A STUDY OF INFLUENCES ON THE CHOICE OF MATHEMATICS OR MATHEMATICS EDUCATION AS AN UNDERGRADUATE MAJOR

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CHAPTER I

INTRODUCTION

This study was concerned with the problem of identifying the existence of, or the lack of existence of, a pattern of influences on the choice of mathematics as an undergraduate major. This problem is one of many problems associated with the exploding age of technology and the resultant urgent need for more scientists. Focus is upon the source of one type of scientific personnel necessary for continued national growth. The type referred to is mathematicians. Future mathematicians and mathematics teachers are among the urgently needed. The "sputnik spurt," the reaction to our evident lag in initial space explorations, was reflected in the growing awareness of society concerning the desirability of more mathematicians along with more engineers, physicists, chemists, etc. And in Oklahoma, specifically at Oklahoma State University, a fact worth noting is the increase in the number of bachelors degrees in mathematics conferred over the years 1957-58 and 1958-59. This was an increase from 19 to 37 (15, 16), nearly 100%, while the percent increase in enrollment in the University was but a small fraction of this. Consequently, this suggests there could be reasons other than the rapidly increasing student population causing students to choose to major in mathematics. This study was an investigation of some of these reasons.

The Problem

Is there a characteristic pattern of influences affecting the choice of mathematics as an undergraduate major?

The Need For This Study

There is accumulating, in studies on college graduates, evidence of the undergraduate's choice of major being a very important factor in final career choice. While many undergraduate students give serious thought to this decision, there are many who are allowed to choose a major with little sound expectancy of successful completion of the requirements involved. As an example of studies related to this problem, one may refer to an article, "Changes of Majors by University Students," by Rowland R. Pierson (33). This was a report on a study of the responses of 403 seniors scheduled to graduate with majors other than those originally selected. These students were in the Class of 1958 at Michigan State University. They represented approximately 55% of the number of possible respondents. Pierson's article is referred to also because of an inherent limitation in his study of the same type present in this study. That is, the student's ability to accurately recall the reasons, real or imagined, for his choice.

In this article Pierson (33, p. 459) observes,

> In reference to the seriousness with which the subjects made their original choices, it is clear that a sizeable majority felt that they were conscientious about this step. However, the fact that almost half admitted that their choices were only tentative suggests the presence of weaknesses in their decision making abilities or inadequacies in the assistance that they received from others.

Also found in the literature are follow-up type studies wherein different groups have been subjected to questionnaires for the purpose

of determining if they are presently employed in a job directly related to their final major in college.

The considerable cost in time and money involved in obtaining a bachelors degree as preparation for a vocation would imply to the efficiency-minded individual a definite need to avoid changes in major. It was felt that the group of students under consideration in this study would possess this characteristic inefficiency to a large degree. This was also implied in a statement by Everett W. Stephens in an article in the February 1962 issue of the Journal of College Placement (46, p. 73). He states,

> Unfortunately, study after study has revealed that our traditional higher education has produced too large a number of College Joes who neither understand themselves nor the world of work well enough to make adequate vocational or community responses.

Aside from the practical, vocational-minded side of this topic, the person whose leanings are toward the liberally educated graduate as most important should concede that once a major is chosen there is implied a specific type of preparation whether the major is restrictive or broad in scope. The practicalities are that no matter how real, sincere or deep the reasons for a particular choice of major, the evidence is mounting that the choice of major and the job one will take are related. Materialistic values being as they are in our society implies there will continue to be a service of vocation-preparation expected of most colleges and universities. Thus, in one sense, it is a disservice to students to allow inefficient use of their time in college. When it is at all possible to detect an area of specialization for the student which could produce a good chance of providing preparation for a satisfying, rewarding career, this should be done. Thus there should

be a continual probing of the areas of identification of talent, of recognition, of poor choices of endeavor, and of proper counseling techniques to take advantage of that knowledge. This study is an attempt to contribute to the fundamental question, how to make better use of the potential of our human resources?

CHAPTER II

REVIEW OF LITERATURE

While much of the published work in the area of career choice has been summarized and analyzed by different persons, the most often quoted source noted in this author's review of the literature was probably that done by Anne Roe (40). In concentrating on the literature concerning influences on the decision of choosing a major in college, the remarks made by Roe are pertinent, as are many others.

In 1937 Sparling (45, p. 39) stated, "In the average the students choose their vocations at the age of sixteen . . . only one person in three retained his original choice of vocation."

In 1946 Korner (26, p. 329) points out, "It is a well established fact that vocational choice often is made in answer to a basic personal need within the individual or is imposed by others and incorporated by the individual."

C. H. Patterson (32, p. 388) also pointed out the inefficient utilizations of knowledge about career choice when he wrote,

> The external influences in the choice of an occupation are given too little consideration in most theories of vocational choice. Family influences are recognized but the wider influences of the socio-economic level of the individual, as well as the general cultural characteristics of the community and the society and nation, and of religion are underemphasized. Limitations of occupational opportunities and of the opportunity to prepare for certain occupations, result in many forced choices of occupations.

Since 1937 there has occurred in the literature writings similar

to the above indicating concern for the lack of utilization of available information pertinent to the problem of choosing a vocation or a career. Furthermore there occurs also in the literature evidence of the acceptance of college as career preparation, of the practical uses made of the skills and knowledge obtainable in college.

Dyer (13, p. 282) reported,

> The evidence in these 89 cases indicated that college work does prepare for the vocation followed for ten years after graduation in more than seventy percent of the cases. Here is impressive evidence that a college education and all that term implies is truly a preparation for life, at least in the area of vocational adjustment.

This was based on the study of cases which had been followed from 1924 to 1935.

And a more recent study of a much larger group of graduates, but over a shorter time lapse since graduation, tends to substantiate these claims. Laure M. Sharpe, (43, p. 5) with the Bureau of Social Science Research, Inc., Washington, D. C., surveyed the 1958 college graduates in 1960-61. There were approximately 3200 responses.

> From the data on hand it is not possible to judge whether this close correspondence between college major and later development, even in non-technical occupations, results from the graduates own choice of an occupation or from employer's preferences for students who have majored in a field related to the job to be filled. However, the choice of major represents a clear vocational commitment in the sense that more often than not, occupations and college major tend to be matched.

It is timely to recall at this point what John G. Darley and Theda Hagenah expressed in Vocational Interest Measurement (10, p. 6).

> Beginning no later than the early high school choice between the academic and the vocational curriculums, the pressure grows steadily to "make a choice." The highly differentiated curricular offerings at the beginning university and college level represent probably the heaviest pressure point. As adults, we are anxious for our children to take their "proper" place in this hierarchy of job titles.

