A COMPARISON OF THE TREND OF TENNESSEE COLLEGE GRADUATES OF MATHEMATICS PURSUING CAREERS IN TEACHING WITH THOSE PURSUING CAREERS AS INDUSTRIAL MATHEMATICIANS, 1955-60

by

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TABLE OF CONTENTS

INTRODUCTION

For the college graduate in mathematics, the two professions most commonly entered are "Teaching" and working as "Mathematician" in industrial research. A "trend" is presented each year as to which area most of the graduates in mathematics will enter.

The choice of area of employment must certainly be left entirely to the graduate, with certain influences within and about him ultimately causing the choice. The choice may depend to some extent upon his degree of efficiency in mathematics, his personality, or the desire for some particular contribution.

Man's fastest and most spectacular period is under way and our world is becoming more and more dependent upon mathematics. For the individual well trained in mathematics, innumerable doors are open inviting him into many exciting careers. There are not nearly enough people trained in mathematics to fill the jobs that are now available, and the demand is increasing tremendously. The qualifications needed are high, but individuals meeting them will be able to choose their jobs and be assured of good pay. Persons trained in the area of mathematics have only to decide which area will provide the most congenial and satisfying work, and in so doing will provide a sound basis for exemplifying and projecting their very best into their work.

In this report, the writer was particularly concerned with discovering the apparent trend of employment in "teaching" as compared with "industry," taken by the mathematics graduates of two of Tennessee's largest universities during the years 1955-60.

For long periods of years, educators as well as scientists have considered as a matter of concern, the course or direction of employment the individual trained in mathematics will pursue. Educators and scientists are seriously concerned for reasons which may be obvious to many. It is upon the shoulder of the teacher, that the burden of training the leaders of tomorrow lies. It is upon the shoulder of the industrial mathematician, that the burden of carrying the country forward in its advances in research, technology and outer space achievements lies.

Certain limitations were involved in this study. As was stated earlier, findings in this report were limited to only two of the universities in Tennessee, which to some extent may limit the validity of results. Also, results were given in this report without specific mention of environmental or socio-economic conditions of subjects, which many times tend to influence direction of employment for individuals. There may be some limitation imposed because of the shortness of the time period in years studied within this report. This is to say that the particular "trends" discovered as referred in this report, would perhaps have more validity as the time period studied was lengthened.

STATEMENT OF THE PROBLEM

The purposes of this study were: (1) to discover the trend of employment taken by mathematics graduates of two of Tennessee's leading universities -- Tennessee A & I State University and the University of Tennessee relative to "teaching" and employment as "mathematician" in industry during the years 1955-60; (2) to provide first hand information to teacher personnel executives as well as industrial executives, as to which area of employment generally has been most attractive, as indicated by the mathematics graduates, hoping that factors underlying the causes of the unattractiveness of an area are discovered, thereby providing the groundwork for solutions of such occupational problems.

SCOPE AND PROCEDURE

The type of research that was involved in this tudy is termed "descriptive" and represents a "historical" type of survey.

The sources of data used in this report included the Placement Bureaus of the colleges concerned, where records of employment and other information concerning graduates are kept. It also included information relative to employment that administrators or heads of the departments of mathematics of these schools kept on file.

Procedures used were as follows: First, the researcher made personal contacts with the schools involved when convenient. Next, the researcher gathered data by correspondence from the schools concerned in this report.

In analyzing the data, the researcher compared the number of graduates entering "teaching" to the over-all number graduating for each year, with the number entering "industry" to the over-all number graduating for each year. These comparisons were made for each individual school involved by means of percent, thus discovering the apparent trend.

DEFINITIONS

The term "trend" in this study has been defined to mean the most frequently chosen area of employment (teaching vs industry), taken by the mathematics graduates of the Tennessee universities. This most frequently chosen area was indicated by the combined six year per cents expressing numbers of mathematics graduates who entered the profession of "teaching" as compared to those who entered "industry" or research under the title of "mathematician."

The term "college graduate" was defined to refer to an individual who has completed requirements for an undergraduate major in mathematics and received a Bachelor's Degree for such, advanced degrees being disregarded.

A person was said to be "pursuing a career" if he was a graduate whose occupational work was begun in one area or the other, within the given years involved.

"Teaching" was used in this study to mean the instruction of student course work within any institution of learning.

"Industrial mathematician" in this study was defined as an individual employed to a position of "mathematician" connected with any agency or laboratory, where research and development of scientific knowledge is the primary concern. The term was also used in referring to any individual employed under the title of "mathematician" for government work.

"Tennessee universities" as used in this study referred only to two of Tennessee's major universities, the University of Tennessee and Tennessee A & I State University.

DESCRIPTION OF THE TWO UNIVERSITIES

Two of Tennessee's largest and outstanding universities, Tennessee Agricultural & Industrial State University and the University of Tennessee, are located in two of Tennessee's largest cities, Nashville and Knoxville respectively.

Tennessee A & I State University, a predominantly Negro school, (approximately 99%) has had an average enrollment of 3,500 students in its undergraduate and graduate departments combined, during the years 1955-60. (inclusive)

The University of Tennessee, whose undergraduate enrollment consists entirely of Caucasian race, has had an average enrollment of 7,000 students in both undergraduate and graduate departments combined, during the years 1955-60 inclusive.

Each year included throughout 1955-60, both of these universities enrolled many students in various curriculum areas of study.

For both schools concerned, one of the departments chosen as major area of study experiencing fewer students than most areas during 1955-60, has been the mathematics department. This perhaps is no real surprise to most, since this outcome has traditionally existed for many schools. Usually, some apparent fear or dread of the difficulty of the subject accounts for much of the reason for lack of interest on the part of students.

During the year 1955-60, the mathematics department of Tennessee A & I State University experienced an average yearly enrollment of 22 students,

while at the University of Tennessee, there was an average yearly enrollment of 38 majors in mathematics. This shows that an average of six tenths per cent of the students enrolled at Tennessee A & I were enrolled as mathematics majors while an average of five tenths per cent of the students enrolled at the University of Tennessee were mathematics majors for the six year period 1955-60 combined.

