefited equally from a comparable increase in academic subjects.

Although causal relationships were not necessarily reflected in that part of the study using program completion as the criterion, the results obtained were compatible with the conclusions concerning scholastic achievement. There was no relationship between graduating from or dropping out of school and amount of senior high school industrial arts taken in the post-high school automotive, drafting and electrical curriculum clusters; in the machine shop curriculum, where the number of students involved was relatively small, those with greater amounts of industrial arts tended to have a lower proportion of graduates.

2. Are there differences in the post-high school scholastic achievement of students atributable to a) high (A, B grades) or b) low (C-F grades) achievement in senior high school industrial arts courses as compared with those students who took no industrial arts?

There were no differences in the scholastic achievement of students enrolled in the post-high school automotive and machine shop curriculum clusters attributable to differences in average grades earned in senior high school industrial arts. However, students in the post-high school drafting and electrical curriculum clusters who earned C - F average industrial arts grades did not benefit as much from their industrial arts experience as the students who took no senior high school industrial arts, while students with A, B average industrial arts grades did benefit as much from that experience as the students who took no industrial arts. This conclusion is especially significant since the A, B group of students and the C - F group had similar intelligence scores and patterns of high school preparation, but both groups had fewer academic courses, including physical sciences and foreign language, than the students with no industrial arts.

In addition, with the exception of the machine shop curriculum, students with C - F average senior high school industrial arts grades tended to have a higher proportion of drop-outs than those with A, B average industrial arts grades.

3. Are there differences in the post-high school scholastic achievement of students attributable to the a) direct or b) indirect relationship between the content of senior high school industrial arts courses taken and the content of the post-high school trade and technical curriculums in which they were enrolled as compared with students who took no industrial arts?

There were no differences in the scholastic achievement of students enrolled in any of the four post-high school trade and technical curriculum clusters studied attributable to having had a) no senior high school industrial arts, b) industrial arts courses which were directly related, or c) industrial arts courses which were not directly related to the curriculums in which they were enrolled.

Further, there were no differences in the proportion of students in the above three groups who graduated from any of the curriculum clusters.

4. Are there differences in the post-high school scholastic achievement of students attributable to a) above or b) below average emphasis on "prevocational" or "vocational" objectives in the senior high school industrial arts courses taken as compared with students who took no industrial arts?

There were no differences in the scholastic achievement of students enrolled in any of the four post-high school trade and technical curriculum clusters studied attributable to having had a) no senior high school industrial arts courses, b) industrial arts courses with below average, or c) with above average emphasis on "prevocational" or "vocational" objectives.

Similarly, there was no relationship in any curriculum cluster between status in the above three groups and the extent to which students graduated from or dropped out of school.

Implications

This study raises serious questions about the unique prevocational value of senior high school industrial arts. After taking into consideration other relevant variables, it found that differences in amount, content, and objectives of industrial arts experience had no observable influence on the scholastic achievement of students in four different clusters of post-high school trade and technical curriculums. The study showed that academic courses, particularly the physical sciences, were apparently as effective in preparing the students who took them, as industrial arts was for the students who enrolled in it. The results, therefore, indicate that industrial arts educators should be a great deal more conservative in the future than they have been in the past about justifying senior high school industrial arts on the basis of its greater prevocational value for all youth who intend to enter post-high school trade and technical curriculums. As most programs now exist, they are probably not in a position to "put up".

The fact that boys with high achievement in senior high school industrial arts tended to receive a greater amount of help from the experience than their peers with lower grades indicates that industrial arts does have some, although no special, prevocational value for its students.

It seems logical to hypothesize, based on personal observation and the results of the study, that the content of post-high school trade and technical curriculums goes far beyond the common "practical" competencies provided by most industrial arts courses. Within a short time, students with industrials arts experience find new, specialized, and more "theoretically-oriented" skills being required of them, for which they have had relatively little basic academic preparation. Of course, the more these students learned in industrial arts, the greater the proportion of possible benefit obtained. It is likely, however, that as trade and technical occupations continue to increase their demands for cognitive skills, the relative prevocational value of industrial arts courses, as they are presently constituted, will decrease. While the content of senior high school industrial arts can be made more like the trade and technical post-high school curriculums, the problem of providing adequate academic preparation for the new industrial arts courses remains unanswered, and the more basic value question of whether to adopt a vocational purpose arises.

