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ABSTRACT

The problem of the extremely small number of scientists coming from the ethnic minority groups is of interest because of current social, moral, and ethical standards. The more recent development in federal funding requires institutions to show affirmative action accounts for the demand for scientists from minority groups. Considerable attention has been paid to the problems of minority student enrollment in higher education during the past decade; the purpose of this study was to investigate the reasons of minority underrepresentation in the scientific field, focusing primarily on the multitude of variables contributing to this phenomenon in higher education today. A 92-item career choice questionnaire was developed and administered to 474 juniors and seniors at Wayne State University in Michigan. Results of the study are reported and interpreted. Recommendations for further study are included. (Author/RH)

Minority Groups and Science Careers

An Ecological Analysis[1]

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Introduction

The purpose of this study which was supported by a grant from the National Science Foundation, was to investigate the reasons underlying the under-representation of minority groups in scientific fields. This study focused primarily on the multitude of variables contributing to the development of career decisions during the college years.

Although considerable theory and research are available on career development, much of the variance on career decision-making is still unaccounted for. Inasmuch as the overwhelming majority of high school graduates change career choices made while in high school, it is reasonable to hypothesize that events during the years between high school graduation and eventual career decision play an important role in these career shifts. Thus, the study of the post-secondary school years is of importance in understanding the total career development process.

The problem of the extremely small number of scientists coming from the ethnic-minority groups is of interest because of current social, moral and ethical standards as well as from the point of view of career development research. The recent development in federal funding, which requires institutions to show through affirmative action that they are equal opportunity employers also accounts for the demand for scientists who are members of certain racial and ethnic minority groups.

Considerable attention has been paid to the problems of minority student enrollment in higher education during the past decade. Research in this area has studied both undergraduate and graduate populations. A survey conducted by El-Khawas and Kinzer in 1974 showed that students from minority backgrounds - Blacks, Spanish-surnamed, Asian Americans, and American Indians represented about 7.2 percent of the total graduate enrollment at Ph.D. granting institutions sampled. The largest percentages of total graduate student enrollment are in the fields of education (25.9%), arts and humanities (14.5%), and basic social sciences (9.5%). The only exception to this pattern of distribution is the Asian American group. The percentages of black students in the fields of engineering, life sciences, physical sciences, and mathematics were all lower than those reported for the other minority groups. Tables I and II contain the number and percentages.

Wilbur (1974) presented additional data to support the view that blacks are under-represented in the sciences. Carmondy, Ienske and Scott showed in their study that 57 percent of the males and 41 percent of the females who had selected science as their major fields in college remained in science two years later. Project TALENT surveyed the career plans of the welfth grade males five years after their high school graduation. The results showed that 81.4 percent of the group sampled were no longer pursuing the same career as they had planned as high school seniors (Flanagan and Jung, 1971).

During the high school years, students seem to engage in a sorting, sifting, and floundering process which generally results in a shift "out" of science (H.S. Astin, 1967; Cooley, 196 , 1966: Flanagan, 1966). This process tends to continue during the ear y college years, with more students shifting "out" of science programs than shifting "in" (Reves, 1973).

TABLE I*

Fall 1973 Enrollment of Minority Graduate Students:[1]
Percentage Distributions by Field of Study