In an effort to aid readers of this report to more successfully interpret the findings, the writer has seen the necessity of listing and elaborating briefly on factors which perhaps contributed toward the particular outcome or results. Tables listed in this report express findings quite explicitly, however. The factors which the writer believed to have exerted influence on the initial choice of employment taken by the graduates of mathematics for each school were the following:

1. Historical background of each school.
2. Geographical areas covered by permanent residence of students enrolled.
3. Traditional area of employment of college graduates of race concerned. (Caucasian, Negro)
4. Differences in accumulative grade average (school bound vs industry bound)

These factors are first discussed with regards to Tennessee A & I, and afterwards discussed with reference to the University of Tennessee.

Tennessee A & I, a land grant university, opened as a state normal school in the year 1912. It became an accredited teachers college in 1922 with a four year training course. In 1937 the State Legislature authorized the school to grant the degree of Master of Arts.[1] Since that time the school has grown to the status of a full university, including the following schools: (Offering programs leading toward the Master's Degree)

Education

Agriculture

Business Administration

Engineering

Home Economics

Liberal Arts

Graduate School

The permanent residences of students attending Tennessee A & I include sections of all fifty states with a gradual increase of students from foreign countries. However, over 50 per cent of the students attending the school originate from Tennessee or the surrounding states of Alabama, Mississippi, Georgia, South and North Carolina.

As has been pointed out, Tennessee A & I's enrollment is approximately all Negro. Since this is true, many factors involving job opportunities available for Negro college graduates, and hiring practices involving these graduates undoubtedly tended to influence somewhat the data reported in

[1]James Aswell. Tennessee (New York: The Viking Press, 1939), p. 204.

this paper. Incidentally, there were no non-Negro graduates of the department of mathematics during the years studied, 1955-60.

An understanding that these possible influences have existed will enable the reader to best interpret results included in Tables which are forthcoming with reference to Tennessee A & I State University.

The University of Tennessee was established in 1794 as Blount College. By an act of the General Assembly in 1807, Blount became East Tennessee College, which in turn was chartered in 1840 as East Tennessee University, assuming its present name in 1879.[2]

The University of Tennessee, like Tennessee A & I, is a state university, and also a Federal Land Grant institution of the State of Tennessee. The institution is owned and supported by the people of Tennessee, and it receives some Federal support for certain programs sponsored cooperatively by the State and Federal Governments.[3]

Since its establishment, the university has grown into an institution consisting of fifteen different colleges and schools, and it has become statewide in its physical location as well as its services. The fifteen academic colleges and schools are as follows:

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[2] Ibid. p. 246.

[3] The University (General Catalog of University of Tennessee, Vol. LXIV., No. 6 Knoxville: University Press, 1961), p. 9.

Graduate School (Offering programs leading toward the Master's or the Doctor's Degree)

College of Agriculture

College of Business Administration

School of Journalism

College of Engineering

College of Home Economics

College of Law

College of Liberal Arts

College of Medicine

College of Dentistry

College of Education

College of Pharmacy

College of Nursing

School of Basic Medical Sciences

Graduate School - Medical Sciences

Graduate School of Social Work

The university's colleges and schools not only offer studies leading toward the Bachelor's, Master's and Doctor's Degree, but they also conduct research and engage in extension and public service activities in their specialized fields of knowledge.[4]

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[4] Ibid. p. 13.

Like Tennessee A & I, students attending the University of Tennessee hail from all fifty states, with an increasing number originating from many foreign countries. More than fifty per cent of the university's students originate from Tennessee and the states bordering it.

REVIEW OF THE LITERATURE

The first presentation of a study was found in a bulletin describing the economic situation of Negroes in the United States. Data found in this bulletin gave support to statements made regarding the probable expectations of occupational choice of the Negro graduates as compared to whites. This implication, of course, refers to the occupational restrictions which have confronted Negroes for many years.

As was stated in this bulletin "occupational differences between Negroes and whites are still large, but Negroes have raised their occupational levels appreciably faster, in the past 22 years, than whites."[5]

The ideas expressed in this bulletin can perhaps best be described in the following Table, which was also found in the bulletin:

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[5] W. Willard Wirtz, "Occupational Status of Races," The Economic Situation of Negroes in the United States (Washington: U. S. Government Printing Office, 1962), p. 2.

TABLE I

DISTRIBUTION OF EMPLOYED PERSONS
OCCUPATION GROUP, COLOR-SEX
APRIL 1940 TO APRIL 1962
BY PER CENT

MAJOR OCCUPATION GROUP	PER CENT							
	MALES				FEMALES			
	White		Non-White		White		Non-White	
	1940	1962	1940	1962	1940	1962	1940	1962
Professional, Technical & Kindred Workers	5.9	12.3	1.9	4.4	14.3	13.8	4.3	7.4
Managers, Officials, Proprietors except Farm	10.6	15.3	1.6	3.8	4.3	5.5	.8	1.7
Clerical and Kindred Workers	7.1	7.2	1.2	6.2	24.6	33.5	1.0	10.2
Sales Workers	6.7	6.4	.9	1.6	8.0	8.2	.6	2.2
Craftsmen, Foremen and Kindred Workers	15.5	19.9	4.4	9.0	1.2	1.1	.2	.7
Operatives and Kindred Workers	18.8	18.7	12.2	23.7	20.2	14.5	6.6	14.6
Laborers, except Farm and Mine	7.5	5.9	20.5	21.9	.9	.5	.9	.8
Service Workers, except Private Household	5.8	5.7	12.4	14.7	11.3	13.8	10.5	22.5
Private Household Workers	.2	.1	2.9	.5	10.8	6.3	58.0	37.3
Farmers and Farm Managers	14.0	5.9	21.3	5.4	1.2	.7	3.2	.3
Farm Laborers and Foremen	6.8	2.6	19.9	8.6	1.2	2.2	12.8	2.4
Occupations not Reported	1.0	----	.7	----	2.0	----	1.1	----

As can be noticed, from the preceding table, more than a fourth of the white males working -- but only 8 per cent of non-whites -- were in professional or managerial occupations outside of agriculture. Well over half the non-white men were in non farm manual occupations, but only 9 per cent were skilled craftsmen or foremen, as against nearly 20 per cent of the whites. More than 15 per cent of the non-white men were in service occupations, and almost as many were still doing farmwork compared with about 6 and 9 per cent for the whites. These percentages represent a gain in occupational status and occupational choice for both white and non-white men, but particularly for the latter.

