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THE PREPARATION OF MATHEMATICS TEACHERS IN THE UNITED STATES OF AMERICA

BY

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During the last quarter of a century there has been an unprecedented transformation within the American universities in favor of providing greater opportunities for those students who are or who expect to become teachers. The two most noteworthy results in this connection are the Summer Sessions and the Schools of Education. Both of these institutions have had a marvelous growth during recent years, and they seem to have thoroughly entrenched themselves in our American universities. They have fulfilled, even beyond the expectation of the most sanguine, the condition of success so dear to the administrations of many of our universities, viz: to give rise to a rapid increase in the number of students in these universities.

While both of these institutions serve the interest of all teachers they are such fundamental factors that they must be considered among the prominent influences in connection with the preparation of the mathematics teachers of our land. In fact, these teachers have availed themselves, to a marked degree, of the advantages offered by these modern institutions, and in some cases the Summer Sessions were really inaugurated for the sake of students of mathematics. « Previous to the year 1891, there had been no general movement in this country to organize summer courses in connection with the schools, colleges, and universities. Certain summer

courses for teachers had been offered at Harvard University as early as 1871, but not until 1891 were any regular courses in mathematics given¹. »

It is interesting to observe that the giving of regular courses in mathematics during the summer was begun at about the same time that the American Mathematical Society was founded. Although this society has devoted most attention to the interests of the college and university teachers it has also had a marked indirect influence on the teachers of secondary mathematics. Like the Summer Sessions, the American Mathematical Society has been very influential in providing incentives for the continuation of their studies on the part of the American teachers.

Most of our Summer Sessions at the universities started from small beginnings, being inaugurated by instructors who were willing to teach for several weeks during the summer for their portion of the tuition fees collected from the students. Even after the universities took charge of this work they frequently aimed to pay for instruction only about as much as they received from the summer students in the form of tuition. Consequently the salaries paid during the Summer Sessions have been usually much smaller than the proportionate part of the salary during the regular sessions.

This condition has been gradually changing and there is a tendency in the universities to pay higher salaries for work in the summer. It has been found necessary to do this in order to secure the services of the stronger members of the faculties for such work. The Summer Sessions of the American universities are thus tending towards increasing the teaching duties of the most scholarly members of their faculties, and hence they are viewed with some misgivings by those who feel that these members can render, in the long run, more important service to their institutions than that of instructing the teachers of secondary mathematics. While the Summer Sessions tend to raise the level of scholarship among secondary teachers they may tend, in their

¹ H. E. SLAUGHT, *American Mathematical Monthly*, vol. 18 (1911), p. 147.

usual present form, to lower the highest peaks of university productive scholarship. In some institutions provision against the latter tendency has already been made by allowing vacations at other times during the year to those who teach during the summer.

The length of the Summer Sessions usually varies from six to twelve weeks, the former period being the most common. The University of Chicago has been the most influential factor in the development of summer work in the American universities, by providing for practically continuous work at the university and by aiming to place the work during the summer on exactly the same basis as the work during the other sessions of the year. At this institution the work of the year is divided into four quarters of about twelve weeks each, and agreeing approximately with the four seasons of the year, while most of the other large American universities follow the two semester plan with long vacations in the summer.

During the first years 1892-93 no summer courses were offered at the University of Chicago on account of the Columbian Exposition, but during the summer quarter of 1894 there were 597 students at this institution, and the enrollment increased rapidly during the succeeding summer quarters, being 3983 in 1914. As the summer quarters come at a time when most of the secondary teachers are having vacations, they were very largely attended by these teachers, many of whom come from great distances, especially from the southern states, where the summer climate is less pleasant than at Chicago.

The great success of the summer courses at Chicago led other institutions to provide such courses and to increase the attractiveness of their summer programs. In recent years Columbia University in New-York City, and the State Universities of California and Wisconsin have had especially large Summer Sessions, the attendance at the first of these being 5590 in 1914. As mathematics is well represented among these summer courses it is clear that the Summer Sessions have a very great influence on the development

of the mathematics teachers in America. The suddenness with which this influence has become a mighty educational factor may be largely due to a rapid improvement in our educational standards, and to a poverty of good general mathematical literature in English since this poverty increases the difficulties of private study.

While the Summer Sessions of our universities are especially useful to those teachers who desire to continue their studies during their vacations, the Schools of Education reach more largely those who are preparing to begin teaching. « Of the various schools of education now existing in the United States the oldest are Teachers College of Columbia University and the School of Pedagogy of New-York University. Teachers College was founded in 1888 as a privately endowed institution under the presidency of Nicholas Murray Butler, and was then known as the New-York College for the Training of Teachers. It was a school of university grade and enjoyed reciprocal relations with Columbia University. In 1898 it became one of the professional schools of Columbia University, ranking with the schools of law, medicine and engineering. Teachers College was the first professional college of education of university grade » in the United States ¹.