Field of Study[2]	Total Enrollment	Minority Enrollment			
		Black	Spanish-Surnamed	American Indian	Asian American
Arts & Humanities	14.5	9.3	19.9	13.9	9.5
Education	25.9	43.0	27.9	32.5	11.6
Engineering	8.4	2.3	6.6	3.1	20.1
Health Professions	3.6	4.5	4.1	6.4	5.1
Life Sciences	7.4	2.6	6.2	5.3	10.2
Biology	(1.4)	(0.8)	(0.9)	(0.3)	(1.7)
Biochemistry	(0.5)	(0.1)	(0.2)	(0.4)	(1.1)
Microbiology	(0.5)	(0.2)	(0.4)	(0.5)	(1.1)
Physiology	(0.3)	(0.1)	(0.3)	(0.3)	(0.4)
Other	(4.2)	(1.2)	(3.6)	(2.9)	(5.0)
Mathematical Sciences	3.3	1.9	2.0	2.0	5.2
Physical Sciences	5.8	1.8	3.5	4.2	11.1
Chemistry	(2.2)	(0.8)	(1.3)	(1.3)	(5.0)
Physics	(1.5)	(0.4)	(0.8)	(1.0)	(3.3)
Other	(1.8)	(0.5)	(1.1)	(0.9)	(1.9)
Basic Social Sciences	9.5	9.1	10.7	9.3	7.5
Economics	(1.6)	(0.7)	(1.2)	(1.3)	(1.8)
Psychology	(2.8)	(2.7)	(3.0)	(2.5)	(1.7)
Sociology	(1.2)	(1.6)	(2.2)	(0.9)	(1.2)
Other Basic Social Sciences	(3.5)	(3.7)	(4.1)	(4.2)	(2.6)
All Other Fields	21.6	25.5	19.3	23.4	19.7
Total, All Fields	100.0	100.0	100.0	100.0	100.0

[1]Based on data from 154 institutions able to provide minority enrollment data within field of study

[2]Figures in parentheses sum to less than their respective subtotals because some institutions could report only for the total field category but not for subfields.

*Quoted from El-Khawas and Kinzer, 1974.

TABLE 2*

Fall 1973 Enrollment of Minority Graduate Students:[1]

Number In Each Field of Study

Field of Study[2]	Total Enrollment	Minority Enrollment			
		Black	Spanish-Surnamed	American Indian	Asian American
Arts and Humanities	53,920	1,516	794	164	484
Education	96,568	6,990	1,113	384	587
Engineering	31,273	368	253	37	1,020
Health Professions	13,238	727	164	76	260
Life Sciences	27,641	419	247	62	519
Biology	(5,027)	(130)	(34)	(4)	(84)
Biochemistry	(1,804)	(22)	(11)	(5)	(57)
Microbiology	(1,801)	(33)	(17)	(6)	(57)
Physiology	(1,110)	(17)	(10)	(3)	(22)
Other	(15,504)	(191)	(145)	(34)	(253)
Mathematical Sciences	12,446	305	78	23	262
Physical Sciences	21,629	299	140	49	565
Chemistry	(8,040)	(129)	(53)	(15)	(253)
Physics	(5,559)	(68)	(31)	(12)	(169)
Other	(6,560)	(78)	(44)	(10)	(98)
Basic Social Sciences	35,583	1,471	426	110	380
Economics	(5,766)	(109)	(47)	(15)	(92)
Psychology	(10,318)	(435)	(121)	(30)	(87)
Sociology	(4,566)	(263)	(89)	(10)	(61)
Other Basic Social Sciences	(12,969)	(592)	(163)	(49)	(130)
All Other Fields	80,666	4,146	769	276	999
Total, All Fields	372,964	16,241	3,994	1,181	5,076

[1]Based on data from 154 institutions able to provide minority enrollment data within field of study.

[2]Figures in parentheses sum to less than their respective subtotals because some institutions could report data only for the total field category but not for subfields.

*Quoted from El Khawas and Kinzer, 1974.

The research methodology deals with the development of the questionnaire as survey instrument, the sample used in this study, analysis of the data, and the characteristics of Wayne State University as a unique ecological setting.

Questions on the 92-item career choice questionnaire is made up of four sections: 1) students' college experience, 2) factors influencing students' career selection, 3) family background factors and the elementary and high school years, and 4) student biographical data.

The construction of the survey instrument was based on theory and research in career development and the general goals of this study. The questionnaire required 45 minutes for completion and yielded 229 variables.

The sample was comprised of 474 juniors and seniors at Wayne State University in seven disciplines; physical science, life science, engineering, social science, humanities, education and business. The population was further subdivided into eight groups for data analysis based on sex, race and major field of study.