> Through education, the "proper" place should be as high as possible in terms of the American dream. For in that dream, the higher one's status, the greater will be one's security, satisfaction, earning power and contribution to society. On net balance and in spite of many defects and individual failures, the dream is not too far from reality; this mobile society, with the assistance of extensive public education, has provided a good demonstration of a functional aristocracy of jobs.

This then points out the motivation for early choice such that adequate use may be made of public educational institutions. But it also clearly points out the possibility of choices based on immature knowledge. This pressure has persistently been pushed downward with respect to the age vocational preparation begins. In fact it is possible that the very services offered by secondary school counseling cause earlier and possibly more immature consideration of vocational or academic preparation in many cases. In our democratic society obviously counselors will not in general tell a high school youngster that he is pigeon-holed, categorized, already on the basis of past performance, race, parent's occupations or any other such reasons. Thus the choice of curricula, the academic or vocational preparation which is chosen in high school, is in general the choice of the student as a compromise to the gentle pressures of counseling, and, perhaps, to the lack of, or the non-gentle parental pressures, along with the pressures of the groups he wishes to belong to.

One of the most discussed theories in the literature is found in Occupational Choice by Ginzberg et al. (20, p. 27) and would tend to support the above possibility.

> In view of the limitations of both the accident and the impulse theories of occupational choice, we set out to construct a more comprehensive and valid theory. Our basic assumption was that an individual never reaches the ultimate decision at a single moment in time, but through a series of

> decisions over a period of many years; the cumulative impact is the determining factor. It is important to note why this is so: The actions following a considerable number of decisions made at great cost are more or less irrevocable, and this indicates their importance for the future.

While in this author's review of the literature several attacks on the theory of Ginzberg and others were noted, it was also evident that few attacked the idea of the final vocational decision as a compromise. Excerpts from one article in the Journal of Counseling Psychology shows this compromising aspect in very understandable and unsophisticated language. Ziller (56, p. 62) proposed,

> Vocational choice is a decision-making situation in which risk plays a major role, and therefore, individual risk-taking tendencies determine, in part occupational choice. . . . Thus an individual in the process of selecting a vocation may be compared to a gambler who must decide what he is prepared to wager for a given prize under certain expectations of success.

Many high school graduates planning to go to college do not understand the risks involved in their choice of institution. As Sharpe (43, p. 7) pointed out,

> Selecting a given undergraduate institution often predetermines career outcome--if a student is restricted in his choice of a major because of limitations in the type of programs offered, he is probably permanently ruling out study or work in areas not available to him as an undergraduate. Yet it is common for students to select their school and especially their major field of study without giving much thought to the long-term implications of their choices, perhaps in the mistaken belief that they are not making a major career decision when choosing a field of undergraduate study.

There were very few articles observed which report positive action toward the problem of choosing careers by high school students but one such article by R. P. Fox, "Recruiting for the Professions," (19) shows the attempts of at least one counselor to bring to those students of high school who were seriously interested in learning more about why

people chose certain professions, the opportunity to make more realistic evaluations than before. A series of visits with persons in the professions was arranged by Mr. Fox. In large metropolitan areas, such as Boston and suburbs, as in this case, many opportunities to explore a multitude of professions exist. And this can be accomplished early in one's development. But unfortunately, these opportunities are not nearly so plentiful in states predominantly rural in nature. No matter what the choice, whether or not a choice is made in high school, there is an irreversibility which is considered a basic element of the theory of occupational choice of Ginzberg et al. (20). Thus one of the many "subdecisions" made at this level will influence the decisions of college problems, where to go and what to major in. The broadening of one's knowledge and experiences assist in making more sound decisions. It would seem reasonable to believe that while people differ they also possess similarities, some being more similar than others as a result of general knowledge. And this affects occupational choice in our society for, as Patterson (32, p. 378) wrote,

> If there is opportunity for occupational choice, there is a place for theories of occupational selection. And if there are some similarities in personal characteristics among those in particular occupations then this suggests that certain personal characteristics have a part in determining occupational choice. One might perhaps reason that different occupations require different personality characteristics, and that the person chooses the occupation on the basis of knowledge of the requirements of the occupation and of his own personal characteristics. This is no doubt true to some extent. But the personal requirements of occupations are not well known, even to psychologists and counselors, and thus many who choose an occupation do so without knowing its requirements. And it is no doubt true that the number of people who know their own personal characteristics well is small.

Also pointed out by Deunk (12, p. 1119), emphasizing the observations of Patterson,

> College students have a longer period than others in which to evaluate alternative jobs, yet many seniors approach graduation undecided as to the job they should seek.

And the authors of Occupational Choice (20, p. 250) state,

> The fact that realistic choices tend to be made in college rather than earlier is suggested in the study of Threlkeld (100). . . . Strong (96), Spencer (93) and Pace (78) found that a sizeable minority of college seniors were without a crystallized choice. The importance of the exploration stage which precedes crystallization is suggested by Threlkeld's finding (100) that about a third of the students change their major subject while in college.

Thus that the majority of college seniors has already realized the importance of a sound occupational choice is implied. This same observation was made by Sharpe (43, p. 7)

> Whether one likes it or not, it is clear that the choice of a major may well turn out to be a serious career commitment -- not only for the pre-professional student but for students majoring in the arts, sciences and humanities as well. Some doors are almost automatically closed and others opened once a decision is made to major in history, business or English.

Recognition of these problems inherent in career choice has caused many people to attempt to identify factors which influence the choice decidedly. One may find those factors of interests, abilities, parents' opinions, friends' influences, and others in many different places. Among the sources are writings by Baer (2), Borow (7), Burington (8), Ginzberg et al. (20), Holland (23), Patterson (32), and Roe (38, 39, 40) to name a few.

There are many efforts still being made to determine more about career choosing. The area of counseling psychology as a separate study is a relatively new and growing field. Furthermore, there are certain organizations receiving subsidies from various sources for the purpose of exploring this field. Some examples are, The Fels Group Dynamics Center at the University of Delaware, Horace Mann-Lincoln Institute at

Teachers College, Columbia University, The Harvard Studies in Career Development group, and even in the U. S. Employment Service, Functional Occupational Classification Structure is emerging. Borow also points out research being done in Japan and France (7).

Warren reported an attempt to relate self-concept, occupational role expectancy and change in college major (54). This is an illustration of the many smaller facets being explored by individuals. Also for an example of limiting the problem to particular classes of occupations, consider Hermanson's article, "Employment in Professional Mathematical Work in Industry and Government." (22). This was a study requested by the National Science Foundation and the Mathematical Association of America of the Bureau of Labor Statistics to conduct a survey of mathematical employment other than teaching. The return of the questionnaires was about half of the estimated total and yielded about 10,000 responses for study. One of the unemphasized observations of the study, coupled with data from government circulars on degrees conferred (15, 14) indicates a large number of graduates in mathematics had not entered mathematical employment other than teaching.