As New-York University established, in 1890, a School of Pedagogy ranking with its other professional schools, there are at least two regular schools of education in American universities which were established during the latter part of the nineteenth century. During the first decade of the present century a considerable number of such schools were established in the Middle West of our country, beginning with the one at the University of Chicago in 1901. The establishment of these schools is evidence of the emphasis which universities have placed on providing courses for the better preparation of teachers, of secondary schools.

Although the American universities have provided libe-

¹ International Commission on the Teaching of Mathematics, American Report. Committee No. V. 1912, p. 6.

rally in recent years for courses on teaching they still select their own teachers very largely from those who have not taken such courses. In fact, it is becoming more and more general to make the Ph. D. degree an essential for appointment as instructor in a good university, but no special training along pedagogical lines is usually demanded for this degree. In a general way it might be said that the number of courses in methods of teaching for those who are preparing to teach varies inversely with the advancement of the subjects to be taught. Those who aim to teach in the highest institutions usually take practically no courses in methods of teaching, while those who are preparing to teach the most elementary courses devote the greater part of their time during their student days to such courses.

While the ideals of most of the larger universities require for appointment to instructorships attainments at least as high as those represented by the Ph. D. degree, yet in practice there are still many shortcomings along this line, which are often due to a lack of candidates possessing such high attainments. This lack explains also the fact that the majority of the professors of mathematics in our small colleges and the normal schools do not have the Ph. D. degree. In fact, only about 36 per cent of the latter have done any graduate work at the universities and comparatively few of these pursue mathematical studies beyond those which are directly connected with their teaching.

Ideal attainments of teachers of mathematics in the secondary schools are stated in the American Report of the International Commission on the Teaching of Mathematics, Committee No. V, page 13, in the following terms: « On the side of pure mathematics we may expect the calculus, differential equations, solid analytic geometry, projective geometry, theory of equations, theory of functions, theory of curves and surfaces, theory of numbers, and some group theory. On the applied side we should demand a strong course in mechanics, theoretical and practical astronomy, descriptive geometry, and some mathematical physics with a thorough course in experimental physics. To this should

be added special courses in surveying and general applications of mathematics that the student may see to what all the above work is leading. As pedagogical training there should be included a strong course on the teaching of secondary mathematics with observation and practice teaching under expert supervision, a course on the history of mathematics at least one graduate course on the history and teaching of mathematics, and a course of an encyclopedic nature dealing critically with the field of elementary mathematics from the higher standpoint. A foundation in psychology and the history of education is also necessary. »

While there are instances where this ideal of preparation is reached and even surpassed by teachers of secondary mathematics, yet these instances are still exceptions to the rule. As the better secondary schools usually pay higher salaries than can be obtained in the lower positions in the universities, it sometimes happens that those who are really prepared to assume the latter positions accept the former positions by choice. This is, however, not common since the opportunities for advancement and study at the universities are usually considered to more than offset these differences in salary at the start. It appears likely that more and more people who have secured the Ph. D. degree will enter the field of teaching secondary mathematics in view of the increasing opportunities in this field. In fact, this degree has already been given by leading American universities for work in elementary and secondary mathematics.

Although the universities are emphasizing the preparation of teachers, only a few of their schools of education aim to prepare students for the teaching of elementary mathematics since the State normal schools exist for the purpose of training such teachers. These schools are usually supported by special appropriations made by the State legislatures, and nearly all of their graduates teach at some time in the public schools. The normal schools usually charge no tuition fees, except slight incidental fees, to students who declare their intention to teach in the State where the school is located, and it is estimated that more than 70 per cent of their gra-

duates teach five years or more. The universities usually aim to prepare teachers for the high schools and the more advanced positions.

According to the report of Committee No. III of the American Report of the International Commission on the teaching of Mathematics, 1911, page 78, « the fight for the recognition of the principle that high school teachers should have the training represented by the bachelor's degree is practically won. There is but a small portion of the country where this is not at least a clearly recognized ideal, however remote from realization in practice... A notable example of a state in which the minimum requirement for high school teachers is unusually high is California. There the minimum requirement is essentially that the candidate must present evidence that in addition to eight years in high school and college he has done a half year of graduate study in a university belonging to the « Association of American Universities », and a half year of practice teaching in a high school conducted for this purpose by such a university. »

As our schools are organized in State and local systems, and not as a national system, there are very great differences as regards standards and efficiency in different parts of the United States. There are also very great differences as regards salaries, as may be readily seen from a recent publication entitled « The tangible rewards of teaching », which was issued by the United States Bureau of Education as Bulletin 1914, No. 16, and is devoted to data relating to salaries paid to teachers in the different parts of our country. These great difference have advantages since they serve as incentives for the teachers to prepare themselves for the better positions. High educational attainments, as evidenced by certificates or degrees, are fully appreciated by school officials provided these attainments are combined with ability along the line of teaching. Most communities take a great deal of pride in their educational advantages.