The study has served to identify questions that require answers before a complete picture of the prevocational contribution of industrial arts can be assessed. First, what is the relative prevocational value of industrial arts and academic courses within various strata of intelligence? For example, would a low ability student gain as much from physical sciences as he would from industrial arts? Second, since achievement within industrial arts is a significant variable, what about differences in achievement in the academic courses? For example, how much would be gained by students with A, B average grades in the physical sciences as compared with A, B students in industrial arts? Third, a more detailed examination of the content within academic areas might reveal additional information. For example, would physics be more or less beneficial than general science? How would algebra and business mathematics compare? Fourth, as the result of industrial arts experience, do students achieve better in the "practical" aspects of the post-high school curriculum, and worse in its "theoretical" aspects, than students with more academic preparation? Fifth, how can extent and direction of student motivation be measured more accurately? Motivation seems important in the prediction of achievement, yet only indirect and inaccurate indices are currently available for its assessment.

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APPENDIX

INTERCORRELATION MATRICES

Table A1

ZERO ORDER CORRELATIONS[1] AMONG CONTROLLED VARIABLES ($X_1 - X_{27}$) AND AVERAGE EARNED GRADES (D_1): AUTOMOTIVE

(N = 104)

X	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	D_1
1	-	.14	.03	.06	.09	.02	.02	.02	.09	.00	.12	-.02	.09	.01	-.02	.09	.02	.05	.12	.11	.01	.13	.09	-.06	-.15	.01	.12	.11
2		-	.67	.77	.62	.38	.20	.05	.26	.16	.47	-.14	.01	.03	.18	.26	.24	.29	-.03	-.06	-.03	-.06	.12	.15	.04	.13	-.02	.40
3			-	.32	.23	.24	.11	.07	.19	.00	.28	.03	-.01	.06	.24	.25	.32	.41	.01	.01	.06	-.02	.07	.14	.25	.18	.01	.19
4				-	.29	.21	.29	.07	.07	.18	.43	-.20	.05	-.01	.18	.19	.21	.20	.08	-.03	-.02	.05	.15	.07	-.05	.10	.04	.25
5					-	.39	.00	.05	.33	.19	.25	-.14	-.01	-.07	-.05	.10	-.05	-.05	-.08	-.03	-.04	-.09	.07	.14	-.05	.09	-.10	.32
6						-	.42	.26	.41	.29	.13	.08	.17	-.04	-.05	.07	.01	.08	.09	.06	.16	.01	.09	.14	-.01	.03	-.04	.20
7							-	.20	.34	.39	.26	.08	.22	-.03	.00	.06	.03	.02	-.06	.04	-.04	-.09	-.01	.09	.05	-.08	-.05	.23
8								-	.26	.39	.16	.12	.05	.03	.04	.12	.05	.13	.04	-.07	.12	.12	.29	.09	.13	.15	-.20	.05
9									-	.54	.04	-.14	.13	.09	-.02	.06	.01	.07	.09	.09	.06	.03	.13	.14	.08	.14	.03	.18
10										-	.20	-.16	.04	-.02	.09	.04	.01	.03	.05	-.05	.05	-.00	.14	.24	.13	.11	.03	.11
11											-	-.06	-.13	.04	.21	.25	.20	.18	-.18	-.02	-.07	-.07	.18	.10	.04	.09	.01	.45
12												-	.13	.02	-.04	.00	.01	-.03	-.17	-.04	.13	-.13	-.12	-.08	.26	.10	-.03	-.03
13													-	.00	-.04	-.05	-.07	-.06	.04	.05	-.05	.10	-.06	-.11	-.14	-.07	.02	-.08
14														-	-.05	.10	.31	.24	.07	.03	.12	.28	.04	-.05	-.10	.06	.09	-.02
15															-	.39	.53	.45	.12	.02	.03	.17	.08	-.05	.10	.20	.08	.12
16																-	.76	.49	-.05	-.10	.11	.02	-.12	.04	-.00	.05	-.08	.21
17																	-	.81	.08	-.06	.17	.17	-.12	.02	.02	.16	.11	.18
18																		-	.11	-.04	.13	.23	.04	.14	.10	.22	.13	.15
19																			-	.46	.40	.79	.43	-.03	-.10	.04	.33	-.09
20																				-	-.02	.57	.27	.10	.15	.15	.27	-.12
21																					-	.26	.19	-.14	.00	.04	.07	-.02
22																						-	.53	.08	-.10	.14	.38	-.23
23																							-	-.03	.08	.13	.17	.00
24																								-	.16	.09	.11	-.03
25																									-	.40	.04	.05
26																										-	.19	.12
27																											-	-.18