The most common occupation of non-white women even in 1962 as in 1940, was domestic service work. However, the number at such work fell from 58 to 37 per cent of non-white women workers. The number of women in service work outside private households rose above 22 per cent. Far more of the non-white women were clerical workers by 1962, though they still constituted only a fraction of the percentage among white women. A big drop occurred in the per cent of non-white women doing farmwork. These data indicate the limitations and confinements as to occupational choice for Negroes, and to a great extent indicate the growth and expansion in occupational choices of this racial group.

With specific reference to employment of Negroes in industrial occupations, valuable material was discovered in a study from a book on "Negro Labor in the United States." The data obtained is the following:

"The World War of 1914 brought on the dawn of day of new opportunity for Negro labor. In the period prior to the war, Negroes had made their first appearance in skilled industry. The war industries increased the labor demand and for the first time Negroes who had been laborers, carpenters, blacksmiths, etc. entered many industrial occupations.

The facts of the transition to skilled labor and industry which are revealed by investigations in industrial centers are supported by census reports on occupations for 1920. In this census report, there was a shift of thousands to industrial pursuits.

The transition to an industrial activity and an economic position which will bring the Negro group to a place comparable with other race groups in America has not been completed. It is a continuous process at the present time in Negro life.

The tide of prejudice has been continuing where colored and white workmen meet and an increasing spirit of cooperation must be developed, so each group may realize that the successful solution of the labor problem, from the point of view of the worker, lies largely in the worker's cooperation without regard to race or sex.

One need not leave the role of historian and essay the role of prophet to realize that the future of Negro labor would be immeasurably advanced by education, cooperation, organization, and racial self-help. The history of the past economic development presages a greater advance in the immediate future. These facts present the view at the threshold of a closed door which is now slowly being pushed open by Negro labor--- the door to larger industrial opportunity."[6]

An interpretation of the previous data on Negro industrial employment may lead one to believe that this area of employment could possibly still

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[6] Charles H. Wesley, Negro Labor in the United States, (New York: The Vanguard Press, 1927), pp. 282-306.

be hesitantly pursued by Negroes, mainly because of former discriminatory hiring practices.

From another study has come important data which may support another factor which this report will introduce as perhaps having exerted influence on the initial choice of employment taken by the mathematics graduates of both schools: That certain trends of employment may have been taken by graduates of a particular school because a school may have established a tradition for producing graduates who enter a certain type of employment. Such statements and beliefs are supported by a study brought out by Aswell and Bunce, "Tennessee A & I State University opened as a State Normal School in 1912, but became an accredited teachers college in 1922 with a four year teacher training course."[7]

Aswell and Bunce from Federal Writers Project also state concerning the University of Tennessee "the University of Tennessee was established with a strong military tradition from the beginning. The College of Liberal Arts began to offer graduate courses in 1872, and not until the following year 1873, were courses for teachers added to the curriculum."[8]

On the basis of the previous quotations from the study, it perhaps is suggested that Tennessee A & I State University has had a tradition of producing teachers.

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[7]Aswell, Loc. Cit.

[8]Ibid., p. 246.

Whereas, quite contrary to the previous statement, the historical background of the University of Tennessee did not at all indicate a tradition for producing teachers or being that of a teachers college. In fact, no emphasis at all was placed on an education department at this school until 1873 which was noticed to be nearly 80 years after the establishment of the school.

To some degree, this data presented may reflect a more appreciable understanding as to the particular trend of distribution of occupational pursuits taken by the mathematics graduates of the two schools.

Other studies tend to offer support to trends taken by the mathematics graduates who strongly pursued teaching. A study may, at the same time, offer support to trends not strongly favoring the teaching area, but with about as much emphasis on "industrial mathematician" employment as on "teaching." In such a study, attractive and inviting characteristics of teaching and also of industry are presented and are a compliment to each profession. Such advantages and fine qualities of the mathematics teaching area and also of research and industrial work in mathematics are brought out in a booklet prepared by the National Council of Teachers of Mathematics, the National Academy of Science, and the National Research Council. The points presented are as follows:

> The teaching of mathematics requires a liking and understanding of people, and an enjoyment to helping people find their way to greater knowledge. It may be a most satisfying career by helping to meet one of the greatest needs in our country today -- the training of more people in mathematics.

Teachers salaries in public schools are improving. In many school systems it is possible to begin at $4,500 and to reach $8,500 or more in 12 or 13 years. In some large school systems top salaries are in the $10,000 to $12,000 range, depending upon length of service and amount of advanced study. The National Education Association is urging that salaries should range from $6,000 to $13,000 or more. These salaries are for the school year of nine or ten months. Teachers have the advantages of regular promotions, tenure, retirement systems, and summer vacations.

In colleges or universities, salaries vary greatly with the institution and from instructor to full professor. A few professors get as much as $15,000 to $20,000. While salaries generally are not as high as would be desired, professors enjoy the advantages of academic life, such as security of tenure, retirement plans, and above all, the freedom to work on what interests them.[9]

With regard to research and industrial work in mathematics, the booklet offered the following information:

If you are not only an outstanding student of mathematics, but have the ability to do creative work as well, you may be attracted by the relatively new field of research in industrial mathematics. Today most big industries employ a number of mathematicians who do mathematical research on methods, plans, and products. There are not nearly enough people trained to meet the demand in this area.

People who work in the area of pure research in mathematics must be versatile in their field and interested in pushing back the frontiers of man's knowledge. We in the United States have produced very few of these people. Now that we are on the threshold of the space age, we find that this shortage is critical.

Training for pure research in mathematics is long and intensive. It takes at least three years of concentrated study in mathematics beyond the college level. A career in research calls for keen, highly intelligent people who deal easily with abstractions.

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[9]National Council of Teachers of Mathematics. "Teaching Mathematics" Careers in Mathematics, 3:22-23, January, 1963.