All the while we cannot ignore the existing international competition in technology. This is placing an increasing demand on the colleges to provide more and better prepared mathematicians as well as other scientists. To point out the broader uses of the mathematicians' talents, note the article by Burington (8, p. 109) in which he discusses the role of mathematicians in the development of a hypothetical propulsion system. He explains that at several stages in this development,

> Careful analysis and evaluation of the system are absolutely necessary to disclose the characteristics of the system, its utility, weaknesses, advantages, disadvantages, feasibility,

> reliability and so on. Such analyses and evaluations commonly require the service of people of many talents. It has been found that mature mathematicians of sound judgement widely versed in the physical, economic and statistical sciences, are particularly well suited for this type of work.

Such information exposes new fields for mathematicians. It is clear that to reach a position of maturity and broad experience such as described above, one would necessarily be in the field of mathematical occupations for no short time. But this perhaps could have been shortened to some extent by adequate preparation in college. Thus the time element has entered the picture, and this emphasizes efficient utilization of the opportunities available at college. Again referring to Sharpe's study (43, p. 8)

> Many educators and social observers deplore the present orientation toward early specialization and vocationalism of which many of the findings presented here offer further evidence. But ignoring the realities is no solution, and represents a disservice to young people about to make major decisions. The real challenge for those who help guide college students is to find ways of reconciling the students' total needs . . . vocational and nonvocational . . . so that he can make the most of the tremendous opportunity and investment which a college education represents.

CHAPTER III

METHOD AND PROCEDURE

Briefly the procedure was to conduct a semi-interview with junior and senior majors in mathematics or mathematics education in order to obtain certain reactions from them. These reactions were to be the result of conducting the interview in three stages. The first stage was to obtain reactions to a question of the type, "Why did you choose this particular major?" The second stage was to obtain a relative measure of influence felt from suggested reasons for the choice of major. The third stage was to obtain a relative ranking of importance for these suggested reasons. The analysis of the data from the first stage would involve frequency count. For the second stage, analysis of the data was to determine the average response to each suggested reason, to determine the amount of scatter among these responses, and to determine which reasons could thus be judged as members of a pattern of influence. The method of m - rankings was to be the technique used to analyze the rankings of the third stage. There was a deliberate attempt to make the meeting as brief as possible yet long enough to obtain the data needed to investigate the chosen problem. The students awareness of the attempt to be brief was felt to encourage the desired cooperation. The methods and the instruments used were designed to meet this aim. An announcement of the intended study and a request for their assistance was made to the seniors present at an evening gathering

for all senior mathematics majors. This was followed up by a short letter from the Head of the Department of Mathematics urging their help. (Appendix A). These letters were mailed to all the selected students.

Selection of Students

The students to be "interviewed" were selected by the following criteria: (1) If their names were on the mathematics list of advisees or on the mathematics education list of advisees at the beginning of the spring semester, 1962, at Oklahoma State University, (2) if they were listed as either juniors or seniors on their advisor's list, (3) if on their spring registration cards at the Registrar's Office they had indicated mathematics or mathematics education as their major. Observing these criteria, the listing for the mathematics education majors was as indicated in Table I.

TABLE I

INITIAL DISTRIBUTION OF MATHEMATICS EDUCATION MAJORS

	Juniors	Seniors	Totals
Males	7	13	20
Females	3	3	6
Totals	10	16	26

The listing for the mathematics majors was as indicated in Table II.

Appointments were made by the author's visits to classrooms between classes, by telephone, or (in rare cases) by the student's

voluntary action in seeking out the author. In the course of securing appointments, revisions of the distribution of the potential appointees were made on the basis of discovering some individuals who should have been on the list of advisees but for some reasons had not originally been included, discovering some of those of the listing had withdrawn from school since registration, or discovering some had unofficially withdrawn or changed majors (this was based upon absenteeism and course changes recorded at the Registrar's Office). Thus there were revised distributions as indicated in Tables III and IV.

TABLE II

INITIAL DISTRIBUTION OF MATHEMATICS MAJORS

	Juniors	Seniors	Totals
Males	33	43	76
Females	10	6	16
Totals	43	49	92

TABLE III

REVISED DISTRIBUTION OF MATHEMATICS EDUCATION MAJORS

	Juniors	Seniors	Totals
Males	9	12	21
Females	3	3	6
Totals	12	15	27

TABLE IV

REVISED DISTRIBUTION OF MATHEMATICS MAJORS

	Juniors	Seniors	Totals
Males	31	42	73
Females	10	6	16
Totals	41	48	89

Of these 116 students Tables V and VI show the distribution of those actually "interviewed."

TABLE V

MATHEMATICS EDUCATION MAJORS INTERVIEWED

	Juniors	Seniors	Totals
Males	9	6	15
Females	3	3	6
Totals	12	9	21

TABLE VI

MATHEMATICS MAJORS INTERVIEWED

	Juniors	Seniors	Totals
Males	25	34	59
Females	8	5	13
Totals	33	39	72

The total distributions of the potential appointees and of those actually interviewed were as indicated by Tables VII and VIII.

TABLE VII

TOTAL DISTRIBUTION OF POTENTIAL PARTICIPANTS

	Juniors	Seniors	Totals
Males	40	54	94
Females	13	9	22
Totals	53	63	116

TABLE VIII

TOTAL DISTRIBUTION OF PARTICIPANTS

	Juniors	Seniors	Totals
Males	34	40	74
Females	11	8	19
Totals	45	48	93

The main reasons for not obtaining interviews with 24 of these were (1) schedule conflicts caused unfavorable or undesirable appointment times (2) appointees failed to appear due to forgetfulness (3) appointees had no desire to participate, thus ignored the appointments when made or the effort to make appointments (4) appointee lived out of town or was constantly at a part time job. While reasons for only a few of the 24 cases are known, inconvenience seemed the main reason for missing them. It was even suggested to several of the out of town

people that at their convenience they would be interviewed in their home town or temporary residence. However, only one interview was conducted out of Stillwater.

The Interview

The interview was broken into three distinct but relatively short steps. The intent was to utilize a technique which would not be lengthy, which could be simply administered and yet provide the necessary data to allow investigation of the reported reasons for choosing mathematics or mathematics education as an undergraduate major.

STEP A. Upon arrival the appointee was greeted in a manner to ensure identification of both parties. He was briefly engaged in conversation to determine, in the author's opinion, whether or not this person was of a frame of mind favorable to participating in this study. There were very few persons who met their appointments with hesitance or reluctance toward participation. These few voiced doubt as to how they could contribute any valuable information as their reason for hesitancy or reluctance. These were satisfied with a few comments on the type of work being done on career choice along with the suggestion that perhaps they were unaware of what they could contribute.

