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PERSONALITY CHARACTERISTICS OF SUCCESSFUL
2- AND 4-YEAR ENGINEERING STUDENTS

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BACKGROUND

Admission to a college engineering program is usually based on a candidate's academic performance in high school and on the verbal, mathematics, and reasoning sections of the Scholastic Aptitude Test. Counseling and guidance tools such as the National Engineering Aptitude Search (NEAS) test similarly stress scores on science reading, mathematics, and mechanical problem solving as indicators of engineering potential. Given that an engineering student's primary goal is the acquisition of engineering knowledge, it is hardly surprising that admission and counseling procedures stress cognitive and intellectual abilities. Everyone knows that such skills are a prerequisite for success in a college engineering program.

We agree that proficiency in reading, mathematics, and reasoning makes it more likely that a student will succeed in engineering. We would also argue, however, that intelligence and ability alone will not guarantee success. Take, for example, Terman's famous study of the intellectually gifted. In the 1920's Terman identified 1470 children with an average IQ of 151. Although everyone in Terman's sample was intellectually gifted, not everyone was occupationally successful as an adult. Terman found that "the difference between the relatively successful and unsuccessful gifted was largely determined by nonintellectual qualities such as social adjustment, emotional stability, and drive to accomplish" (Seagoe, 1975, p. 97).

Tests of nonintellectual traits (temperament, interests, motivation, personality) have been shown to predict academic success time and again (see for example Megargee, 1972, Ch. 12). Typically these studies look at academic success across all majors rather than within specific majors like engineering. Thus, we know very little about the nonintellectual correlates of success in engineering specifically.

We do have some information about the personality characteristics of the "typical" or "average" engineering student. McCaulley et al. (1983) found that the stereotypical engineering student is logical, tough-minded, and decisive. They also tend to be more introverted than students in other majors. Although this study is interesting, it does not tell us whether these personality traits are associated with doing well in an engineering program.

The present report describes a study that inquired specifically about the relationship between nonintellectual traits and success in an engineering program. Plans for the continuation of the research program are also described. It is our hope that our research will redress the balance between intellectual and nonintellectual factors in student guidance, counseling, and college admission procedures.
Method

Persons surveyed included all students at the Pennsylvania State University's DuBois Campus who were finishing their second year of study in 1982. The students received a questionnaire that inquired about their background, experiences at the campus, and nonintellectual traits. Out of 209 students surveyed, 109 returned a completed questionnaire, for a 54% return rate. The students were distributed equally across the campus's most popular majors: 4-year Business, 2-year Business, 4-year Engineering, 2-year Engineering, and 2-year Wildlife Technology.

"Success" is a nebulous concept, easy to identify but difficult to define and measure. Rather than use a narrow definition of academic success such as grade point average, we chose to define success more broadly. Five items from the questionnaire were used to create a "successfulness" score for each student: reported grade point average, rated satisfaction with choice of major (on a 1 to 5 scale), reported satisfaction with overall experience on campus (on a 1 to 5 scale), absence of problems on a checklist of 15 common academic problems, and outlook for the future (probability of obtaining a job in one's field or of continuing one's education). An overall "success score" was computed by standardizing each of the five items across the entire sample and then averaging the standardized scores. This equal weighting system assumes that none of the five criteria of success is more important than any of the others. A one-way analysis of variance showed that there were no significant differences among students in different majors in overall success.

Three types of nonintellectual predictor variables were scored from the questionnaire: reasons for enrolling, vocational interests, and personality traits. Eleven possible reasons for enrolling were offered, including not knowing what else to do, pleasing parents, getting a high paying job, and just wanting to be better educated.

Vocational interests were measured with Holland's (1973) Vocational Preference Inventory. The inventory yields six scores that simultaneously describe occupational preferences and personality types. The Realistic type values money, status, and concrete things, tends to be asocial, frank, and uninsightful, and prefers occupations such as automotive engineer, farmer, and electrician. The Investigative type values science, tends to be intellectual, analytical, and introspective, and prefers scientific occupations. The Artistic type values aesthetic qualities, tends to be expressive, intuitive, and nonconforming, and prefers occupations such as interior decorator, photographer, and musician. The Social type likes to help others, tends to be friendly, sociable, and kind, and prefers occupations such as teacher, counselor, and librarian. The Enterprising type values political and economic achievement, tends to be assertive, self-confident, and leader-like, and prefers occupations like lawyer, salesperson, and restaurant manager. The Conventional type values business and economic achievement, tends to be orderly, conscientious, and conforming, and prefers occupations such as accountant, bookkeeper, and computer operator. Engineers are predominantly Realistic and investigative types. Whether one's scores on the six scales are related to success in engineering is a question that has not been addressed until the present study.
Personality was assessed by including in the questionnaire a short version of the Hopkins Personality Inventory (HPI; see Hogan, 1982; Hogan & Johnson, 1981). The HPI was constructed to measure all of the major dimensions of personality. The HPI contains seven scales that reflect these major dimensions: Intellectence (how bright one appears), Adjustment, Likeability, Rule Attunement (respect for rules and authority), Ascendance (ambition and assertiveness), Sociability, and Self-Control. Each of the major scales is composed of smaller scales that reflect facets of the larger dimensions. For example, the Ascendance scale consists of the following facets: Enjoys Competition, Sets High Standards, Leadership, Status-Seeking, Will, and Influence. For the present study several facet scales were selected from each major dimension based on their predicted relevancy for academic success.