> The Federal Government is the largest single employer of mathematicians, and constantly needs more qualified people. Opportunities for women are particularly good in government. There are a wide variety of jobs available in government whose duties range from routine computation to a few in the area of pure research in mathematics. Among the many bureaus and departments in Washington that need mathematicians are: National Bureau of Standards, Department of Defense, (Army, Navy, Air Force), Bureau of Mines, Coast and Geodetic Survey, Weather Bureau, and Census Bureau.
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> The beginning salaries for certain levels of college training (or the equivalent) are approximately: Bachelor's Degree $5,300, Master's Degree $6,300, Ph.D., $7,500. However, those who, because of superior academic performance as students, receive "quality" ratings from their schools can begin at salaries considerably higher. Top-level salaries in government jobs are in the $12,000 to $15,000 range, with the ceiling open to $17,000 for a few exceptional persons.[10]

From the immediate preceding findings, reasons may be clearly deduced as to why a school's mathematics graduates may not overwhelmingly pursue the area of research and industrial work. As was especially noted, the area of pure research requires in addition to being an outstanding student in mathematics, creative ability, long and intensive training, more advanced years of concentrated study, and demands keenly and highly intelligent people who easily work with abstractions. As also was noted, these particular strenuous requirements clearly presented a distinction between industrial research employment and the teaching area. As was observed, the area of teaching has not demanded such an unusual and exceptional list of requirements.

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[10] Ibid., pp. 23-24.

From a study presented by the U. S. Department of Labor, comes other data regarding salaries and employment trends specifically pertaining to the year 1960. The data is as follows:

> "Numerous employment opportunities at record pay levels are available to the 1960 college graduates, according to college placement officials and campus recruiters surveyed by U. S. NEWS AND WORLD REPORT. A similar survey of personnel officers of corporations by the "Wall Street Journal" indicates that employment of college graduates is being increased even by some firms which are not too optimistic about business conditions for the next few months. This is being done so that firms can obtain personnel for training in needed skills.
>
> Demand is particularly strong for graduates with professional, scientific and technical training, such as engineers, physicists, chemists, and mathematicians. Salaries of $525 to $550 a month are offered these specialists by firms engaged in electronics, nuclear energy, and missle-development fields. The graduate with a master's degree received an additional $75 to $100 a month.

Starting Salaries for the Class of 1960

Engineers and Scientists	$6300 to $6600
Accountants	$5400 to $5700
Lawyers	$5100 to $5600
General Business Graduates	$4900 to $5400
Liberal Arts Graduates	$4800 to $5400
Salesmen	$4400 to $5000
Newspapermen	$4000 to $4300
Teachers	$3800 to $4200

> It is clearly seen that salary wise, the most inviting opportunities for the year 1960 were in engineering and scientific work which of course also include the employment of mathematicians for industry. It is noticed that the teaching area ranks the very lowest in salary."[11]

While there were pointed out many advantages to both areas of employment under discussion, generally it was noticed that beginning and ending salaries for industrial and research mathematicians have been appreciably higher than in the teaching areas, which obviously is one attractive feature of this phase of work. This particular feature would perhaps serve as an influence for those graduates who pursued employment as "mathematicians."

A study relative to this paper is found in a "Handbook of Research on Teaching" which is a project of the American Educational Research Association. Data drawn from this study may clearly support the results of the occupational trends taken by mathematics graduates of the schools concerned. This study, written by W. W. Charters, Jr., points out that "teaching clearly draws heavily from the female population. Currently, slightly less than three-quarters of the nations teachers are women, a figure which has varied substantially during the past 100 years."[12]

Concerning the geographical and social factors which may influence students to select the teaching profession, Charters points out the following:

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[11] U. S. Department of Labor, Current Labor Market Conditions in Engineering, Scientific & Technical Occupations, (Washington: U. S. Government Printing Office, 1960), pp. 22-23.

[12] N. L. Gage, Handbook of Research on Teaching. (Chicago: Rand McNally and Company, 1963), pp. 718-719.

> "Most studies on occupational background have surveyed teachers-in-training, not teachers on the job. Generalizing from such data to the teaching population at large is hazardous. Aside from the fact that substantially less than 100 percent of these students enter teaching, several studies have demonstrated important characteristics, and differences among types of college in background characteristics of their students. Teacher-trainees in the small teachers colleges, for example, are more likely to come from agricultural and laboring families than teacher-trainees in liberal arts colleges or the larger universities."[13]

Studies providing statistical information on teaching and industrial employment with regard to nativity and race of individuals did not seem very plentiful, as the writer of this paper discovered during research. However, it is very safe to say that nationally the overwhelming majority of teachers are Caucasians.

As Charters further points out, "dependable national statistics regarding the nativity and race of public school teachers are less abundant, but it is probably safe to say that the overwhelming majority of American teachers are native-born and white. The 1950 census, for example, reported that Negro and other non-white races constituted less than seven percent of the teaching population."[14]

With reference to employment in mathematics on a nationwide basis other than teaching, it may be interesting to note the results of a survey which solicited information from individuals employed primarily in mathematical work in private industry and the Federal Government. The results of this survey show the following: "Approximately 22,000 persons were

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[13] Charters, op. cit., p. 720.

[14] Ibid., p. 719.

employed in mathematical work other than teaching by mid-1960. Of these, more than 17,000 were employed in private industry in companies with a total employment (of all occupations) of 100 or more. Almost 3,000 were in the Federal Government and 300 in nonprofit organizations."[15]

It perhaps can be deduced that possibly there is a shortage of mathematicians in industry. This idea is supported in a study written by Dr. Norris E. Sheppard who writes, "The shortage of mathematicians is acute in every sphere. Universities, industrial companies, insurance firms, other businesses, and governmental agencies are all hungry for mathematically trained personnel. Job openings are plentiful both in Canada and the United States."[16]

In another study, the writer of this paper has found data which may very well serve as justification for the fact that few of the mathematics graduates pursued the industrial area. It reads as follows:

> "Graduate training is required for many mathematical positions, particularly in research and teaching. In industry, advanced degrees are required for an ever increasing number of jobs, not only in research but also in many areas of applied mathematics. The Ph.D. Degree is especially important for most college and university teaching positions and for the more advanced research work."[17]

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[15] National Science Foundation, Employment in Professional Mathematical Work in Industry and Government. (Washington: U.S. Government Printing Office, 1962), p. 12.

[16] Norris Sheppard, "Should You Be a Mathematician," New York Life Insurance Advertisement, 33:1-2, June, 1958.

[17] United States Department of Labor, Employment Outlook for Mathematicians, Statisticians, Programmers (Occupational Outlook Report Series. Washington: U.S. Government Printing Office, 1959), p. 2.