When willingness to participate was recognized, the first phase, the narrative, was explained. This was to be an attempt to obtain a sketch of several of the more important reasons, as they could best be recalled, for the choice of present major. This was to be done with no suggestiveness on the part of the author. It was initiated by asking when the choice was made. If the student could identify the approximate time, then he was asked a question of the type, "If you had been

asked at that time why you wanted to major in this area of specialization what do you believe you would have answered?" They were asked to write this information down. Care was taken to stress the fact that the reasons they had then were the desired ones, no matter how adequate or inadequate these reasons appeared at the time of the interview. After the narrative was written, then the author read it and gave his understanding of the comments to the student asking to be corrected if there was any misinterpretation.

STEP B. The second phase was to obtain a rating of each of the 18 items selected for the study. These items were based on the reasons given in the literature for choice of vocation or career. Accepting the general idea that decisions of choice are conditioned by many previous decisions and their consequences, then, for college students, their eventual career choice must be conditioned by their choice of major. Since the reasons of the literature are very basic and general they should be applicable to the pre-decisions of choosing a career also. Therefore, considering the results of studies reported by Roe (40) and the experience of the author, 18 short items were selected. (Appendix B). Of the 18 selected items all but seven (Items G, I, J, K, M, N, and P) were utilized in studies by Endicott and Peters (40, p. 257). Six of these seven (all but Item I) were factors used by Edmiston and Starr (17, p. 218). Item I is a general item to include influences due to counseling reported by Dyer (13, p. 285) as well as those influences due to being informed of results of aptitude or achievement tests. The student was instructed to rate the items with a 1, 2, 3, or 4. He was given a loose leaf notebook with a page of instructions on what each rating was to mean. (Appendix C). On the

next page (a half page which, when turned, allowed the instructions still to be visible) (Appendix C), he was to make an appropriate mark for that item. A single item was on each half page, thus as the half pages were turned the preceding item was covered and the instructions were again in plain sight for easy reference.

The marking of the items was also explained at the beginning of this phase. To place a check mark, ✓, under Column 1 meant that the item had never directed the student toward any particular major. The item had no suggestiveness for the student as to his potentialities nor as to a good choice of major. Columns 2, 3, and 4 were described as a means of indicating the degree of influence of the item. Considering separately the use of the positive mark, +, and the negative mark, -, the student was informed as to the meaning of each. A positive influence item was to be an item which had indicated to the student that the student had ability in mathematics or that choice of mathematics as a major would be consistent with the item's evaluation of the student's potential. Then by placing the mark, +, under column 2 the meaning is that the item was of positive influence, felt or recognized, but not considered as a factor in the choice of major. In other words, the value of this influence had not been considered very high and had little if anything to do with their choice (consciously). Placing the mark, +, under column 3 indicated a positive influence was felt and considered as fairly important in helping to make the choice of major. However, it was not to be as important as if it had been marked with a + in column 4. For such an indication was to mean the items influence was one of the main reasons for making this choice.

Then each student was instructed as to the use of the negative mark, -. If the item had indicated a direction to take or a choice of

major other than mathematics, it was to be considered a negative item. An example was usually cited as, "Suppose Joe is the item and he thought you had abilities in art. You were aware of this opinion. Then Joe was a negative item." The degree of negative influence was explained as in the positive item for columns 2 or 3, but for column 4 it was to be used when it was because of this negative influence the student chose this major. This implied such a mark would mean an almost spiteful reaction had been made to that particular item.

The use of the + or - sign was to encourage the student to feel free to indicate the importance of negative influences as well as positive influences. He thus had the opportunity to show a sort of rebellious attitude if he felt it had existed then. The positiveness or negativeness were of relatively minor importance as compared to the degree of influence the item seemed to have incurred. It was felt that the optional use of these two marks would produce a more complete consideration of the item. The student was also advised that any explanation he felt was essential to understanding his marking of the item could be written on the item page. Also after the markings, the author glanced over the item pages and where he felt there might be more than one way to interpret the marks, the student was asked to explain verbally. If this differed from the author's interpretation, it was written on the item page. These results are hereafter referred to as ratings.

STEP C. The student was asked to consider these items once more (without access to the previous information). He was asked to rank the items in an order of relative importance he would have assigned at the time of his choice of major. Here he was cautioned that positiveness and negativeness were not to imply necessarily that the relative

ranks of the positive items as higher than that of the negative items since it was quite possible to have a negative item considered much more important than some positive items. Each student was asked to avoid ties, however, in the case of items of absolutely no importance relative to their choice of major, ties would be understandable and these items would be tied for last rank. Each item was written on a small card about three inches square. The student was instructed to place these cards in a file or line on the desk such that their position would indicate the relative rank. To expedite the decisions, it was suggested that they first separate the cards into three piles then to order each pile, finally pooling the piles and checking the final alignment. Immediately after the completion of this ordering the relative ranks were recorded.

Treatment of the Data

The purpose of this study was to determine the existence of, or lack of existence of, a pattern of influences or reasons for choosing either of these particular majors, mathematics education or mathematics. For an item to belong to the pattern it must have met a predetermined set of conditions. Originally the criteria was (1) the distribution of responses to the item, as obtained in the ratings, should have an average or mean response of 2.5 to 4.0 inclusive and (2) the condition that the sum of the squares of the deviations from the mean was to have a value less than or equal to 0.64 times the total number of responses. (This is analogous to a standard deviation of 0.8 for normally distributed data.)

The total data from the ratings of the items was to be so analyzed.

Since there were three identifiable sub-groups of students it was decided to also analyze the data for each of these sub-groups. For reference, the group of mathematics education majors were designated Group β (lower case beta), the mathematics majors were designated Group γ (lower case gamma), and the third group composed of all those who had changed major at least once, as Group α (lower case alpha). Group α was to be determined by studying the narratives and the response to Item J of the ratings, "The courses required of me in my former major, (if you have changed majors) . . . (Please indicate your last major prior to mathematics _____)."

The narrative of each individual was to be studied and compared with the ratings of that individual to observe any obviously gross inconsistencies. It was felt a large number of these would indicate a complete insincerity on the part of the individual. Thus of the 18 items an arbitrary figure of 2 was decided to be the maximum number of inconsistencies allowable as a result of human error. There was no particular effort made to justify this number. But the occurrence of all inconsistencies was to be tabulated to consider the adequacy or inadequacy of this value.