Wayne State University is an urban university located in the city of Detroit. It ranks 24th in the nation in terms of total enrollment (approximately 60,000 students) and has the highest percentage of black students enrolled in the university of any non-black university in the country (approximately 20%). Wayne's recognition of minority students a generation ago has made it possible for college-educated minority students to play a major role in education, city government and the professions in the city of Detroit as well as the densely populated county area of industrial southeastern Michigan.

Some of the results showed that the great majority of Wayne State University students come from working class families, and more than half of the full-time students were gainfully employed, either on a part-time or full-time basis. The black students have less favorable home environments than their white counterparts. The black and female students felt most discriminated against by their professors and administrators. At times, the black science majors also showed more feelings of discrimination from secretaries and fellow students. Approximately half of the students surveyed expressed a feeling of uncertainty about the future. Black students were more concerned about security, and the feeling of insecurity was most pronounced among the black female science majors.

Student evaluation of their teachers revealed that teaching was viewed as largely satisfactory. Services provided by the administration were rated relatively low. In the area of interpersonal relationship with faculty, non-science people fared better than the science people. Within the science group, the black students are the least contented subgroup in terms of interpersonal relationship with their faculty. However, a strong and congenial relationship existed among fellow students.

In terms of academic preparation and achievement, the white female science majors were rated high whereas black science males received the lowest grades. In terms of aspiration of advanced study, the white female non-science majors ranked lowest. The overall results indicated that the selection of a particular major was largely a function of interest in a particular subject matter.

The educational importance of this study is manifold. It presented a comprehensive review of career development and ecological theory, problems and possible solutions concerning survey studies in higher education, implementation of the findings of the study and recommendations for facilitation of future research studies. For example, based on the findings, the authors recommended the study of factors involved in junior college settings that influence later major selection in urban universities.

The study pointed out the need to examine the antecedents and temporal determinants of subject matter interest which played a key role in major selection. The study also pointed out the importance of recruitmentefforts of college faculty, science programs in the high school years, high school science curriculum reform, career guidance and counseling program, involvement of the home and parents of high school students and the need for improved relationship between students and faculty in the universities.

Summary of Results

In order to obtain data relevant to the major questions of this study a questionnaire was developed and administered to Wayne State University junior and senior undergraduate students. This questionnaire contained 92 questions, required approximately 45 minutes to complete and yielded 229 variables. Descriptive data were presented by sex, race, and science and non-science categories.

The results of this study indicated that:

1) Wayne State University students were older than the average college population, and that most were unmarried and without dependents. Although most were full-time students, more than half were gainfully employed, either on a part-time or full-time basis.

2) A significant number of students attended junior or community colleges before transferring to Wayne. More white than black students support their college education through work and family assistance. More black than white students were on financial assistance through loans and scholarships. White science majors had the highest grade point averages as college freshmen.

3) Most of the white students were either born in Detroit or in Michigan; whereas, nearly half of the black students were born in the South.

4) Parental educational level varied by race, with the parents of white students being generally better educated than the parents of black students. The students' grandparents had less education than the parents, most had elementary or junior high school educations, and very few went beyond high school.

5) Although students at Wayne State University clearly came from working class families, the white students tended to come from relatively

higher income level families than the black students. Black students were more apt to have either "both parents" or "mother only" working than the white students.

6) Home environment was fairly stable for all students. There was and increase of widowed parents as students entered high school, and twice as many black students reported parental widowed status than whites.

7) Generally, female students read more than male students, and white students read more than black students. The white students made more visits to the library.

8) White families tended to be patriarchal and black families tended to be matriarchal.

9) Students generally received little help in terms of advisement and career information prior to entering college. Most took college preparatory courses of study. More of the non-science black students took general or business math in high school.

10) High school science and math preparation played an interesting role in the choice of a major. Female science majors were high achievers and black science males received the losest grades. White female non-science majors also achieved high grade point averages while in high school.

11) In analyzing factors influencing career choice and the selection of majors, it was found that, in most instances, students at Wayne State University received help from advisers and friends and other faculty members while in college.