On the other hand, the same study further points out:

> "In general, mathematicians in private industry tend to have higher incomes than those in other types of employment. For example, the median annual professional income of mathematicians was about 15 per cent greater than in colleges and universities, according to the 1956-58 Register."[18]

Interesting studies and surveys have been made by governmental and other agencies on the employment situations with regard to professional mathematical work in industry, research and government, also with regard to the teaching area. These surveys have been done on a nation-wide basis and are quite comprehensive in scope. The first survey presented was taken from an OCCUPATIONAL OUTLOOK QUARTERLY, in an article by Hermanson which is as follows:

> "Young people with a good educational background are in demand for a wide variety of positions in industry and government. Between 1954 and 1960, employment of mathematicians in private industry more than doubled. Employment in related occupations requiring a great deal of mathematics training has also risen rapidly in recent years.
>
> Professional mathematics positions are found in the space, missile, atomic energy, and other programs of industry and government; in aircraft, electronics, chemicals, and other manufacturing plants; in insurance companies; and in a wide variety of other employment agencies.
>
> To learn more about these employees and the kind of work they perform, the National Science Foundation and the Mathematical Association of America asked the Bureau of Labor Statistics to conduct a survey of mathematical employment other than teaching. In early 1960, questionnaires were distributed to professional personnel in full-time positions in which mathematical work predominated

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[18] Ibid.

and in which a knowledge of equal at least to that provided by a four-year college course with a major in mathematics was required. In addition to mathematicians, employees with position titles as mathematical statistician, actuary, operations research analyst, computer programmer, and engineering analyst met the requirements for inclusion in the survey. About 10,000 persons (roughly half of the estimated total in mathematical employment in industry and government in 1960) responded; about one in seven was a woman. Their replies provided the data for the final survey report which is condensed in the following article:

Major Employer and Functions

More than half the respondents to the 1960 survey were working for aircraft and electrical equipment manufacturers and the U. S. Department of Defense. Private industry alone employed about 80 per cent of all professional mathematical workers. In addition to the aircraft and electrical equipment companies, other large employers were machinery manufacturing, petroleum products, and insurance. Many employees in mathematical work were also found in engineering and architectural services, telecommunications, and utility companies. Nearly all Federal Government agencies employed at least a few people in professional mathematical work. However, the Department of Defense was by far the largest employer. The National Aeronautics and Space Agency and the Commerce Department also employed significant numbers. The table which follows, presents a picture of the over-all types of mathematical employment, functions of employees and types of employers:

TABLE II

MAJOR FUNCTION OF PERSONS IN MATHEMATICAL EMPLOYMENT, BY TYPE OF EMPLOYER, 1960
BY PER CENT

FUNCTION	All Employers	Private Industry		Governmental Agencies	Non-Profit Org.
		Insurance Indus.	Other Indus.		
All functions					
Number.	9,867	914	6,189	2,542	222
Percent.	100.0	100.0	100.0	100.0	100.0
Basic Research in Natural Sciences & Engineering. . . .	7.0	.1	5.5	11.4	25.7
Applied Research and Development in Natural Sciences & Engineering.	45.4	2.9	51.8	44.8	50.4
Nontechnical Research, including marketing & other economic research.	4.0	5.0	3.8	3.6	10.4
Technical Services allied to production	18.3	19.6	21.4	11.7	2.2
Technical Services allied to Sales, Promotion, or Distribution.	4.4	17.4	4.1	.8	.5
Teaching & Training	.8	.3	.9	.8	.9
Administration	8.2	25.5	4.6	11.1	2.2
Other.	11.9	29.2	7.9	15.8	7.7

As was noted, basic or applied research and development in the natural sciences and engineering was the major mathematical function of more than half the survey respondents. However, it was seen that about six and one half times as many respondents were primarily concerned with applied research (forty-five per cent) as with basic research. Technical services allied to production was the only other type of function in which a sizeable proportion (eighteen per cent) of the mathematical workers were engaged.

Educational Attainment

Ninety-four per cent of the survey respondents had college degrees, and one-third had received advanced degrees -- seven per cent at the Ph. D. level. A much smaller proportion of women than men employees had earned advanced degrees. Only two per cent of the women in this employment had doctorates, and fifteen per cent had master's degrees -- compared with eight and twenty-eight per cent, respectively, for the men.

About two-thirds of the survey respondents who had college degrees had majored in mathematics at their highest degree level; this includes five per cent whose degrees were in statistics or actuarial science. In addition, almost one in four of those who held advanced degrees in other fields had majored in mathematics at the bachelor's degree level. Thus seventy per cent of the college graduates in the survey had received at least one degree in mathematics."[19]

From a section entitled "Mathematics Teachers" in a government publication containing a study on Science and Mathematics Teachers in public high schools, comes data relative to the nationwide number and distribution of mathematics teachers and various other aspects and trends in mathematics teaching. Some of these data are:

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[19]George Hermanson. "Employment in Professional Mathematical Work in Industry and Government," Occupational Outlook Quarterly, 5:15-18, December, 1961.

"Of the 592,228 teachers in the public secondary schools in the fall of 1961, 118,298, or twenty per cent were teaching one or more periods in mathematics. Of the 118,298 mathematics teachers, 38,779 were teaching in the junior high school; 41,060 were teaching in the junior-senior high school; 28,245, in the senior high school.

Of the approximately 118,000 mathematics teachers, 76,512 teach four or more periods in mathematics each school day. Thus sixty-five per cent of the mathematics teachers devote most of their time to mathematics instruction. These teachers, referred to as full time mathematics teachers, were thirteen per cent of the total teaching staff of the public secondary schools in the fall of 1961.

The 76,512 full time mathematics teachers were distributed by type of schools as follows: junior high school, thirty-four per cent; junior-senior high school, 32.9 per cent; senior high school, 9.9 per cent; and regular four year high school, 23.2 per cent. The distribution of all public secondary school staff in 1958 was the following: junior high school 23.7 per cent; junior-senior high school, 32.6 per cent; senior high school, 14.3 per cent; and regular four year high school, 29.3 per cent.

These data do not indicate a great difference between the distribution of full time mathematics teachers in the various types of schools and the distribution of all secondary school teachers.