The rankings were to be analyzed in the manner of the method of m-rankings as presented in Kendall's Rank Correlation Methods, Chapter 6. (24). This was to establish the overall rankings while considering the coefficient of concordance of these rankings. This coefficient is a measure of agreement among the m students rating the same item. Its value is determined by the following:

$$W = \frac{S}{1/12\, m^2 (n^3 - n) - m \sum_{T'} T'}$$

where m is the number of persons in the group

n is the number of items being ranked

$\sum_{T'} T'$ is the sum of all T' over all rankings

T' equals $1/12 \sum_{t} (t^3 - t)$

t is the number of items tied within the ranking of one individual

$\sum_{t}$ means to sum all $(t^3 - t)$ over all ties within the ranking

S is the sum of the squares of deviations of the totals of the ranks for the items from the mean of these totals

To determine the significance of this coefficient of concordance the following hypothesis is tested: There is no significant difference between the distribution of ranks obtained in this study and that which would have been obtained by the individual students randomly assigning the ranks. The test is conducted using the Chi Squared test of significance. Comparison of an appropriate calculated value for Chi Squared with an appropriate tabular value for Chi Squared is needed. The calculated value is $\chi^2_r = m\,(n - 1)\,W$ with n-1 degrees of freedom. The tabular value is χ^2_t obtained from tables entering with n-1 degrees of freedom and the 1% significance level. If $\chi^2_r > \chi^2_t$ the hypothesis is rejected.

This procedure was to be carried out for all the groups discussed above. These procedures were anticipated to provide answers to the following:

(1) Are there any elements of a "pattern" of influence?

(2) Is there agreement on the relative importance of these influencers?

(3) How many of these students had previously a major other than

the two of this study.

(4) What were the previous majors of the persons in Group α ?

(5) Was it possible to notice any great differences between the Groups α , β and γ with respect to ratings or rankings or both?

(6) What are the first-thought-of reasons given in the narratives?

CHAPTER IV

RESULTS

Ratings

The data obtained from the ratings yielded the distribution of responses found in Table IX.

After the data of the ratings were recorded, it was compared with the narratives. Since any item mentioned in the narrative was to be an important reason influencing the choice of major, it should have been rated a 3 or 4 if it was among the selected 18 items of influence. Each person's ratings and narratives were studied. The total distribution of inconsistencies was: eighteen persons with only one inconsistency, five persons with two inconsistencies and one person with three inconsistencies. In light of the relatively small numbers of persons with more than one inconsistency, all the ratings were used to determine the mean ratings and $\frac{SS}{93}$. $\frac{SS}{93}$ is a direct measure of dispersion or variation and is the quotient of the sum of the squares of the deviations from the mean response divided by 93, the number of responses for the item.

Group α was determined from studying the narratives and Item J in the ratings. Of the 93 students meeting their appointments, 50 had made at least one change of major prior to being interviewed. Of this 50, there were 11 mathematics education majors and 39 mathematics majors. Of the 11 mathematics education majors 8 were formerly engineering majors, 1 was formerly majoring in each of Architecture, Home

TABLE IX

DISTRIBUTION OF RATINGS

Items	Ratings 1	2	3	4	Mean Rating	SS 93
A	40	19	26	8	2.02	1.06
B	4	15	38	36	3.14	.709
C	17	26	42	8	2.44	.793
D	53	22	10	8	1.71	.948
E	62	13	14	4	1.57	.813
F	0	2	25	66	3.69	.260
G	31	29	27	6	2.09	.884
H	38	14	25	16	2.20	1.34
I	37	15	25	16	2.21	1.32
J	51	19	21	12	1.94	1.29
K	31	20	31	11	2.24	1.10
L	19	20	31	23	2.62	1.15
M	26	24	33	10	2.29	.991
N	36	23	27	7	2.05	.986
O	76	10	4	3	1.29	.491
P	37	17	27	12	2.15	1.19
Q	57	14	14	8	1.71	1.03
R	49	19	17	8	1.83	1.04

Economics and Mathematics (Arts and Sciences). Of the 39 mathematics majors 23 were formerly majoring in Engineering, 2 each in Pre-medicine and Mathematics Education, 3 in Chemistry, 6 in Physics and 1 each in Agriculture, Journalism and Philosophy.

The ratings of Groups α , β and γ yielded distributions of responses shown in Tables X, XI, and XII respectively.

Observing these distributions, it was noted that for all students the ratings yielded only one item satisfying the criteria of the previous chapter. This was Item F, "My own ability in mathematics." But the Items B and C, which are respectively, "My grades in high school mathematics," and "My own abilities in other courses," are rather apart from the remaining items and much closer to the acceptable values for the measures of mean and dispersion. (Item C was interpreted, in general, by the students to be a positive influence when mathematics was considerably stronger than the other courses or when the other courses were felt to require use of mathematics. It was considered negative when their abilities were sufficiently good in other areas to have suggested a different major.)

For Group α we find similar results. Only Item F is acceptable. While for Group β we find Items F, B, C and L, "A high school teacher" acceptable with Item M, "Salaries of jobs I expect to be qualified for upon graduation," an almost acceptable item. It was observed that 9 of the 21 in this group showed M as a negative item. Also in Group γ , as in Group α and the total group, we find only Item F acceptable with Item B as the nearest almost acceptable item. Figure 1 is a set of graphs of plotting $-\frac{SS}{N}$ versus the mean rating. The shaded regions are the acceptable regions. Items falling in these regions constitute

TABLE X

GROUP α DISTRIBUTION OF RATINGS

Items	Ratings 1	2	3	4	Mean Rating	SS/50
A	21	12	15	2	1.96	.878
B	3	13	22	12	2.80	.880
C	11	14	19	6	2.40	.92
D	29	14	6	1	1.58	.604
E	34	8	6	2	1.52	.730
F	0	2	17	31	3.58	.324
G	17	17	13	3	2.04	.838
H	4	12	20	14	2.88	.826
I	24	9	12	5	1.96	1.12
J	8	9	21	12	2.74	.992
K	13	14	16	7	2.34	1.02
L	15	15	13	7	2.24	1.06
M	12	15	18	5	2.32	.898
N	20	11	17	2	2.02	.898
O	43	5	1	1	1.20	.320
P	16	11	16	7	2.28	1.12
Q	23	10	12	5	1.98	1.10
R	30	7	10	3	1.72	.962

TABLE XI

GROUP β DISTRIBUTION OF RATINGS

Items	Ratings 1	2	3	4	Mean Rating	SS / 21
A	7	5	7	2	2.19	1.02
B	0	0	11	10	3.67	.262
C	1	10	9	1	2.48	.462
D	9	6	3	3	2.00	1.20
E	15	1	3	2	1.62	1.09
F	0	1	5	15	3.67	.333
G	8	8	4	1	1.90	.791
H	10	3	4	4	2.10	1.49
I	7	5	8	1	2.14	.929
J	13	2	3	3	1.81	1.36
K	6	6	8	1	2.19	.862
L	2	2	11	6	3.00	.600
M	4	7	9	1	2.33	.733
N	7	3	10	1	2.23	.991
O	17	2	1	1	1.33	.633
P	7	6	4	4	2.23	1.29
Q	13	4	2	2	1.67	1.03
R	9	8	3	1	1.81	.762