After the questionnaires were collected a number of statistical analyses were carried out. These analyses are described below.

ANALYSES

Questionnaire data were sorted into groups according to major. Within each major the average overall "success" score was determined, and, again within each major, students were divided into two groups: those above the average success score for their group and those below the average success score.

Chi-square analyses showed that for all majors, success was quite unrelated to the student's reason for enrolling. All students, including the engineering students, tended to give one of three reasons for enrolling: to qualify for a high paying job, to learn specific skills for a job, or to become generally better educated. It is conceivable that a student giving a statistically rare reason for enrolling (e.g., my friends talked me into it) might be less successful. With our limited sample size we could not answer this question.

Next, success scores were correlated with the occupational interest and personality scales within each major. For the engineering students in 2-year Engineering, success was significantly related to Realistic interests (r = .43), Conventional interests (r = .33), Planfulness (r = .35), Appearance-Consciousness (r = .39), and, inversely, to Competitiveness (r = -.35) and Excitement Seeking (r = -.27). For 4-year Engineering students, success was associated with Prior Academic Achievement (r = .52), Freedom from Anxiety (r = .52), Self-Confidence (r = .53), Sense of Identity (r = .45), Competitiveness (r = .45), and Excitement Seeking (r = .46).

Some variables (e.g., Prior School Success) tended to predict success across all majors. Others, such as Realistic interests, were related to success only for engineers. Realistic scores were inversely related to success for students across all majors (r = -.17). Interestingly, self-rating of Math Ability was not related to success for 2-year Engineering students, and only marginally related to success for 4-year Engineering students. For 4-year Business majors, Math Ability was strongly related to success (r = .52). All in all, success within each major was associated with a unique pattern of interest and personality variables.
The final set of analyses entered the most potent predictor variables identified above into discriminant functions to try to predict whether a student would fall into the above average or below average subgroup within his or her major. Using such a function, 82.4% of the 2-year Engineering students were correctly identified, and 93.3% of the 4-year Engineering students were correctly identified.

DISCUSSION

The discussion below is divided into three parts. First we discuss the implications of the present findings. Second, we point out some of the limitations of the present study. Finally, we describe our proposed follow-up research.

We think that the kind of research described in this report has enormous implications for counseling students about a choice of major. A student may be very bright (in the sense of having high SAT scores) yet be very uncertain about a choice of college major. The solution to such a student's dilemma would be to administer an inventory of nonintellectual traits and to compare the student's responses to the profile of successful students within each major. One could tell the student, "Your personality resembles that of the successful 2-year Engineer, but not that of a successful physicist. Therefore, chances are that 2-year Engineering is a good choice." Currently, vocational interest inventories are used to determine whether a student resembles a "typical" engineer, physicist, etc. We think it would be more useful for a student to know whether he or she resembles a successful student in that field.

The current study suggests that some fine distinctions about choice of major can be made on the basis of personality and interest scores. Successful 2-year Engineering students are planful, calm, appearance-conscious, conventional, and non-competitive. In contrast, successful 4-year Engineering students are confident, competitive, excitement-seeking, and have a strong sense of identity. Armed with this knowledge, an advisor can more easily make suggestions to a student who is uncertain about whether to enroll in a 2- or 4-year program.

The present study has some obvious limitations. The sample size is small, particularly when we get down to the level of different majors. All of the results reported here are statistically significant (ps less than .10), but the small sample size decreases our confidence in the results. The obvious solution is to replicate the study several times. That is what in fact we are planning to do.

A second problem is that the study is not "predictive" in the strict sense of the word. All of the data were gathered at one point in time—at the end of the students' second year. What we are doing presently is collecting the predictor variable information for each class as they first enroll, and then waiting for two years to collect the success data.

Another problem is that we couldn't compare the predictive strength of intellectual and nonintellectual measures. This can be corrected in the future by including SAT scores and high school grade point average in the predictor set.
As indicated above, part of our proposed future research is to replicate the present study several times while strengthening the design. A related future project is to determine the predictive validity of a test administered as part of the National Engineering Aptitude Search (NEAS). The NEAS test, designed by the Junior Engineering Technical Society (JETS) and the American College Testing Program, assesses students interests, background experiences, and aptitude in the areas of mathematics, science reading, and mechanical reasoning (ACT, 1982).

Presently, interpretation of NEAS test scores is limited to comparing a student's three aptitude scores against age norms and to conjuring up an intuitive feeling, based on the interest and background items, about the degree of fit between an individual's personality and the requirements of a college engineering program. To date there is no published information on the predictive validity of any part of the NEAS test.

Our plan is to contact by mail 162 students who took the NEAS test last year and to ask them to complete a short questionnaire about academic success and satisfaction. The questionnaire is nearly identical to the section of the questionnaire assessing success in the study described in this report. The NEAS test item responses will be retrieved from ACT, and the background and interest items will be grouped into scales where possible. Some of the scales will reflect themes identified as important in the present study. Success scores will be regressed on the nonintellectual scores and aptitude scores. Such an analysis will help determine the unique contribution of nonintellectual and intellectual factors to academic success. If this proposed study goes well, we plan a replication at the state and perhaps the national level.

REFERENCES


