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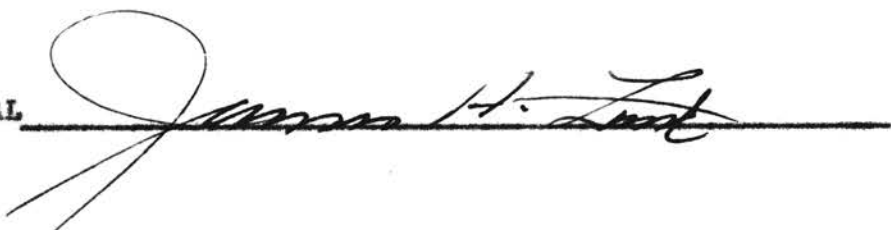
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Major Field: Natural Science

Scope and Method of Study: Influencing factors indicated as pertinent in career selection by 231 physical and biological scientists were analyzed and compared. The school age at which the influencing factors became prevalent was identified and related to those aspects of the environment which were indicated by scientists as being influential. Intrinsic factors were analyzed as were the human qualities possessed by teachers who were able to influence the selection of careers. Parental and family influence was noted and those influential factors arising from the home were studied.

Findings and Conclusions: A comparison of influencing factors indicated by physical and biological scientists concerning the school age, level of the teacher, and level of the course showed that physical scientists were primarily influenced during high school years, while biological scientists were influenced during college years. The human qualities of the teacher as a person were indicated as responsible for his ability to influence career selection by students. The home environment and family influence was indicated as an early influence in career selection. The intrinsic factors aroused within the individual scientist by complex causal mechanisms were found to be very important in the choice of a career.

ADVISER'S APPROVAL



A STUDY OF INFLUENCING FACTORS IDENTIFIED
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A RANDOM SAMPLE OF 231 PHYSICAL
AND BIOLOGICAL SCIENTISTS

By

DONALD RICHARD MILLER

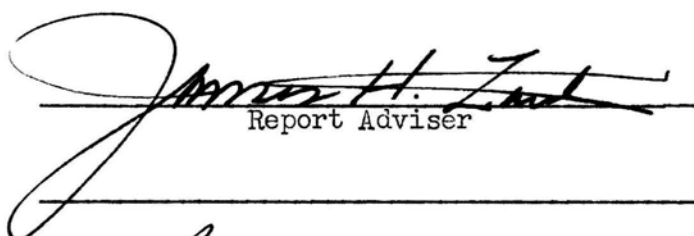
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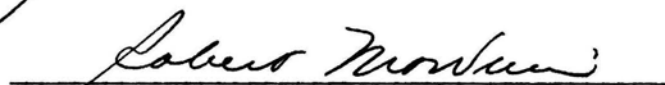
Master of Science
Oklahoma State University
Stillwater, Oklahoma
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Submitted to the faculty of the Graduate School
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the degree of
MASTER OF SCIENCE
May, 1958

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Report Approved:


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PREFACE

The influential factors underlying the choice and pursuit of a career in science have been determined for outstanding students, teachers, and scientists. The belief that a random sample of accomplished scientists, throughout the physical and biological sciences, might yield significant results was instrumental to the subsequent investigation. The success of the study was determined primarily by the excellent cooperation received from participants, advisory staff members, fellow students and close associates.

The excellent response from busy professional people selected for participation in the investigation was deeply appreciated. The interest shown and time taken to supply additional information which they considered pertinent largely determined the success of the investigation. Certainly, the forty-six per cent response to the inquiry suggested their willingness to avail valuable time and personal information for the study.

The fine cooperation and many suggestions offered by Dr. James Zant warrants special mention of thanks. Also, appreciation is expressed for the help extended by Paul Eugene Pulley in analysis of data. The helpful suggestions and encouragement from Academic Year Institute members and office personnel facilitated early completion of research with minimum error. The tolerance and patience, on the part of my wife and typist, while completing the research and composing the report is gratefully acknowledged.