TABLE XII

GROUP γ DISTRIBUTION OF RATINGS

Items	Ratings 1	2	3	4	Mean Rating	SS 72
A	33	14	19	6	1.97	1.06
B	4	15	27	26	3.04	.801
C	16	16	33	7	2.43	.896
D	49	16	7	5	1.62	.801
E	47	12	11	2	1.56	.729
F	0	1	20	51	3.69	.243
G	23	31	23	5	2.14	.910
H	28	11	21	12	2.24	1.30
I	30	10	17	15	2.24	1.45
J	38	7	18	9	1.97	1.29
K	25	14	23	10	2.25	1.17
L	17	18	20	17	2.51	1.21
M	22	17	24	9	2.28	1.07
N	29	20	17	6	2.00	.986
O	59	8	3	2	1.28	.456
P	30	11	23	8	2.13	1.18
Q	44	10	12	6	1.72	1.04
R	40	11	17	7	1.95	1.02

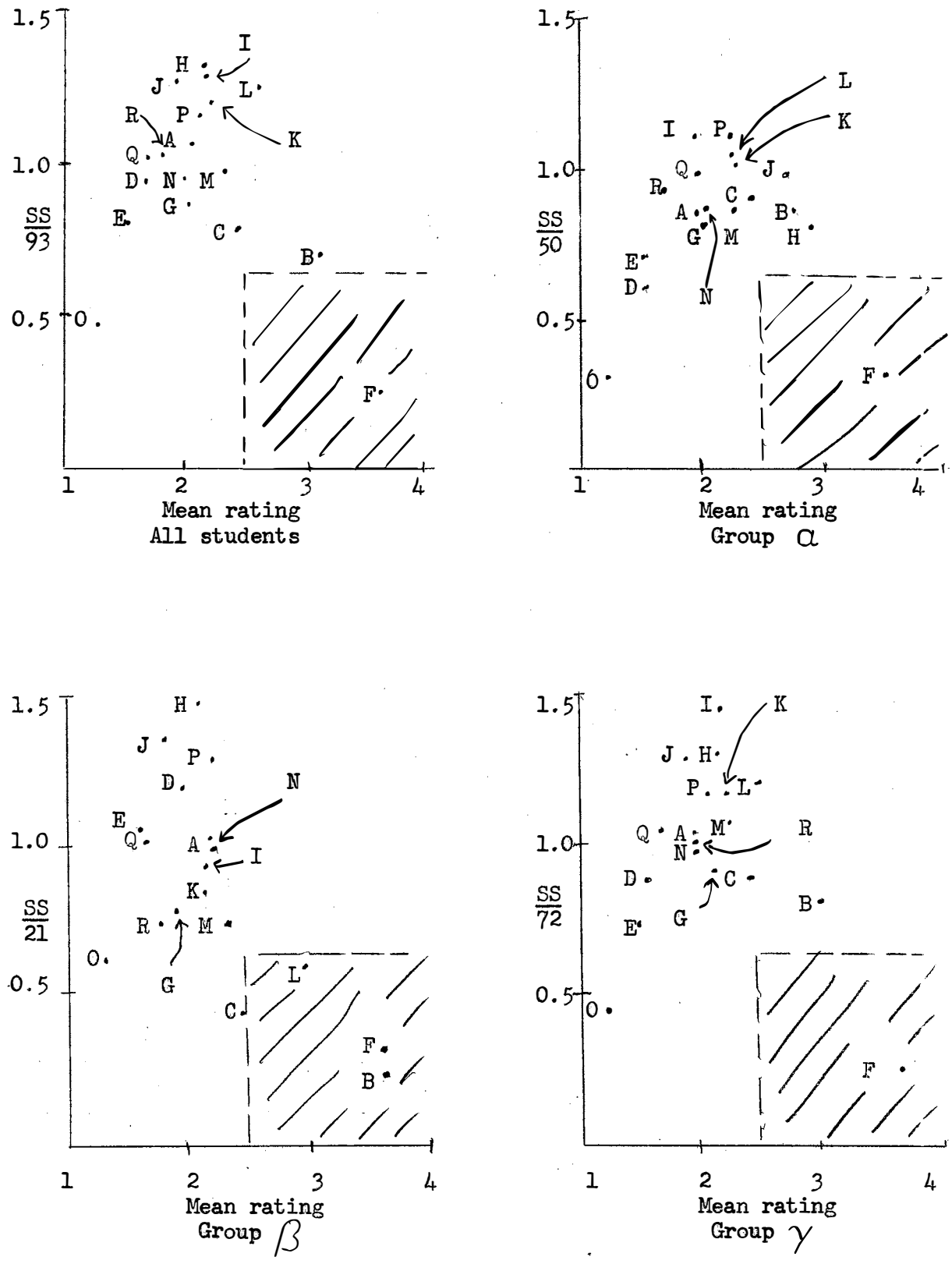

Figure 1. The Mean Ratings Versus Dispersions of the Items

elements of the pattern if a pattern exists.

The Narratives

The narratives provided the first-thought-of reasons for choosing their majors. The frequency distribution for the different reasons is given in Table XIII. Thus, the types of reasons most frequently given were those concerning enjoyment of the subject matter, the challenge of the subject, encouraged to study mathematics in college by high school or grade school teachers, the feeling that these majors offered many different job opportunities, the results of aptitude and/or achivement tests, the desire to teach, the fact that high school math was easy for me, and the amount of time to obtain a degree in these areas was felt to be less than that which would have been required in other possible choices. It was of interest to note that of the 21 reporting a desire to teach as one of the main reasons for choosing the major, 13 were mathematics education majors and 8 were mathematics majors. It was also noted that 8 of the 13 mentioned above were also members of Group α, having changed majors at least once, while 3 of the 8 mathematics majors mentioned above were of Group α. While the reason was not stated specifically in the narratives in this way, from the conversations of the interviews, several students indicated that the cost of equipment in pursuing the engineering curriculum caused them to look about for a possible alternate choice of major. Noticing that the mathematics requirements for their already spent time was very similar to those of the two majors here considered, they reasoned it was economical time-wise to choose these majors.