This local pride is responsible for much of the educational advance in the United States. One community feels that it ought to have just as good schools as any other, and, if pos-

sible, it ought to excel the others. In fact, somewhat similar reasons have been offered with a view to securing large appropriations for State universities. While such incentives do not work evenly it is a question whether they are not the best in a new country where business opportunities are plentiful and where the number of properly prepared teachers is consequently much smaller than the number of positions to be filled. Hence it has often happened that teachers prepared themselves for their positions long after securing them, and the teachers of mathematics were naturally among the first to discover that they were not yet prepared for the positions which they occupied.

It has often been said in recent years that the most serious mathematical problem in America is the proper training of her teachers of mathematics, especially those engaged in the teaching of secondary and higher mathematics. The State normal schools have provided fairly well for the preparation of the teachers in the elementary schools. Unfortunately the salaries attached to these positions are usually too small to secure the services of men, and hence about four-fifths of these positions are held by women¹, most of whom teach for only a few years. The salaries attached to secondary and higher positions are usually much better, and hence these positions attract more men. Only a small portion of the mathematical positions in the universities are filled by women. Hence it would appear that the most efficient movement towards improving the preparation of the mathematics teachers would be to increase the salaries of these teachers.

Since the beginning of the present century a considerable number of mathematical associations have been organized in various parts of the United States, and these associations have already proved their usefulness in increasing the interest and enthusiasm among the teachers of mathematics. There is as yet no really national association for teachers whose main interest is the improvement of teaching, since the only large national mathematical organization, the American

¹ Report of the U. S. Commissioner of Education, 1913, vol. 2, p. 28.

Mathematical Society, is devoting itself to the interests of those who are engaged in mathematical research. Recently some steps have been taken towards the organization of a national society devoted mainly to the interest of the former type of mathematics teachers.

At least two of the given local associations are publishing regular periodicals as their official organs; viz. *School Science and Mathematics*, which is the official organ of the Central Association of Science and Mathematics Teachers; and the *Mathematical Teacher*, being the official organ of the Association of Teachers of Mathematics in the Middle States and Maryland. The former of these periodicals is issued nine times during the year while the latter is a quarterly. In both of these periodicals the mathematical articles are devoted chiefly to matters of teaching and to the exposition of elementary mathematical questions.

Not only have the universities established schools of education and summer sessions in the interest of secondary teachers but a considerable number of courses within the mathematical departments have recently been organized for the benefit of such teachers. In the larger mathematical departments it is now common to find one man who specializes along the line of courses which aim especially to prepare teachers of secondary mathematics. These courses vary considerably and are usually announced under such names as the following: The teaching of algebra and geometry, history of elementary mathematics, history and pedagogy of secondary mathematics, teachers course, etc. While such courses seem to have been unknown in our universities twenty-five years ago they are now very common and they are contributing much towards the better preparation of high school teachers.

The State universities have indirectly contributed largely to the improvement of high school teachers by sending out members of their faculties to inspect the high schools of the State in which the university happens to be located. This establishes direct contact between the university and the high school teachers, and this contact is emphasized by the

holding of annual conferences of high school teachers at these universities. At these conferences the university and the high school teachers jointly discuss questions of interest to the latter, and the university teachers frequently form the talking majority even if they generally are numerically in the great minority. Similar conditions frequently hold at the meetings of the mathematical associations which are becoming more and more frequent, and are largely of an inspirational nature.

Among the various types of inspirational work among the elementary teachers the Teachers' Institutes are perhaps the most noteworthy. These are much older than the inspirational work considered above, having been effectively inaugurated towards the end of the first half of the nineteenth century. These institutes vary very much both as regards duration and the type of work undertaken. It is customary to require teachers to attend these institutes when they are held during the regular school session, and to pay them their regular salaries while in attendance. The usual duration of the county institute is about five days, which are often largely devoted to lectures presenting special methods, and to illustrative lessons with classes. When longer institutes are held they are often largely devoted to reviews of subjects taught in the schools.

Summary.

The American universities have inaugurated many changes during the last twenty-five years with a view to providing better facilities for students who either are teachers or who expect to become teachers. The Summer Sessions serve the needs of the former while the Schools of Education within the universities aim to serve the interests of the latter. The regular departments of mathematics have also introduced special courses for those who expect to become teachers of mathematics, and they often have on their staff a man who makes a special study of such courses.

The main reason why standards as regards the preparation

of teachers are not higher in America is that the number of properly prepared candidates for positions is much smaller than the number of the positions which have to be filled. This is especially true with respect to the secondary and higher positions. Salaries are still relatively too small although they have been increased rapidly during the last two decades. A large number of American teachers strive to prepare themselves for their positions after having filled these positions for some time. The number of those who are well prepared before they assume such positions is rapidly increasing.

The American Mathematical Society is exerting a very wholesome influence on the teachers of higher mathematics but there are still too many professors who terminate their study of higher mathematics when they receive the Ph. D. degree. There is as yet no large national society whose main interest is the improvement of the teaching of mathematics although steps have been taken recently with a view to such an organization. The last two decades were a period of awakening especially among the teachers of secondary mathematics, and they have given rise to numerous mathematics teachers associations as well as to two regular periodicals published by such associations. The average preparation of mathematics teachers has been raised considerably during the last two decades.

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