Of the 118,298 mathematics teachers, 24,347, or 20.6 per cent, were teaching two or three class periods in mathematics each day. Generally these teachers had some other teaching duties; therefore, they are referred to as part-time mathematics teachers.

Nearly fifteen per cent (17,439) of the 118,298 mathematics teachers taught only one period per day in mathematics. In many cases, due to the increase in enrollments,

an extra class section developed beyond the capacity of the normal mathematics staff. These teachers are referred to as one period or one class mathematics teachers.

Although the data in this study does not show the preparation of the one class mathematics teachers, other studies indicate that most of these teachers majored in another field. While it is not always possible to schedule classes under fully qualified full-time mathematics teachers, it is certainly desirable for a pupil to study mathematics under a teacher whose major interest is in that field.

Regarding mathematics teachers turnover, approximately twenty per cent of all mathematics teachers were new to the school in which they were teaching."[20]

From the two previously mentioned studies, come important data relative to this report. For example, nationwide trends of mathematical employment can be noticed with regard to industrial and also the teaching occupations. As a result of these type data certain comparisons may be made.

For example, it was noticed that the 10,000 persons who responded in the survey on mathematical employment other than teaching, represented approximately half of the estimated total in this type of mathematical employment nationally. It is therefore safe to say that as of 1960, the total of all persons employed in mathematical employment in industry and government was approximately 20,000.

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[20] Kenneth E. Brown, Science and Mathematics Teachers in Public High Schools. (Washington: U. S. Government Printing Office, 1963), pp. 19-26.

In the other study on mathematics teaching nationally, it was noticed that as of early 1961, there were 118,298 teachers of mathematics within the public secondary schools. No data was provided in this study on private or other schools' mathematics teachers.

Noticed also was the fact that 17,439 of these mathematics teachers taught only one class per day in mathematics, and that most of these teachers pursued majors in other subject matter areas.

If these 17,439 teachers are exluded in a comparison between the national total number of persons in industrial mathematical employment with the number teaching mathematics, it can be seen that approximately 20,000 persons in industrial employment are then compared with approximately 101,000 teaching mathematics full time.

Here the national trend of employment for mathematics graduates is easily seen. Nationally, more than five times as many mathematics graduates had entered the teaching area than had entered the industrial employment areas. This made the teaching area, around the years 1960 and 1961, the most nationally pursued by far.

EMPLOYMENT TRENDS

Table III which follows, shows the trend of employment for mathematics graduates of Tennessee A & I State University with regard to teaching and industry for the given years involved.

TABLE III

NUMBER AND PERCENTAGES OF MATHEMATICS GRADUATES ENTERING TEACHING AND INDUSTRY DURING YEARS 1955-60

Tennessee A & I State

Years	Number Graduating	Number Teaching	Number Entering Industry	Number Entering OthOccu.	% Teaching	% Industry	% Other
1955	5	3	1	1	60	20	20
1956	3	0	2	1	0	66.7	33.3
1957	7	5	0	2	71.4	0	28.6
1958	7	6	0	1	85.7	0	14.3
1959	5	4	0	1	80	0	20
1960	5	4	0	1	80	0	20

Combined Per Cent Teaching: 69

Combined Per Cent in Industry: 9

In Table III, it was noted that a definite trend toward teaching was taken by the graduates in mathematics at Tennessee A & I during each year involved with the exception of 1956. It was interesting also to note that throughout the six year period, the combined number of mathematics graduates entering occupations other than teaching or industry more than doubled the combined number entering industry. It was further noted that the number of students who entered other occupations represented an approximate average of 22 per cent of the total of all the mathematics graduates of Tennessee A & I during the six year period. For each year except 1956, there tended to be a sharp increase in the percent of graduates entering teaching with a steady leveling off during 1959 and 1960. It was noted that for the two years 1959 and 1960, all corresponding percents under each column heading are identical, which means that exactly the same number of students graduated and entered each different occupation listed for both of the two years.

Results obtained regarding the University of Tennessee are brought out in Table IV, which follows:

TABLE IV

NUMBER AND PERCENTAGES OF MATHEMATICS GRADUATES
ENTERING TEACHING AND INDUSTRY
DURING YEARS 1955-60

University of Tennessee

Years	Number Graduating	Number Teaching	Number Entering Industry	Number Entering Oth. Occu.	% Teaching	% Industry	% Other
1955	8	3	2	3	37.5	25	37.5
1956	4	1	1	2	25	25	50
1957	6	2	2	2	33.3	33.3	33.4
1958	8	2	3	3	25	37.5	37.5
1959	11	7	1	3	63.6	9.1	27.3
1960	14	4	6	4	28.6	42.8	28.6

Combined Per Cent Teaching: 38

Combined Per Cent in Industry: 29

In Table IV, relative to the University of Tennessee, a slight trend was observed toward teaching, even though the number of mathematics graduates who entered teaching and industry fluctuated from year to year. This trend is hardly noticeable unless one considers the combined total entering teaching and industrial fields for the six year period, which are nineteen and fifteen respectively. From Table IV, when one observes that the combined six year total of graduates who entered fields other than teaching or industry was seventeen out of fifty-one, or one third, it can be realized that these mathematics graduates were fairly evenly distributed in the three categories. It was discovered that for teaching, industry and other occupations, the percents for the combined six year period were within close proximity of one third, or 33 percent.

With respect to teaching and industry, Table IV further shows that for each year except 1959, the numbers of graduates entering these two areas remained extremely close. It was noted further that there never tended to be a highly obvious trend toward either teaching or industry for graduates of the University of Tennessee except for the years 1959 and 1960, when a large percent of graduates entered "teaching" and "industry" respectively.

It may be expected that occupational distribution as to types of employment, regarding mathematics graduates of the University of Tennessee, to be more widely spread than for graduates of Tennessee A & I. This is because generally, choices for particular types of occupations have been wider for Caucasians as compared to Negroes, especially in southern United States.

Again, the factor concerning accumulative grade average of school bound vs industry bound mathematics graduates cannot be overlooked as a possible influence toward the initial choice of employment, although no data explicitly supporting this belief was discovered.