12) Almost all students felt that an occupation should be satisfying to themselves first, spouse and children nest, and parents last. Most consider "interesting work" as a single most important factor in

choosing a major. Security for self and family, income, and contribution to society ranked next in importance. Personal prestige was ranked as least important.

13) Black students were more concerned about security and were less desirous of working with large groups of people than the white students.

14) Personal preference and enjoyment of the subject matter was a paramount importance for all students. "Getting a good job" was also an important consideration in the selection of a major.

15) Parents, high school teachers, college friends, college counsellors and faculty all play a role in helping the individual students in reaching a decision on a major.

16) About half of the students surveyed indicated a change of major while in college. The white male science majors were the most stable group, with 71 percent of them staying with their original choice, and, they were most likely to be more satisfied with their choice.

17) It was found that the difficulty level of the subject matter and convenience of scheduling had little influence on the choice of majors; nor were racial composition of the student body and faculty relevant factors. All groups, except white science majors, expressed some uncertainty about their majors.

18) Non-science white males tended to aspire to enter law and business schools for graduate degrees. Science majors tended to aim for medical and dental schools. Many of them intended to pursue graduate studies, with one apparent exception, and that was the white female non-science major group.

19) Students were asked to rate the various majors and subject matters according to difficulty level and degree of enjoyment. Students generally rated physical science, life science, and engineering as being

difficult, and social science, business, sociology and social work, and the humanities as being less rigorous in nature. Among the science majors, physical science was perceived as being the most difficult major. Among the non-science majors, business was seen as the most challenging as compared with social sciences and humanities.

20) The student evaluation of their teachers revealed that teaching was viewed as largely satisfactory. Services provided by the administration were rated relatively low. Furthermore, a sizable portion of the students expressed dissatisfaction toward the administration.

21) In the area of interpersonal relationships with faculty, non-science people fared better than the science people. Within the science group, the black students are the least contented subgroup in terms of interpersonal relationships with their faculty. However, a strong and congenial relationship existed among fellow students.

22) On the topic of discrimination, the black and female students felt most discriminated against by their professors and administrators. At times the black science majors also showed more feelings of discrimination from secretaries and fellow students.

23) Approximately half of the students surveyed expressed a feeling of undertainty about the future, and, this insecure feeling was most pronounced among the black female science majors. Conversely, white non-science females felt most confident in this respect.

24) Most of the students seemed to believe in planning ahead, particularly the black science majors. On the other hand, 27 percent of the non-science white students felt that life was too much a matter of luck to plan ahead too far. Half reported that they had to change plans as a result of things not working out as expected. Overall results showed that white female science majors represented the more

confident and self-assured group. On the other extreme lies the black female science majors who, at times, seemed to feel few things worked out for them. Most of the students felt that they could pretty much manage their own affairs. Only 17 percent of the black female science majors felt that the problems of life were sometimes too big for them. As a general conclusion after examining all of the data on the 229 variables the results revealed a surprising lack of differentiation between any of the subgroups in the sample. For the most part, the results did not clearly illustrate any differences between the groups in family background, motivation, or attitudes and experiences within the university. While there were some questions on which some differences could be discerned, the most general finding applying to the most students was that students at Wayne State University decided to attend a university for largely vocational reasons and that once having done so decided to attend Wayne State University for financial reasons. Selection of a particular major was largely a function of interest in a particular subject matter. These general findings seem to apply to both black and white students, males and females and both science and non-science majors.

Discussion

There were considerable difficulties encountered in obtaining the desired sample size (150) for each sub-group, particularly among the black subgroups. The lack of cooperation of the science faculty members was surprising, considering the nature of the study and the racial composition at Wayne State University. It was also disappointing to find the various black fraternities, sororities and other organizations often less than willing to cooperate.