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CHAPTER I

INTRODUCTION

Background of the Problem

The last quarter-century has witnessed the birth and growth of a new era in science. The challenge for supremacy in scientific technology, among world powers, has produced tensions which have acted as the accelerator for the new era. The great advances in scientific technology have required ever increasing numbers of engineers, scientists, and teachers. An increased importance has been placed upon scientific understanding and methodology. Thus, the challenge has focused attention upon educational institutions and the production of scientific personnel.

The scope and tempo of the challenge were ably presented by President Eisenhower when he stated:

"In both education and research, redoubled exertions will be necessary on the part of all Americans if we are to rise to the demands of our times. This means hard work on the part of state and local governments, private industries, schools and colleges, private organizations and foundations, teachers, parents, and --- perhaps most important of all --- the student himself, with his bag of books and his homework."¹

The student and scientific education were sharply challenged. The problem of producing more capable scientific personnel in larger numbers was

¹D. D. Eisenhower, "State of the Union Message to Congress", Science 127 (January 24, 1958), p. 182.

paramount. All aspects of the problem were sharply focused by Dr. Harold C. Urey when he related: "The real problem that faces the country is a long term one. It is a problem of the proper education and inspiration of our youth."²

The approaches to the problem, as stated above, are as varied as the whims of investigators. The approach selected for the following study was an analysis of influencing factors underlying careers in science. Through analysis of influencing factors, related by successful scientists, insight with respect to the problem might be gained.

History of the Problem

Many studies, from a variety of fields, have pointed out significant factors which influence the choice of a career and its successful pursuit. Roe, while working with rigidly selected outstanding scientists, has indicated:

It would appear, then, that there are certain factors in the family situation into which a child is born which are somehow associated with his becoming a successful scientist...One of these factors is a home in which learning is valued for its own sake...We find such homes particularly often when either or both parents are better educated than the average and the father is a professional man.³

Further significance was placed on the home through the work of Weigand who related the importance of parents in student academic success. He purported that:

A background of interest, encouragement, and democratic-positive

²Harold C. Urey, "Some Observations on Educational Problems in the United States With Particular Reference to Mathematics and Science" School Science and Mathematics LVIII (March, 1958), 168-174.

³Anne Roe, The Making of a Scientist (New York, 1953), p. 74.

supervision on the part of parents reinforces a generalized pattern of actions in their offsprings which is highly adaptive, not only in the academic situation but also in the solution of inter-personal and personal problems.⁴

The role of the teacher in influencing science students has been related in the work of Knapp and Goodrich:

It may seem extreme to allude to this student-teacher relation as a sort of "discipleship", but in the best sense this term most truly describes the peculiar personal devotion and admiration with which many of our scientists regard their undergraduate science teachers. This interpersonal relation appears to be of prime psychological significance in the mustering of purpose, the crystallizing of ambition, and the stimulation of emulative impulse toward a career in science.⁵

Brandwien, while working with outstanding high school science students, found the above factor to be true. He further reported that conversations concerning a student's science project soon led to a discussion of their science teacher and praise for his encouragement and aid.⁶

Roe has stressed the importance of the development of personal independence and the need for research experience. These factors were suggested to have a definite influence on the development of the research scientist.⁷ Pressey's work with precocious musicians and athletes led him to suggest that:

⁴George Weigand, "Adaptiveness and the Role of Parents in Academic Success", Personnel and Guidance Journal 35 (April, 1957), 518-22.

⁵Robert H. Knapp and H. B. Goodrich, Origins of American Scientists (Middletown, Conn., 1952), p. 249.

⁶Paul F. Brandwien, The Gifted Student as Future Scientists (New York, 1955)

⁷Anne Roe, Ibid, p. 70-82.

At any age, development of any ability is fostered by a favorable immediate environment, expert instruction, frequent and progressive opportunities for the exercise of the ability, social facilitation, and frequent success experiences.⁸

The above studies indicated that all aspects of a student's life were important determinants in his choice of a career and its successful pursuit. Much of the above mentioned work was centered upon exceptional scientists, students, and teachers. The factors indicated as being influential by a random sample of accomplished scientists might indicate significant trends. The collection and analysis of influencing factors from a random sample of accomplished scientists is the desired purpose of this report.