The writer realizes that these influences mentioned and briefly elaborated upon for each individual school are by no means all influences which could possibly enter into the decision of occupational choice made by the graduates in mathematics. Possible home and family influences, salary, love for particular type of work, and others perhaps played significant roles in determining the kind of work decided upon by the graduates in mathematics. Nevertheless the writer feels that even with as few universities as are represented in this report, results obtained are valid enough to represent the true trend taken within the state of Tennesse. This is believed, especially since these universities concerned are two of Tennessee's largest and also because students attending them represent to some extent every segment or area within the entire state, and certainly represent both of the state's dominant racial groups.

While there was a definite trend toward teaching indicated by graduates in mathematics from Tennessee A & I, and a not so definite trend toward either area for graduates of the University of Tennessee, there were many interesting differences when one school was compared with the other. For example, while the average total student enrollment at the University of Tennessee doubles that of Tennessee A & I, the output of mathematics

graduates at the University of Tennessee during 1955-60 only represents approximately one and one half times as many graduates as Tennessee A & I.

Also, throughout the years 1957-60, it is observed that there was not a popular tendency to enter industry for the mathematics graduates of Tennessee A & I. In fact, while there were no graduates who entered the industrial area during either of the four years throughout 1957-60, there was only one year when no graduates entered the teaching profession. When this was compared to the University of Tennessee graduates, it was observed that there were no years throughout the period under study that either field, teaching or industry was not entered by graduates of the University of Tennessee.

In another comparison between the two schools, it was interesting to note that the combined per cent of mathematics graduates who entered teaching from Tennessee A & I, 69 per cent, represented almost twice the combined per cent of graduates who entered teaching from the University of Tennessee, which was 38 per cent. Whereas, the combined per cent of mathematics graduates who entered industry as mathematicians from the University of Tennessee, 29 per cent, represented three times the combined per cent of mathematics graduates who entered industry from Tennessee A & I, which was 9 per cent.

Though not given explicitly in the table, the combined per cent of mathematics graduates of Tennessee A & I who entered occupations other

than teaching or industry was approximately 22 per cent, which represented still approximately 13 per cent more than the combined per cent of graduates who entered industry from the university. Whereas, at the University of Tennessee, approximately 33 per cent of mathematics graduates entered occupations other than teaching or industry throughout the six year period studied. This percent, of course, represented nearly the same combined percent of graduates who entered "teaching" from the University of Tennessee.

It was further observed in comparison between the two schools that for Tennessee A & I, the year 1960 represented no change whatever over 1959 as far as distribution of the percents among the employment areas were concerned. However, for the University of Tennessee, the two years 1959 and 1960 represented two of the most unstable years within the six year period as far as percent distribution among the areas of teaching and industry were concerned.

These comparisons and observations from the Tables represented and somewhat supported earlier statements made regarding probably expectations which one may have had concerning the extent of the occupational distribution spread from the graduates of the schools studied. Outcomes in the Table representing Tennessee A & I clearly show that mathematics graduates of this school, all of whom were Negroes, overwhelmingly pursued the area of teaching as compared to industry and other

areas of mathematical employment.

On the other hand, the distribution of mathematics graduates of the University of Tennessee clearly supported earlier statements by showing that there was no specific area of employment (teaching, industry, others), which the graduates overwhelmingly pursued. This was shown when it was noticed that combined average percents representing the three areas (teaching, industry, others) in occupational employment were nearly equal for mathematics graduates of the University of Tennessee.

SUMMARY AND CONCLUSIONS

The mathematics graduates of the universities around which this study is centered, by no means represent all mathematics graduates, as was previously mentioned. Likewise, the employment trends taken by these graduates should not be thought of as a definite indication of the nationwide or even of statewide trends. However, the writer believed that due to the findings, the trends expressed in this study quite possibly represent to an appreciable degree of accuracy, the nationwide or statewide trends, especially if graduates considered are graduates of schools which generally are similar to the given schools in background, structure and student composition.

In considering the resulting trends taken, there were several factors which were noted as possibly having exerted influence toward a particular trend, among which were historical backgrounds of the schools, geographical areas covered by permanent residences of students enrolled, and traditional areas of employment of college graduates of certain races.

It was very clearly noted that while the racial composition of the two schools concerned were different, the occupational trends resulting were likewise quite different. More specifically, graduates of the school whose student composition was predominantly Negro, overwhelming pursued the field of teaching, whereas, graduates of the school whose student composition was all Caucasian, did not overwhelmingly pursue any particular

occupational area of employment. Probable reasons for these particular outcomes were cited and discussed.

The writer has attempted to present conclusions in this section after comparing data included in the findings with the review of the literature presented in this study.

One conclusion the writer feels is inherent from this particular study is that the occupational pursuits of graduates of a given school may be partly determined by the general historical background of the school. Most colleges and universities are noted for some degree of excellence in contributing to some profession, whether it is to teaching, science, farming, etc., and therefore usually carry lifelong traditions for being characteristic of making such contributions to the education of our nation.

Another conclusion which the writer of this paper felt justifiable, on the basis of the findings, is that occupational choices of students are partly determined as a result of the geographical environment which exist during the early life of the student. That is, the most prevalent occupational professions around a student's home environment (such as teaching), with which a student becomes more familiar, may be important in an occupational choice.

The writer also felt that because of the nature of this particular study, factors of a racial background inevitably played a significantly important role. That is, because of the many racial stigmas which have

existed in the United States, employment limitations have tended to minimize the professional scope of occupational choices for the Negro race. More specifically, it is believed that the Negro graduates with which this study is concerned, strongly pursued the teaching area because teaching, generally, has been the most popular professional area of employment over a long period of time for this racial group, especially in southern United States.

Studies have been included in the "Review of Literature" which to some extent verify and support findings in this particular study, and have been elaborated on briefly in this summary and conclusion section.

For example, statements made by this writer concerning Tennessee A & I's mathematics graduates who strongly pursued teaching, and the University of Tennessee's mathematics graduates who did not strongly pursue teaching, being partly attributed to the historical background of the schools, were verified by Aswell and Bunce in the "Federal Writers Project" study. In their book, it was pointed out that Tennessee A & I really did have a strong background and tradition for producing teachers, whereas, the University of Tennessee did not have such a background.