There seemed to be a reticence among the black students in regard to participating in the study. This reticence can be attributed to several

factors. Many minority group members, particularly Blacks, have been tested, retested, and overtested during the course of their school years. This testing has been done by school systems as well as by outside researchers. Many students have satiated on such testing and questioning, particularly when their minority group membership is a crucial variable. A general distrust of scientific inquiry into racially based studies makes it extremely difficult to collect the necessary data.

Many science faculty members whose classes were sought as sources of participants refused to give up even the five minutes of their class time necessary to explain and distribute the questionnaire. It should be noted here that Wayne State University is on an eleven week quarter system and class time is frequently at a premium. It was also disconcerting that in one instance a college "research committee" never got around to approving the questionnaire for distribution to their students.

With the various difficulties in obtaining questionnaire data, the total sample (N = 474) was considerably smaller than desired. To further compound this problem, the two smallest samples (N = 12) were in each of the black science major subgroups. The small sample sizes precluded to use of a number of multivariate statistical techniques originally proposed. It was thought then, that descriptive techniques would lead to clearer explanations and less distortion of the data set. Table 3 contains some recent figures of minority enrollments in science and technical fields at Wayne State University.

The general trend that permeates the questionnaire data is that there was little variability between groups on most of the variables considered. When differences did exist, they tended to be black-white differences or male-female differences as opposed to science-non-science differences. The sample was much more homogenous than expected.

Consider the variable of Freshman Grade Point Average (GPA). The

Table 3

Minority Enrollments in Science & Technical Fields
Wayne State University
Fall Quarter, 1976
(Self-Reported Sample Data)

HEGIS CATEGORY	ENROLLMENT STATUS	BLACK		AMERICAN/INDIAN ASIAN & HISPANIC		ALL STUDENTS	
		UNDERGRADUATE	GRADUATE	UNDERGRADUATE	GRADUATE	UNDERGRADUATE	GRADUATE
BIOLOGY	Full-Tire	34	6	10	9	316	191
	Total	68	12	15	16	461	293
COMPUTER SCIENCE	Full-Time	6	3	1	7	52	48
	Total	9	5	3	11	89	82
ENGINEERING	Full-Time	90	10	41	32	645	164
	Total	177	19	73	56	1125	304
MATHEMATICS	Full-Time	2	1	0	4	22	28
	Total	2	5	2	8	40	65
PHYSICAL SCIENCES	Full-Time	7	7	2	22	113	106
	Total	120	9	5	27	185	143
TOTAL UNIVERSITY	Full-Time	3675	560	631	197	14628	3338
	Total	5728	1097	905	356	21119	6723

Excerpted from the Fall, 1976 Ethnic Enrollment Report, Office of Academic Programs and Planning, Mr. Robert J. Knezek.

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percentage of students with a 3.0 or greater freshman GPA by groups - Science White Male (SWM), Science White Female (SWF), Science Black Male (SBM), Science Black Female (SBF), Non-Science White Male (NSWM), Non-Science White Female (NSWF), Non-Science Black Male (NSBM), Non-Science Black Female (NSBF) - are: 60.5 percent, 62.9 percent, 33.3 percent, 50.0 percent, 37.9 percent, 65.0 percent, 26.1 percent, and 37.5 percent respectively. This data indicates that white female students have the highest percentage of students at 3.0 or above. The SWM group have higher GPA's than their non-science counterparts, but SWF and NSWF have similar GPA's as do SBM and NSBM. There are clearcut differences in GPA only with the SWM vs. NSWM, and it is difficult to determine whether these differences are due to intellectual ability or to courses selected as freshmen. Another consideration is that many of the non-science students attended a jurior college before coming to Wayne State.

It should be noted here that a majority of the students sampled indicated financial reasons for attending Wayne State University. Wayne State is predominantly a commuter college and room and board expenses are thus avoided. Researchers have indicated that socio-economic status (SES) may, in fact, be a crucial factor in determining science vs. non-science career choices. Although differences were found in economic level (during the secondary school years) with the white students tending to come from families of a higher income level, these differences may not be true socio-economic differences. The majority of all students ampled indicate family incomes of between $8,000 and $20,000 per year. Thus, most Wayne State students are coming from middle income families.