[1] .195 required for significance at the .05 level; .254 required for significance at the .01 level.

Table A2

ZERO ORDER CORRELATIONS[1] AMONG CONTROLLED VARIABLES (X_1 – X_{27}) AND AVERAGE EARNED GRADES (D_1): DRAFTING

(N = 79)

X	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	D_1
1	-	.06	.14	.15	-.10	.21	.30	.16	-.03	.03	.10	-.03	-.24	-.01	.14	.04	.12	.19	.01	-.02	.12	-.07	.01	-.04	.18	.08	-.03	-.06
2		-	.80	.78	.30	.14	.32	.18	.06	-.03	.28	.10	-.13	.06	.13	.09	.15	.08	.04	-.04	.07	.01	.12	-.03	-.07	-.10	.06	.37
3			-	.49	.04	.15	.29	.19	.09	-.20	.30	.12	-.18	.04	.10	.09	.21	.20	.06	-.01	.12	.06	.14	-.01	.10	.09	.08	.39
4				-	.03	.14	.38	.25	.07	.07	.16	-.01	-.07	.04	.05	.09	.06	-.05	.03	-.07	-.04	-.05	.06	-.13	-.12	-.24	-.04	.26
5					-	.17	-.01	-.11	.02	.08	-.01	.12	-.08	-.01	-.05	-.06	-.05	-.08	.07	-.03	.02	-.03	-.07	-.06	-.08	-.02	.17	.01
6						-	.40	.37	.18	.07	-.03	-.07	-.21	-.17	.06	.01	.12	.15	.06	-.22	-.14	.01	.21	-.09	.10	.14	-.11	-.13
7							-	.34	.20	.02	.05	.02	-.14	.06	.12	.17	.24	.32	-.03	-.22	-.09	-.01	.07	.01	.08	.18	.07	.35
8								-	.08	.31	.09	-.03	-.14	.02	.04	.13	.13	.03	-.09	.00	-.23	-.11	-.04	.02	-.04	-.02	.11	.04
9									-	.22	-.02	-.01	-.09	-.19	-.16	-.07	.06	.07	.00	-.19	-.29	-.12	.02	.05	.04	.02	.13	.16
10										-	.00	-.13	-.01	-.16	-.14	-.24	-.20	-.32	-.29	-.10	-.42	-.40	-.13	.14	-.14	-.15	.07	-.04
11											-	.08	-.05	-.07	.11	.10	.15	.07	-.20	-.06	.07	-.15	-.07	-.02	-.07	-.07	.12	.38
12												-	.09	-.02	.01	.19	.13	.06	.07	.08	.23	.15	.08	.04	.09	.05	-.16	.06
13													-	-.08	.19	.22	.12	-.02	-.07	.23	.02	.05	-.06	-.01	-.11	.09	-.12	.07
14														-	-.03	.16	-.02	-.04	.18	.10	.36	.54	.35	-.10	.19	.05	-.10	.02
15															-	.70	.70	.67	-.05	-.06	.07	.10	-.14	.12	.04	.14	-.01	.25
16																-	.79	.57	-.05	-.02	.11	.31	.00	.04	.00	.21	-.06	.34
17																	-	.82	-.13	-.02	.02	.13	-.06	.04	.19	.27	-.06	.35
18																		-	-.10	-.06	.10	.05	-.04	.10	.30	.37	-.02	.16
19																			-	.05	.41	.77	.34	.05	-.11	.12	.02	.02
20																				-	.08	.09	-.09	-.01	.02	-.17	-.04	-.07
21																					-	.55	.33	-.07	.11	.07	-.12	.13
22																						-	.52	-.06	.05	.18	-.11	.12
23																							-	-.10	.09	.26	-.14	.02
24																								-	-.08	.06	.06	-.01
25																									-	.47	-.11	.04
26																										-	-.04	-.01
27																											-	.14

[1] .222 required for significance at the .05 level; .289 required for significance at the .01 level.