Methods Employed in the Problem

The random sample of scientists selected for cooperation in the investigation was obtained from the listings presented in Volumes I and II of The American Men of Science, 1955 Edition. The biological sciences sample was selected with a frequency of one name per eight pages while the physical sciences sample exhibited a frequency of one name per nine pages. Each selection was the first name presented with a complete bibliography on the desired page. The names of 160 biological scientists and 242 physical scientists were selected for participation in the study.

The form of correspondence selected for use was a personalized form letter which, though concise, presented the purpose of the study and an appeal for cooperation. Enclosed with the letter was (1) an information sheet, and (2) a stamped addressed envelope for its return. On the information sheet, two examples of influencing factors were listed and space

⁸S. L. Pressey, "Concerning the Nature and Nurture of Genius", Scientific Monthly 81 (September, 1955), 123-9.

was provided for the scientist to list the factors which influenced his career selection. No attempt was made to form a questionnaire because it was felt that more accurate results would be gained by allowing each scientist to present pertinent factors without the use of suggestive categories. In an effort to influence greater response, letterhead of the Academic Year Institute was used for production of the form letters and all return envelopes were addressed to the Institute.

The replies were carefully analyzed and a compilation of results by categories performed. The categories employed were those suggested by the scientists through their isolation of pertinent influencing factors. Total representation in each category was determined and categories composed of less than five per cent of the total positive returns eliminated. (Positive returns were defined as those which contained the requested information and did not include returns due to unknown forwarding addresses, etc.)

The categories which promised significant comparisons between replies from physical and biological scientists were isolated and individual totals for the two scientific fields were tabulated and compared.

CHAPTER II

DISCUSSION

The investigation of factors which influenced the choice of a career and its successful pursuit was based upon 231 positive returns. This figure was composed of returns from 140 physical scientists and ninety-one biological scientists. The principal categories indicated by the scientists in their returns were: school age, school level of course, school level of teacher, characteristics of teachers, family and home environment, intrinsic factors, and other factors. The categories of school age, school level of course, and school level of teacher each indicated that significant comparisons between biological and physical scientists could be presented. Therefore, these three categories were broken down and compared.

School Age

The school ages during which scientists were influenced to pursue scientific careers vary from pre-school to post-college ages. In all, eighty-nine biological scientists and 133 physical scientists identified the school age during which they were influenced to choose careers in science. The returns showed that physical scientists were influenced earlier than were the biological scientists. The trend appeared to start during junior high school (probably due to the presence of a general science course in the curriculum) and became very definite during high school and college.

TABLE I
THE SCHOOL AGE DURING WHICH PHYSICAL
AND BIOLOGICAL SCIENTISTS WERE
INFLUENCED IN THE SELECTION
OF SCIENCE CAREERS

School Age During Which Scientist Was Influenced	Physical Sciences		Biological Sciences	
	Number	Per cent	Number	Per cent
Pre-school	1	0.7	2	2.3
Grade School	10	7.5	10	11.2
Junior High School	11	8.3	3	3.4
High School	65	49.0	23	25.8
Post High School	7	5.3	4	4.5
College	36	27.0	47	52.8
Post College	3	2.2	0	0.0
Total	133	100.0	89	100.0

Comparison showed (TABLE I) that 65.5 per cent of the physical scientists had been influenced in the choice of a career upon completion of high school while only 42.7 per cent of the biological scientists had been so influenced. Possibly of greater significance, was the fact that upon completion of junior high school the returns from both scientific fields indicated percentages approximating 16.5 per cent. During high school, the percentage of physical scientists influenced in the choice of a career doubled the percentage of biological scientists so influenced. The biological scientists' returns indicated that they were influenced later in school life (chiefly in college). The percentage of biological scientists influenced in the choice of a career during college approximately doubled the percentage of physical scientists influenced during the same period.