The black male students came from families with lower incomes, but this was the case for both the NSBM and SBM groups. That is to say,

that between majors there was no difference in the SES, so, for our sample these SES differences did not differentiate career choices.

In general, Wayne State undergraduate students were older than the average college population. Most of them were unmarried. Although most were full-time students, more than half were employed on either a full or part-time basis. More white than black students supported their college education through work and family assistance. More black students received their financial assistance through scholarships and loans.

The white students had better educated parents than did the black students. Fifty to seventy-five percent of the sample were either first or second born in the family. Once again it should be pointed out that these differences do not distinguish between the science and the non-science students.

In terms of high school preparation, it appears that most students received little if any career education prior to entering college. More than 80 percent of the white students and over 50 percent of the black students took college prep curricula during high school with the SWF group having 97.3 percent in a college preparatory curriculum. More black than white students were enrolled in a general course of study.

Mathematics background is considered by some to be an important prerequisite to science careers. More than 40 percent of the non-science black male group took general or business math during high school. The science majors took more math courses in high school than did the non-science majors. The exceptions to this finding were the non-science white male and the science black female groups. The non-science white male group had a math background comparable to the science groups. The black science female group seemed to have little background in algebra

during high school. This group in general tended to deviate from the other science groups on many variables. Within the science groups the females had more geometry than the males.

Math background did seem to play a role in distinguishing between science and non-science majors, but even within the science groups there were differences in the type of math background. While the math background was important, causality certainly cannot be implied. The question that remains to be answered with respect to this variable is whether people who have some proclivity towards science careers take more math or whether taking more mathematics leads people into the sciences.

White female science majors tended to do more non-required reading than all groups while the black male science majors did the least reading. Once again we are confronted by the extremes of a variable both being in the sciences. Over 70 percent of the white science majors felt their high school training was adequate while less than 50 percent of the black science majors did. Approximately 55 percent of the non-science majors felt that their high school training was adequate.

Obviously, the adequacy of training in high school is an important factor in later major selection and success. It was beyond the scope of the present investigation to determine the inadequacies in the high school preparation of the students sampled. Whether the student perceived inadequacies as a function of course offerings, lack of advisement, poor teaching, etc. is not known. It seems reasonable to assume that with inadequate science or math courses in secondary schools, students are not going to become excited about the sciences.

The majority of black students sampled went to high school in Detroit. Interestingly enough, of the 24 black science majors, 13 went to Cass Technical High School (where science is a strong point). It is not

known whether these students developed their interest in science at Cass Tech or whether they chose Cass Tech because of their interest in science.

Most of the white science majors went to high schools outside the city of Detroit. An analysis of this data indicated that nor more than three white science majors sampled came from any one high school, thus diminishing the probable effect of a "high school" variable on the selection of a major for the shite science students.

Because of the necessary requisite skills, science majors should receive a good high school background in both science and math courses. It is difficult to explain why someone without these skills and background experiences chose a science major, as in the case of a number of the science majors sampled.

With respect to high school grade point averages, the white female group outperformed all other groups with the black males showing the lowest levels of academic performance. These findings did not differentiate between science and non-science majors.

Most students indicated that their career information came from either friends or their college adviser. Others indicated that they received such information from faculty members teaching various college courses. The college adviser is generally the main source for career information (for all groups). It should be considered here that the student obtains an adviser after he or she has selected a particular discipline. Thus, this adviser is probably not the person responsible for aiding the student in the selection of a major.

In considering the factors involved in career selection, most students felt that an occupation should be, first, satisfying to themselves; second, satisfying to their spouse, and lastly, satisfying to their parents. This was the case regardless of whether the student was a science or a non-science major.

In selecting a major, most students considered "interesting work" as the single most important factor. Interest in subject matter was an important factor for almost all students sampled, both science and non-science majors. The questionnaire, unfortunately, did not get at the source of this interest. Security for self and family was also considered important by most students. Black students indicated a greater concern for future security than did the white students. Enjoyment of the subject matter was also a strong concern of all students in terms of major selection as was getting a good job.