Table A3

ZERO ORDER CORRELATIONS[1] AMONG CONTROLLED VARIABLES ($X_1 - X_{27}$) AND AVERAGE EARNED GRADES (D_1): ELECTRICAL

(N = 129)

X	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	D_1
1	-	.16	.08	.18	-.00	-.01	-.07	.07	.02	.08	-.00	.12	.10	-.08	.07	-.03	-.02	-.11	-.15	.11	-.06	-.05	.01	.32	.03	.05	.07	.13
2		-	.71	.72	.39	.39	.47	.28	.34	.30	.29	.17	.09	.06	.25	.21	.31	.23	-.12	.03	-.01	-.01	.08	.08	.13	-.01	.10	.41
3			-	.39	.05	.15	.29	.25	.20	.20	.32	.03	.17	.10	.15	.11	.21	.14	.07	.05	.17	.13	.14	.01	.07	.00	.18	.26
4				-	.00	.38	.50	.31	.28	.33	.22	.18	-.02	-.05	.19	.24	.27	.15	-.25	-.07	-.02	-.11	.08	.12	.09	-.08	.00	.23
5					-	.32	.13	.03	.19	.13	-.00	.05	.06	.03	.14	.10	.10	.14	.02	.08	-.06	.06	-.05	.04	.04	.00	.02	.16
6						-	.63	.38	.42	.33	.01	.05	-.02	.06	.09	.09	.08	.12	-.15	.05	-.05	-.17	.02	-.08	.05	-.09	-.05	.03
7							-	.01	.52	.42	.46	.12	.13	.03	.06	.13	.11	.13	.17	-.05	.14	.00	-.08	-.23	-.02	-.09	.07	[illegible]
8								-	.36	.65	.01	.14	-.10	.17	.17	.17	.16	.18	-.11	.01	.09	-.03	.07	.05	.12	-.03	.05	.06
9									-	.61	.08	.08	-.02	.16	.18	.21	.22	.15	-.03	.12	-.01	.03	.01	.03	.06	-.09	.05	.09
10										-	.06	.22	-.04	.10	.16	.22	.19	.14	-.02	.10	.05	.08	.18	.02	.14	-.02	.11	.15
11											-	-.02	.07	-.15	.21	.18	.18	.11	-.00	.03	-.01	.03	-.08	.06	-.04	-.05	-.09	.33
12												-	-.10	-.01	.06	.04	.10	.11	-.17	.06	-.14	-.09	-.11	.05	.20	[illegible]	.07	.09
13													-	-.02	-.02	-.00	.10	.00	.29	.68	-.03	.38	.18	.02	-.05	.06	.20	.18
14														-	-.06	-.05	-.08	-.05	.18	-.06	.12	-.28	.02	-.12	-.01	-.11	-.00	-.10
15															-	.80	.57	.62	-.16	-.10	-.03	.08	-.09	.04	.21	.13	-.12	.21
16																-	.77	.69	-.18	-.05	.09	.15	-.07	-.03	.27	.12	-.15	.15
17																	-	.69	-.17	-.07	.11	.09	.03	-.01	.03	.19	-.03	.16
18																		-	-.14	-.04	-.07	.12	.07	-.16	.26	.10	.01	.13
19																			-	.24	.31	.79	.22	-.19	-.17	-.21	.16	.09
20																				-	-.11	.22	.08	.05	-.03	-.06	.18	.10
21																					-	.38	.12	-.29	-.06	-.07	.09	-.03
22																						-	.29	-.22	-.10	-.22	.16	.11
23																							-	-.08	.03	.05	.26	-.12
24																								-	.20	.17	.04	.19
25																									-	.45	.02	.12
26																										-	-.09	.04
27																											-	.07

[1] .174 required for significance at the .05 level; .228 required for significance at the .01 level.