School Level of the Course

Many of the returns indicated that a definite course had influenced the individual's choice of a career. A comparison of the percentages of scientists influenced by courses at different school levels further strengthened the trend exhibited in the previous section. Comparison of the returns from fifty-seven physical scientists with those from forty-two biological scientists (TABLE II) indicated that high school level

TABLE II

THE SCHOOL LEVEL OF THE COURSE DURING
WHICH PHYSICAL AND BIOLOGICAL
SCIENTISTS INDICATED THEY
WERE INFLUENCED IN
CAREER SELECTION

School Level of the Course Which Influenced Scientist	Physical Sciences		Biological Sciences	
	Number	Per cent	Number	Per cent
Grade School	0	0.0	4	9.5
Junior High School	2	3.5	1	2.4
High School	34	59.7	12	28.6
College	21	36.8	25	59.5
Total	57	100.0	42	100.0

courses influenced the majority of physical scientists while college level courses were responsible for influencing the majority of biological scientists.

School Level of the Teacher

The school level of the teacher who influenced students in the

choice of a career was indicated in the returns from fifty-seven physical scientists and forty-three biological scientists. Comparison of the returns (TABLE III) indicated that the trend shown in section one was

TABLE III
THE SCHOOL LEVEL OF THE TEACHER
WHO INFLUENCED SCIENTISTS IN
THE SELECTION OF CAREERS

School Level of the Teacher Who Influenced Scientist	Physical Sciences		Biological Sciences	
	Number	Per cent	Number	Per cent
Grade School	1	1.7	4	9.3
Junior High School	2	3.5	1	2.3
High School	35	61.4	10	23.2
College	19	33.4	28	65.2
Total	57	100.0	43	100.0

further strengthened. The returns from physical scientists indicated that 61.4 per cent of their number had been influenced by teachers at the high school level. The returns from biological scientists indicated that 65.2 per cent had been influenced in their choice of a career by college level teachers.

Characteristics of the Teacher

Throughout the returns scientists indicated certain characteristics of the teacher who had influenced their choice of a career. A roster of characteristics (TABLE IV) mentioned in five per cent or more of the positive returns revealed the personal qualities of an influencing teacher.

TABLE IV
PERSONAL QUALITIES OF INFLUENCING TEACHERS

Qualities Indicated	Incidence
1. Able to inspire, stimulate or arouse the curiosity of students.	42
2. Expressed confidence in students, gave advice and encouragement concerning further education.	28
3. Exhibited a personal interest in students.	11
4. Helped to secure scholarships or employment for students.	13
5. Personal love for his work and science.	11
6. Enthusiastic presentation.	12
7. Knowledge of the subject.	15

The indicated qualities listed above are in full agreement with the results stressed by Knapp and Goodrich.

Most of the variables that showed significant correlations with teacher effectiveness represented general character traits, not specific teaching techniques. This suggests strongly that it is the quality of the teacher as a total human being, more than his command of particular instrumental skills, that determines his success.¹

The Family and Home Environment

The importance of the home in influencing the choice and pursuit of a career cannot be overlooked. The analysis revealed that 108 of the 231 positive returns indicated that the choice of a career had been influenced by members of the family. The parents had influenced the

¹Robert H. Knapp and H. B. Goodrich, Origins of American Scientists (Middletown, Conn., 1952), p. 257.

career choice of seventy-six of these. Sibling influence was indicated in eight while relative and wife influence was indicated in nineteen and five returns respectively. Family influence was indicated in 46.8 per cent of the positive returns.

The atmosphere created by the family in the home environment influenced the choice of several careers. The freedom allowed in study, investigation and research initiated early exploration in science. The encouragement parents gave their offspring fostered early independent study and thought. The factors which scientists indicated were associated with the home environment and conducive in the early pursuit of a career are listed in TABLE V.