Interestingly enough, the difficulty level of the subject matter and convenience of scheduling had little importance in major selection. Racial composition of the students and faculty also did not seem to play a role in major selection.

About one-half of the students surveyed indicated that they had changed their major since entering Wayne. The science white male group was the most "stable" group; 71 percent of them stayed with their original major selection; and they were most likely to be satisfied with their major.

Many science majors surveyed aspired for later enterance into medical and dental schools. The non-science white males plan, in many instances, to enter either law schools or business schools. Many of the students indicated plans for graduate studies in their fields with the exception of the non-science white females. This was surprising considering the high academic levels of this group.

Students were asked to rate the various majors and subject matters according to difficulty level and degree of enjoyment. Students generally rated physical science, life science, and engineering as being difficult, and social science, business, sociology, and social work as being less

rigorous in nature. Science majors tend to prefer the physical sciences, biological sciences and math to a high degree and languages and English literature to a lesser degree. Non-science majors tend to prefer courses in psychology, and speech as well as English and non-science subjects.

While most students seemed satisfied with the quality of the teaching in their major field, many students felt that the administration and the administrative services were less than adequate. The non-science majors were more satisfied with the quality of their interpersonal relationships with their faculty than were the science majors. Within the sciences, the black students were the least contented about their interpersonal relationships with the faculty. Most students indicated a good relationship with their fellow students. The questionnaire used does not consider the specific flaws with the administration and the administrative services which cause the dissatisfaction. It is then difficult to assess what the problem is in such instances.

While most students used the "grapevine" on occasion in selecting the faculty and courses they will take, the black students were more frequent users of the grapevine. More black students felt discriminated against than did white students. This could account for using the grapevine. Black science majors felt the greatest amount of discrimination. Whether or not this discrimination exists or is just perceived is not known. In either case it could affect a student's major selection or course selection within a given major. Most students who said that they had encountered discrimination responded that the professors were doing the discriminating, followed by the administrators.

When discrimination was experienced, it was most likely to be felt by the black students and the women. Black male science majors and black female non-science majors were the most likely groups to have experienced

some discrimination with over 50 percent and 44 percent respectively indicating some discrimination. The discrimination encountered was often contended with by the students avoiding a particular professor.

Although half of the students sampled expressed a degree of uncertainty about their future, this insecurity was most prevalent among the black female science majors. Conversely, the white female non-science majors were the most confident group. Almost 20 percent of the black female science majors felt that the problems of life were sometimes too big for them.

It is hard to account for major selection on the basis of the data collected. Over and over the differences, where they existed, were black-white. With the exception of plans for future graduate study, the white female groups look the same on almost every variable. They appear to be the best group as a shole in terms of academic performance, both in high school and in college. They are the most secure group, coming from higher income homes, with better educated parents. Why a white female student either selects or does not select the sciences is not answered by the present data. There are just not enough differences between the science and non-science groups. For the most part, the black male science and black male non-science majors show little differences in background, academic grades, and experiences. In three instances the high school attended apparently played a role, but, for the most part, the critical factors involved in their career choice are unknown.

As mentioned earlier, the lack of variability in questionnaire response both between and within groups was surprising. If it had been possible to attain a larger sample, the variability problems might not have been as great. It should be noted here that a large number of

correlations (over 10,000) were computed for many of the variables being studied. Since correlation considers concommitant variability and the variances were small, most of the correlations could not add to the explanations of the data and, in many cases, would have led to obfuscation of the data.

Limitations

There are a number of limitations that should be considered in evaluating the results of the present study. Some of these limitations are specific to the present study, while others are common to most studies using questionnaire data.

1) The sample size (N = 474) was not as large as the researchers would have preferred. The sample size among the black male science majors (N = 12) and the black female science majors (N = 12) were particularly low. There was a general reluctance among minority group members to participate in the study as well as a reluctance on the part of many science faculty members to elicit the participation of their students. This fact decreased the sample size of the various groups and decreases the generalizability of the findings.