Table A4

ZERO ORDER CORRELATIONS[1] AMONG CONTROLLED VARIABLES ($X_1 - X_{27}$) AND AVERAGE EARNED GRADES (D_1): MACHINE SHOP

(N = 51)

X	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	D_1
1	-	.09	.12	.03	.06	.12	.15	.13	-.02	-.01	-.13	-.03	-.05	.27	.26	.29	.19	.15	.03	.03	-.09	.19	.19	-.10	-.02	-.17	.29	.20
2		-	.76	.69	.48	.31	.48	.27	.24	.25	.22	-.08	-.13	.09	.14	.18	.13	.18	.10	.03	-.13	.10	-.04	-.04	.00	-.19	.28	.45
3			-	.38	.06	-.02	.39	.21	.20	.17	.19	-.14	-.16	.05	.16	.23	.12	.14	.31	.06	-.02	.23	.03	-.20	-.07	-.17	.22	.34
4				-	.13	.37	.62	.42	.13	.36	.07	-.15	-.23	.06	.26	.25	.30	.36	.14	.20	-.06	.23	.05	.00	.05	-.10	.31	.36
5					-	.49	.23	.03	.22	.15	.05	.18	.27	.04	-.25	-.21	-.22	-.18	-.13	.06	-.27	-.16	-.27	.14	-.06	-.10	.02	.22
6						-	.58	.24	.18	.30	-.27	.03	.02	.14	-.23	-.08	-.17	-.04	.12	.14	-.18	.18	-.07	-.08	.15	.05	.21	.22
7							-	.44	.19	.52	-.21	-.13	-.01	.01	-.07	.05	-.04	.04	.35	.38	-.13	.45	-.03	-.19	.03	-.14	.16	.26
8								-	.44	.59	-.04	-.12	-.01	.11	.01	.09	.06	.10	.29	.35	-.01	.33	.07	-.01	.16	-.13	.13	.14
9									-	.25	.15	-.03	.14	-.07	-.08	.02	.01	.05	.17	-.04	.20	.04	.01	-.01	.16	-.35	-.10	.13
10										-	-.10	-.20	.11	-.07	-.02	.05	.02	.01	.15	.46	-.15	.20	.14	.09	.14	-.24	.01	.11
11											-	-.03	-.05	-.04	.15	.20	.20	.18	-.18	-.14	-.03	-.20	-.25	.12	-.25	-.06	-.04	.33
12												-	.07	.06	-.16	-.12	-.02	-.13	-.05	-.05	.02	-.17	.02	-.05	-.03	.20	-.10	-.21
13													-	-.09	-.05	-.05	-.05	-.02	-.06	.33	.02	-.03	-.04	.46	-.21	-.15	-.05	.16
14														-	.22	.20	.20	-.09	.31	-.10	.08	.37	-.00	-.09	.02	.07	.22	.26
15															-	.76	.76	.70	-.14	.10	.17	.08	.20	-.08	.16	-.08	.11	.25
16																-	.85	.85	-.14	.04	.06	.17	.20	-.11	.16	-.02	.04	.28
17																	-	.85	-.16	.04	.06	.14	.15	-.11	.16	.03	.04	.33
18																		-	-.17	.09	.05	.15	.23	-.09	.09	-.06	.08	.35
19																			-	.18	.36	.79	.00	-.15	-.21	-.15	.06	.13
20																				-	-.27	.24	-.00	-.08	-.15	-.02	.10	.18
21																					-	.28	.17	.17	-.03	-.17	.13	.00
22																						-	.17	-.26	-.13	-.15	.21	.31
23																							-	.05	.15	-.31	.14	.16
24																								-	-.09	-.18	.20	-.02
25																									-	.22	-.20	-.27
26																										-	-.18	-.16
27																											-	.33

[1] .276 required for significance at the .05 level; .357 required for significance at the .01 level.