In further discussing Tennessee A & I's mathematics graduates, the fact that the writer discovered the greater percent entered teaching areas yearly was supported very strongly in the HANDBOOK OF RESEARCH ON TEACHING, when Charters pointed out that teaching draws heavily from

the female population. Charters also pointed out that slightly less than three-fourths of the nation's teachers were women at the time of his study. It had been previously noted that a greater per cent of women graduated from Tennessee A & I during the period 1955-60 than from the University of Tennessee.

As mentioned earlier, the theory that race must have been an important factor which helped to influence the trend of employment for mathematics graduates of Tennessee A & I, was brought out because of job discrimination, which has long existed. The assumption that job discrimination must have been a factor which limited Tennessee A & I's graduates mainly to the teaching area was verified somewhat in a study on "Occupational Status of Races," which gave rise to statements concerning the largeness of the occupational differences between Negroes and whites, but that Negroes, however, have raised their occupational levels appreciably fast within the past twenty-two years.

There was a great instability in employment trends for the mathematics graduates of the University of Tennessee for the years 1959 and 1960. That is, a much larger per cent of mathematics graduates entered the industrial area in 1960 than in 1959 or even the other years involved, from this school. The writer of this paper discovered data from an Occupational Outlook Report which could have supported this turn in trend. This data presented the starting salaries for various occupations, having the area

of scientific and industrial work with the very top beginning salaries and the teaching area listed at the very bottom in beginning salaries. With knowledge of such an occupational outlook report as this, it is not difficult to understand the very sharp turn in favor of industrial employment for these graduates during the year 1960.

For this writer's study, results of employment of the mathematics graduates of Tennessee A & I which showed the highly noticeable trend toward teaching, were supported in a national study and survey on mathematics teaching and industrial employment. While the combined six year average per cent teaching was almost five times the combined average per cent in industry for Tennessee A & I, it was shown from the national report that there were more than five times as many full time mathematics teachers as industrial mathematicians around the years 1960 and 1961.

It is perhaps well to conclude also that some justification should be made for the results which showed absolutely no mathematics graduates of Tennessee A & I pursuing the industrial field during the years 1957-60. Quite possibly justifying this is data which was obtained from a study presented on "Negro Labor in the United States" which was done around the year 1925. In this study facts were presented relative to doors of industry which were previously entirely closed to Negroes, that were slowly being pushed open. It was pointed out that the gradual opening of

these industrial doors would eventually lead the Negroes into larger industrial opportunities.

Before finally concluding, it is perhaps well to mention a statement which this writer listed as being a possible influence toward the trend of employment taken by the mathematics graduates of the two schools, which may have been significant. It was believed that graduates who entered the industrial areas graduated with the higher of the grade point averages. Though not explicitly stated as such, data was secured which may support this belief. From a study issued by the National Council of Teachers of Mathematics, detailed data on general requirements for entry into the research and industrial as well as the teaching professions, were given. These data indicated noticeable differences in requirements for these different professions. It was emphasized that generally, the research and industrial professions demand the more rigid requirements, i.e., more advanced degrees, longer and more intense training, creative ability, keenly and highly intelligent people, and in addition to being an outstanding student in mathematics, one who works well with abstractions.

Such strenuous requirements were not mentioned as being those demanded for teaching positions. It was pointed out that because of this data, graduates who entered industrial fields, possibly graduated with the higher of the grade point averages from the two universities with whom this study is concerned. At least, this was mentioned as a possibility which should not be disregarded.

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A COMPARISON OF THE TREND OF TENNESSEE COLLEGE GRADUATES OF MATHEMATICS PURSUING CAREERS IN TEACHING WITH THOSE PURSUING CAREERS AS INDUSTRIAL MATHEMATICIANS, 1955-60

by

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ABSTRACT

The immediate purposes of this study were: (1) to discover the trend of employment taken by the mathematics graduates of two of Tennessee's leading universities -- Tennessee A & I State University and the University of Tennessee, relative to "teaching" and employment as "mathematician" in industry during the years 1955-60; (2) to provide first hand information to teacher personnel executives as well as industrial executives, as to which area of employment generally has been the most attractive, as indicated by the mathematics graduates, hoping that factors underlying the causes of the unattractiveness of an area are discovered, thereby providing the groundwork for solutions of such occupational problems.

The writer secured data on the mathematics graduates of the two universities concerned both by personal contact and by correspondence with the Placement Bureaus and heads of departments of mathematics of the two universities.

In analyzing the data secured, the writer compared the number of graduates entering "teaching" to the over-all number graduating for each year, with the number entering "industry" to the over-all number graduating for each year. These comparisons were made for each individual school involved by means of percent, thus discovering the apparent trend of employment.

During research, in reviewing literature of studies which are concerned with data as included in this study, other studies were discovered which verified or supported much of the findings of this writer.

In the findings, it was noted most significantly that the mathematics graduates of Tennessee A & I State University, a predominantly Negro school, overwhelmingly pursued the "teaching" area, whereas graduates of the University of Tennessee whose enrollment was all Caucasian, did not overwhelmingly pursue either particular area of employment, but instead were rather evenly distributed. The results showed that graduates of Tennessee A & I pursued "teaching" as compared to "industry" by six year combined percents of 69 to 9, while for graduates of the University of Tennessee, combined percents of 38 to 29. The remaining percents not listed here represented those graduates who pursued occupations other than "teaching" or "industry."

The writer introduced the following as factors having had influence on the initial choice of employment taken by these mathematics graduates, and was able to secure data to directly substantiate each of these believed influences with the exception of the last listed:

1) Historical background of each school

2) Geographical areas covered by permanent residences of students enrolled

3) Traditional area of employment of college graduates of race concerned; discrimination in hiring practices

4) Differences in accumulative grade averages (school bound vs industry bound)

Among studies which served to support the findings in employment pursuits of these mathematics graduates were studies which brought out the following significant points: (1) Tennessee A & I has long been noted as a teachers college, even since its establishment, whereas, this was not true of the University of Tennessee; (2) the agricultural areas are more likely to produce teacher-trainees for small colleges; (3) the teaching areas draw heavily from the female population; (4) the area of industrial research requires creative ability, long and intensive training, more advanced years of concentrated study, more advanced degrees, besides demanding keenly and highly intelligent people who work well with abstractions; (5) Negroes possibly have not strongly pursued the industrial areas recently because of their late entrance, due to practices of discrimination in hiring procedures in this field for many years.