TABLE XIII

REASONS FOR CHOICE OF MAJOR

Reason	Frequency
Enjoyed mathematics	52
Challenging	30
Encouraged by high school or grade school teacher to study mathematics in college	27
Mathematics provided a large choice of job opportunities	22
Aptitude tests	21
Desire to teach	21
High school mathematics was easy for me	18
It would take less time to obtain this degree over other possible choices	14
Mathematics appeals to my "sense of logic"	10
Good grades in high school methematics	8
Needed to provide background for related career	8
Prestige or desire to show superior intellect by being in mathematics	8
Demand for methematicians and/or mathematics teachers	7
Influence of mathematics teachers at Oklahoma State University, including graduate assistants	7
Best grades were made in mathematics	6
Family had mathematics background or desired one for me	6
Friends were in mathematics and wanted to do as they did	5
Influenced by a junior college mathematics teacher	5
Interested in computer work	5
A specific desire to improve mathematics teaching	4
Father pointed out my strength in mathematics	3
Mathematics education major could provide me a "second job"	3
It was directly related to father's field	2
Relatives other than mother or father influenced me	2
An escape from things	1
Elimination of all other possible majors	1
Excellent instructors created good work habits	1

The Rankings

In considering the data from the rankings, the procedure was to first determine the coefficient of concordance, W. The Chi-Squared test was used to test the hypothesis: there was no significant difference between the rankings by the individuals and rankings which would have resulted from each individual assigning ranks randomly. The value of the calculated Chi-Squared, χ_r^2, was sufficiently large in all cases, for all groups of data, to believe that the hypothesis should be rejected at the 1% significance level. Thus, the overall ranks obtained by ranking the items in the order of their respective totals, (the item with the least total ranking first), is justified as a consensus. Considering each group separately the consensus of opinions as to the relative ranks were as shown in Table XIV. The "strength" of this agreement is reflected in the value of W. The maximum value of 1 for W means complete agreement while the minimum value of 0 for W means no agreement. Thus the strength of agreement for each group was not exceptionally good. This can be seen in Table XV.

So we say there is a probability of less than 1% that the respective distributions of rankings showed no better overall agreement than that obtained by randomly assigning ranks. While the overall agreement does not approach the maximum ($W = 1$), we know the agreement is better than that offered by chance rankings ($W = 0$). Also, if we order the W values from least to most, it is observed that Group α has considerably better agreement within the group as to the relative ranks of these items than the other groups. Similar observations may be made about any pair of groups.

TABLE XIV

OVERALL RANKINGS OF THE ITEMS

Item	Group α	Group β	Group γ	All Students
A	1	1	1	1
B	12	5	11	8
C	9	15	15	15
D	16	11	16	16
E	3	2	2	2
F	14	6	9	9
G	17	16	17	17
H	4	17	13	14
I	11	14	10	12
J	2	12	5	6
K	8	10	6	7
L	13	7	12	11
M	7	13	7	10
N	10	3	4	3
O	6	4	3	4
P	5	8	8	5
Q	18	18	18	18
R	15	9	14	13

TABLE XV

COEFFICIENTS OF CONCORDANCE AND THEIR RESPECTIVE χ^2_r VALUES

Group	Size	W	Approx. χ^2_r	Approx. χ^2_t
All Students	90	.243	371	33
Group α	50	.404	336	33
Group β	20	.356	121	33
Group γ	70	.288	357	33

CHAPTER V

SUMMARY AND CONCLUSIONS

The problem of utilizing the nation's manpower in the most effective manner involves deeper probing into the field of Career Choice in order to better match occupations and capabilities. Within this very large field there is need for more information concerning the bases of choices which precede, but affect, final career choice. This has been an attempt to gain more information about reasons for one such choice, choosing undergraduate majors. Limiting this study to a particular group of students places limitations on the conclusions that may be drawn. The conclusions are valid for this group of students only. However, the procedures and techniques demonstrated could perhaps contribute to similar investigations on a much larger scale wherein a sampling of a large group with similar homogeneous character could produce more general results.

This study involved students from two easily identifiable groups. The two groups were homogeneous with respect to choice of major. One group was the collection of mathematics education majors in the College of Education at Oklahoma State University, the spring semester of 1962. The other group was the collection of mathematics majors in the College of Arts and Sciences at Oklahoma State University, the spring semester of 1962. Each student was requested to participate by meeting with the author for approximately thirty to forty minutes at a time convenient

to the student. There were three different attempts to obtain information from the student during the interview. The student was requested to write down the more important reasons for his choice of major as he would have considered them at the time of the choice. He was also asked to respond to selected items of influence which were based on the literature on career choice. Here he was to indicate the relative degree of influence each item had on his choice of major. Then he was asked to rank these same selected items with respect to their relative importance as he would have ranked them at the time of his choice.

Thus the surface reasons, the first-recalled reasons, for the choice were approximated within the limitations inherent in this interviewing technique. These provided a check for sincerity of the individual in making his decisions on the degree of influence felt per item.

These ratings provided the data needed to determine if an item belonged in the pattern of influences characteristic of this group. The criteria were based on the need for a mean response to indicate the item did affect the choice of major and the need for a clustering effect around this mean response. This was to assure that agreement exists, that there was a sufficient number of students with nearly the same opinion of the item to suspect it to be characteristic of the group.

The rankings provided a means of determining if there was agreement on the relative importance of the items. This gave the participants the opportunity to view these same items from a different viewpoint. Relative importance of an item could thus be compared to the relative influence of the item.

The narrative, written in the first phase of the interview, provided

the author with information which could be used to check the consistency of response. It also provided several reasons for choosing these majors which were not in the 18 selected items. The combined use of the narrative and ratings offered a means of determining a third group of students, who, according to the literature, should have a more realistic choice made by this time than the others. Thus the data of the ratings and the rankings were analyzed with respect to four groups, (1) the total group of all 93 persons (2) the Group α, the changed-majors group (3) the Group β, the mathematics education majors and (4) the Group γ, the mathematics majors.

The Findings

There were 50 of these 93 students who had changed majors, 11 mathematics education majors and 39 mathematics majors. A great majority of this 50 had previously had majors in the areas of engineering or the physical sciences, in fact 41 of the 50 were of this nature.

The eight most frequently given reasons for selecting these majors were in their relative order, (1) enjoyment of mathematics (2) the challenge of mathematics (3) pre-college teachers had encouraged such majors (4) the large number of job opportunities anticipated (5) the desire to teach (6) aptitude test results swayed the person (7) high school mathematics was easy for them (8) it would take less time to obtain this degree as compared to other degrees which interested them.

The items of the ratings which might belong to a pattern for identifying groups were very few. Thus no pattern as such was identifiable with the possible exception of the results for the mathematics education sub-group.