TABLE V
HOME CENTERED INFLUENTIAL FACTORS
INDICATED AS DETERMINANTS IN
THE CHOICE OF A CAREER

Influential Factors from the Home	Incidence
1. Father or mother was a professional person.	19
2. Scientific literature was available in the home.	29
3. The home possessed a scientific atmosphere.	20
4. Home investigations were encouraged.	26
5. Family encouraged home study or participation in nature study groups.	20
6. Family provided hobby sets, gadgeteering apparatus or equipment.	9

The Intrinsic Factors

The group of factors listed in TABLE VI revealed that intrinsic

TABLE VI
INTRINSIC FACTORS WHICH INFLUENCED
THE SELECTION OF CAREERS
IN SCIENCE

Intrinsic Factors	Incidence
1. Admiration for outstanding scientists and their accomplishments.	16
2. Desire to perform research, gain truth, contribute knowledge, and advance the profession.	48
3. Native curiosity.	64
4. Love for, or challenged and fascinated by the subject.	46
5. Ambition to teach.	15
6. Interest in natural history and love for outdoors.	18
7. Sense of accomplishment gained from success in studies or research.	34
8. Desire to improve own status.	31
9. Interest in humanity and human welfare.	16

factors are very important determinants in the choice of a career. While it is true that these factors may be conditioned by family, school, and environmental factors, intrinsic factors were identified with self by the scientists submitting positive returns. The results indicated that native curiosity, concerning the exact nature of the universe, was an important factor. The nature of the subject and the ability of the

scientist to succeed in his work and studies aroused a sense of accomplishment which encouraged further work. The desire to improve one's status occurred with greater frequency than purely altruistic desires.

Other Factors

Two other factors were associated by scientists with their choice and pursuit of a career. These factors, though closely related to some previously mentioned, are treated separately for purposes of clarity. The fact that they had received financial help was listed by eighteen scientists as the predominate influence in their pursuit of a career. Several scientists indicated that their teacher had been instrumental in efforts to gain financial support. Others indicated that the receipt of G.I. Bill benefits enabled them to continue their education and successfully pursue their career.

Fellow students and friends who were successful scientists influenced thirteen of the reporting scientists to pursue scientific careers. The role played by fellow students and friends seemed to reside primarily in their ability to arouse the curiosity of the neophyte. Friends and fellow students were also able to dispel fears concerning the rigors of the unknown course.

CHAPTER III

SUMMARY AND CONCLUSIONS

The factors which influenced scientists to select and pursue a scientific career differed with individuals but were capable of reduction to a few categories. The categories indicated by responses from scientists suggested that influential factors could be grouped into the four main categories of self, home, school, and environment. The following conclusions and trends seemed warranted after analysis of the data.

1. Physical scientists were influenced earlier than biological scientists in the selection of a career. Nearly fifty per cent of the physical scientists identified the high school grades as the grades during which they were influenced in the choice of a career while over fifty per cent of the biological scientists indicated the college grades as the period during which they were influenced.
2. The influence of particular courses and teachers upon physical scientists was indicated with greatest frequency of occurrence during high school while the biological scientists revealed that they had been influenced primarily by college courses and teachers.
3. The success of a teacher in influencing and inspiring students to pursue scientific careers seems to reside in certain human qualities. Influencing teachers demonstrated interest in the personal and interpersonal problems of their students as well as the academic subject matter taught.

4. The family and the home environment influenced the early choice of careers. The stimulation and encouragement by parents produced situations which fostered continued investigation and study.

5. The intrinsic factors influencing the choice and pursuit of a career in science need further study. Certainly, the innate curiosity of humans aroused by natural phenomena and a desire to understand the exact nature of the universe was the predominate influence in this group. The challenge of the unknown, desire for knowledge, and stimulation due to success experiences all played a part. The desire for improvement in personal status or professional recognition far outnumbered altruistic tendencies.

The chief benefit derived from the study was an indication of possible basis for an adequate questionnaire which might be employed to determine the further accuracy of the suggested trends. The basis of education lies in the individual and, if science education is to be stimulated, individual scientists may be capable of producing tangible foundations upon which educational practices may be built.

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