2) All of the subjects in this study were volunteers, and thus, may not be truly representative of the sub-groups they represent.

3) Due to the voluntary nature of the participation in the study, the sample is not totally random.

4) There was a particularly high divorce rate among the black female science majors sampled. This leads to questions as to whether or not they were representative of their sub-group.

5) In reviewing the data, it was found that between 40-50 percent of the sample had attended junior college. This factor may confound the "major" change variables among those sampled.

6) Some variables which might have discriminated black from white, and science from non-science, were not sampled by the questionnaire. These variables were not excluded by choice of the experimenters but, just may not have been included.

7) With any self-report information, there is a possibility of falsification of the answers by those sampled to make their choices more socially acceptable. While any questionable questionnaires were excluded, there is always some question as to the veracity of all of the responses.

Recommendations

The recommendations can be grouped into three general areas: Recommendations for facilitation of future research, recommendations for topics of future research, and recommendations for implementation of the findings of the present study.

1) Because of the difficulty encountered in gaining the cooperation of science faculty members in regard to their asking their students to participate in this study, it is suggested that more support should come directly from the National Science Foundation (NSF). This support could take the form of a letter from NSF requesting aid from the faculty in distribution of the questionnaires, and collection of the data.

2) The sample size of a questionnaire study can probably be increased significantly by using some incentive for subject participation. His incentive might take the form of payment (e.g. $5.00) for filling out the questionnaire. It is suggested that future researchers consider such incentives.

3) Research studies should be imitated to study the factors involved in junior college settings that influence later major selection in four

year colleges and universities. The data indicated that 40-50 percent of the students had attended junior college. The Detroit area is not the only one where junior colleges act as feeders into four year institutions (e.g. California).

4) Interest in a particular subject area seems to play an important role in major selection. Research projects should be initiated to examine the antecedents and temporal determinants of subject matter interest. Such research should consider both school and home settings.

5) Monies should be spent to supply junior colleges and urban high schools with some of the scientific facilities and apparatus available at most four year colleges.

6) Very few students in the present study were actively recruited into their present major. Support for active recruitment of minority group members should be initiated particularly in urban institutions. This support could take the form of special grant funds or minority scholarships and fellowships in the sciences.

7) The present study points out a possible flaw in advisement of students, i.e. the student does not get a faculty advisor until he has selected a major. It is suggested that additional counseling be implemented as early as junior high school and continued through the college leve.

8) More resources and research efforts should be directed to high schools such as Cass Technical High School (Detroit), with strong science programs. Funds to strengthen science programs at other high schools should also be made available.

9) It is recommended that special science projects be conducted by junior and senior high school teachers to stimulate interest in the

sciences. Students must be exposed to the sciences before they can develop an interest in them. Perhaps a PBS television series dealing with the various sciences should be produced to spark the interest in science of even younger children.

10) Evidence seemed to indicate that the science majors had college preparatory courses of study in high school. They also had better preparation in the area of mathematics. It is suggested that students, particularly minority students, ought to receive more guidance in scheduling. Without the appropriate background in mathematics (i.e. Algebra and geometry as opposed to business math courses), students are unlikely to have the requisite skills necessary to select and succeed in a science major.

11) It was found that most students receive career information from their major advisers. It is felt that information on a wide range of careers be made available to the student prior to entering a specific discipline. It is strongly recommended that career information be made an integral part of the total educational program both at the secondary school level and during the first two years of college. More articulation between the high schools and the colleges is necessary to aid in the advising and career education of the students.

12) It is also recommended that programs be established to give career information to the parents of high school students as they are often instrumental in the selection of a particular major.

13) College administrators and professors are often times perceived by minority and female students as being discriminating. At times science students avoid particular courses because of this perceived discrimination. These factors seem to point to the need for improved

relationships between students, faculty, and administration. Whether the discrimination is real or imagined, it is a relavent issue that requires further study.

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