The rankings proved that there was consensus of opinion on the relative importance of the given items. The degree of agreement was less for the total group (as was expected) than for the identifiable sub-groups. In comparing the mathematics education majors to the mathematics majors, the degree of agreement was greater for the mathematics education majors. Yet comparing the changed major group to the mathematics education majors, the changed major group had the greater agreement.

Overall rankings were obtainable from the rankings (Table XIV). Comparing these to the data of Figure 1, it was observed that for all groups there were items of relatively little, or no, influence ranked very high in importance. Also, Item F, considered of great influence by all groups, ranked no higher than sixth in relative importance.

Discussion of the Findings

It would seem that from observing the results of the analyses of both the ratings' data and the rankings' data, there would tend to be a greater amount of sameness in the mathematics education majors than in the mathematics majors. Since there were distinct differences between these groups, according to the two sets of data, this tends to substantiate the possibility of distinct sets of main reasons for the choice of major. From the author's experiences and from reading the literature on career choice, the problem of this paper still remains a reasonable one.

Conclusions

(1) The influences on career choice reported in the literature did not

apply in general to a specific undergraduate major choice in the same manner.

(2) With different choices of major these influences had different roles.

(3) The existence of a pattern of influences characteristic of these two groups of undergraduate majors was not clearly identifiable, using the criteria of this study.

(4) There were over half the junior and senior mathematics education majors and mathematics majors who have previously been enrolled as some other major.

(5) The greatest source of these change of majors was the physical sciences and engineering majors.

(6) The influence of high school mathematics subjects and methematics teachers was a factor in the student's choice of major.

(7) The fact that some items were of little or no influence did not exclude them from being judged relatively important.

Suggestions for Future Study

(1) More of similar types of data should be determined to not only verify or reject these data, but to determine also what majors are pursued by those who shift from mathematics and mathematics education.

(2) A similar interview technique could be utilized on a sampling from two or more groups of undergraduate majors, then one could determine if the selected items might be used as profile data by seeing if the procedures of Sawrey, Keller and Conger (42) would produce identifiable groups.

(3) This type of data should be sought from different schools in different areas of the nation to determine if there are similarities within the groups of students of the same major but on different campuses.

(4) A study of knowledge of the job opportunities available for persons with a mathematics degree (or a mathematics education degree), which the beginning freshmen majors in these areas have, would give some insight as to their understanding of what their majors are preparing them for.

(5) A study of the success or failure of these 93 students to obtain their degrees might result in establishing some relationship between the responses to the ratings or ranks of this data to success or failure.

(6) A follow up study five to ten years after this group of students graduates could determine what type of job they would be holding. The results might be related to the distance function of the profile analysis technique of Sawrey, Keller and Conger (42), using the data of this study in part or by itself as the profiles for these students.

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A P P E N D I X

APPENDIX A

Copy of the letter sent to all potential participants in this study.

OKLAHOMA STATE UNIVERSITY - STILLWATER

Department of Mathematics and Statistics
FRontier 2-6211, Ext. 7160

February 21, 1962

In connection with the preparation of a doctoral thesis, Mr. William E. Hoff, graduate student in the Department of Mathematics, will shortly begin a study to determine what influences operate to cause a student to major in mathematics. Mr. Hoff proposes to interview all junior and senior mathematics majors, as well as mathematics-education majors in the College of Education.

You are requested to assist Mr. Hoff in the study he is about to undertake by cooperating with him in every way possible. It is believed you can provide the information he will require from you in approximately one-half hour, and the interview which Mr. Hoff will arrange with you for this purpose will be scheduled at your convenience.

Yours truly,

/S/ L. Wayne Johnson
Head

Appendix B

The Items

A father

B my grades in high school mathematics

C my own abilities in other courses

D mother

E a relative other than my mother or father

F my own abilities in mathematics

G the prestige that mathematicians appear to enjoy

H my grades in college mathematics courses

I a professional counselor or vocational guidance person who administered certain tests to determine my aptitudes

J the courses required of me in my former major, (if you have changed majors) ... (Please indicate your last major prior to mathematics _____)

K the amount of effort involved in obtaining this degree

L a high school teacher

M the salaries of jobs I expect to be qualified for upon graduation

N the nation's need for scientific personnel

O an elementary school teacher

P the requirements for this degree being considered within easier grasp than for other degrees, (in the light of my own capabilities)

Q a college teacher

R either a close friend or other students, not mentioned previously in an item.

Appendix C

Instruction Sheet

In the colums below, place a plus sign + in the appropriate column 2, 3, or 4 if your choice of major was in general agreement with the influence exerted by the item. Place a negative sign - in the appropriate column 2, 3, or 4 if your choice of major was in general disagreement, or opposite to the influence exerted by the item. Otherwise place a check ✓ in column 1.

It may help you to understand the intent of the item if you read the item in the following manner, adding before the item and adding after the item in this way: The influence of ..... upon my choice of mathematics as an undergraduate major. (Insert the item in the appropriate place in the above sentence.)

1	2	3	4
This item was either not applicable or no influence was felt from it	Influence of this item was felt, but was not considered when making the choice of major	Influence of this item was felt and was considered when making the choice of major	Influence of this item was felt and was considered to be very important when making the choice of major

Sample Item Sheet

... a professional counselor or vocational guidance person who administered certain tests to determine my aptitudes ...

VITA

William Eldridge Hoff

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY OF INFLUENCES ON THE CHOICE OF MATHEMATICS OR MATHEMATICS EDUCATION AN AN UNDERGRADUATE MAJOR

Major Field: Mathematics

Biographical:

Personal Data: Born in Kansas City, Missouri, June 26, 1926, the son of Chester W. and Cliffie M. Hoff

Education: Attended elementary schools in Jerico Springs, and Stockton, Missouri; graduated from Stockton High School in 1943; attended Southwest Missouri State College, Springfield, Missouri, 1943-44; attended United States Naval Academy, Annapolis, Maryland, 1945-49 receiving the Bachelor of Science degree in June 1949; attended the University of Missouri, Columbia, Missouri, 1954-55 and summers 1956, 1957, 1958, received the Bachelor of Science degree majoring in Secondary School Education, in June 1955, the Master of Education degree in August 1958; attended Oklahoma State University from June 1959 to August 1962, completed requirements for Doctor of Education degree in August 1962.

Professional Experience: Entered the Naval Service in July 1944, remained on active duty until June 1954, active in the Naval Reserve Program since. Appointed Physiology Laboratory Assistant at University of Missouri, taught high school Physics and Advanced Mathematics courses in Ferguson High School, Ferguson, Missouri 1954-1958. Appointed as graduate assistant in Department of Mathematics, Oklahoma State University 1960-1962.

Professional Organizations: Member of Phi Delta Kappa, Central Association of Science and Mathematics Teachers, Inc., Mathematical Association of America.