REPORT ON

ACCREDITATION AND CERTIFICATION

Submitted to the

Committee on the Undergraduate Program in Mathematics

by its

Panel on College Teacher Preparation

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Part I - Introduction and Terminology

At its summer meeting in August 1968, the Board of Governors of the Mathematical Association of America requested that the Committee on the Undergraduate Program in Mathematics prepare a report on certification and accreditation, to be submitted in August 1969. Since the basic aim of a system of certification or accreditation in mathematics would be the improvement of the quality of education and the competence of teachers and since CUPM has in the past made numerous recommendations concerning curricula and the qualifications of teachers,* it is perhaps natural that such a request was directed to CUPM. Actually, on several earlier occasions, questions related to the certification of prospective teachers of collegiate mathematics had arisen in the deliberations of CUPM's Panel on College Teacher Preparation, and in June 1968 the Panel received the following charge from CUPM: to "study the question of certification and accreditation, including the history of such programs in other disciplines, what has been accomplished by having such accreditation, what problems and administrative difficulties would be involved." This report is the outcome of such a study.

Over the years mathematics has developed in the United States without any procedures for formal accreditation or certification, but two decades of rapid growth and change within the mathematical professions have generated persistent claims that there is now a need for an appropriate system. These assertions seem to be motivated by concern with a variety of contemporary problems in mathematics education: for example, the proliferation of two-year colleges, the need to identify persons who are qualified to teach in four-year colleges, the need to stimulate and assist improvement in undergraduate education, and the growing diversity of graduate programs in the mathematical sciences.

Effective procedures for accreditation and certification must inevitably refer to clearly stated and generally accepted standards of curriculum and training. The work of CUPM over the past decade has provided various curricular models and has stimulated the development of other models which collectively provide the mathematics community with materials from which standards might be established for a variety of programs. This is not to say that the CUPM recommendations ought to be, or ever were meant to be, definitive standards. On the contrary, they were meant quite literally to be "recommendations," bases for discussion in individual departments and among mathematicians generally. Nevertheless, the experience and effort embodied in these recommendations and their effects may be expected to lighten the task of setting normative standards if this task is undertaken.

The term accreditation refers to the process whereby a college or university or program of study is officially and publicly recognized as having met certain predetermined standards. The term certification refers to the process whereby an individual is recognized as having acquired a certain professional competence, normally as indicated by his performance in an accredited program of study or on an examination administered by a recognized agency. Both terms signify recognition by some official body that the recipient is entitled to a degree of public confidence in the matter of professional qualifications. The two concepts are intricately linked in practice and in theory because the effectiveness of each rests ultimately upon the degree of trust which society at large extends to the accrediting or certifying agency or procedure. Thus individuals are certified either by

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*These recommendations appear in the following reports, among others: GCMC, Qualifications Report, TYC Qualifications Report, Beginning Graduate Program (see Appendix II for full titles and dates).

accredited institutions or by organizations composed of individuals whose competence is widely recognized, while the accreditation of an institution may depend in part on the certification, in some sense, of its staff members.

There are two types of accreditation commonly in use in higher education in the United States. General accreditation of entire institutions is awarded by six regional associations of schools and colleges. These regional groups establish their own criteria, procedures for visitation and evaluation, and methods of periodic review. Specialized accreditation of specific programs within an institution is conducted by a variety of professional organizations, each within a single subject, such as law, dental hygiene, theology, forestry, and about thirty other fields. Most, if not all, of the programs of special accreditation deal with professional training as distinguished from the traditional liberal arts education.

Certification, on the other hand, is official assurance that the certified individual has met acceptable standards of professional training, by completing an accredited program of study, by performing satisfactorily on an examination designed especially to test professional knowledge and skills, or both.

The general aim of certification is to provide a means by which an individual can establish his claim of being professionally qualified for a particular position or task. The effectiveness of any certification procedure, therefore, depends almost entirely upon the degree of confidence which is accorded to the certifying agent. In practice the certifying agent frequently is the chairman of the department or director of the program in which the certified individual attains the established standards. Accreditation of that department or program, therefore, is a means of inspiring confidence in the certifying agent.

Having established terminology, we turn next to an examination of current practice in accreditation and certification. The general setting is discussed in Part II, while the experience of various disciplines, some more closely akin to mathematics than others, is outlined in Part III. The typical department of mathematics serves many roles, so certification or accreditation in mathematics can be undertaken at various levels and can use various devices. Some of the possibilities are amplified in Part IV, while the administrative and fiscal aspects of accreditation and certification programs are discussed in Part V. Arguments for and against accreditation and certification are presented in Part VI. Finally, in Part VII, the Panel sums up its findings and briefly discusses alternatives to a system of formal accreditation.

Part II - Current Practices in Accreditation and Certification: Background

In this part we shall discuss, in some detail, accreditation and certification as they are currently practiced in the United States. This will at the same time sketch the field of which any system in mathematics would become a part, and present a variety of systems that have been found workable.

Regional Accreditation

Accreditation of higher education by nongovernmental agencies is unique to the United States. It was first undertaken in the late 1800's, when there was a rapid proliferation of colleges and universities and representatives of the well established schools took alarm at the threat of a devaluation of American college degrees. Over the years the responsibility for granting general accreditation has been assumed by six regional accrediting agencies, and that for accrediting programs in separate disciplines has been assumed by some thirty recognized bodies within the respective professional organizations. (There are some state accreditation programs, which usually are "not especially effective." Their main concern seems to be with the fiscal responsibility of the schools.)

The regional accrediting associations are concerned with both secondary and higher schools. Specific responsibility for general accreditation of colleges and universities is assigned to variously named commissions under the regional associations. These commissions are essentially independent of one another, and they diffe differ in porcedures and standards. They are, however, members of a Federation of Regional Accrediting Commissions of Higher Education, and through this body the commissions have attained an increasing degree of uniformity and reciprocity. Meaningful generalizations about the standards and procedures of the commissions are therefore now possible.

The basic criterion for receiving accreditation is that the institution should be "fulfilling its objectives in an acceptable manner." Great emphasis is placed on the diversity of these objectives, although "a base of liberal studies required of all or most students" is normally required. This relativistic approach would make detailed *a priori* specifications or *a posteriori* ratings pointless, and everything depends on the integrity and good judgment of the participants in the evaluation process, who ultimately deliver a simple yes or no verdict.

The typical accreditation procedure by one of these commissions consists of the following steps:

(a) The school's chief administrative officer requests consideration. (In accreditation circles the voluntary character of accreditation, which is clearly a necessity, is usually treated as a virtue.)

(b) Following instructions provided by the commission, the institution submits a preliminary report consisting of various facts (list of primary purposes of the school, number of volumes in the library, value of scientific equipment, etc.) and documents (general catalog, faculty code, etc.).

(c) A small committee visits the institution briefly. It then advises the commission on whether the evaluation process should proceed.

(d) The institution embarks on a period of self-study, during which it reviews its reasons for existence and appraises its achievements and needs. It is recommended that two years be allowed for this. The study is conducted in terms of qualitative criteria supplied by the commission, and culminates in a report.

(e) An ad hoc committee of outsiders visits the school, and its members evaluate various aspects of the school's operation in light of the self-study report. Committee members are advised to approach the evaluation as colleagues, but their own report is expected to evaluate, not to describe.

(f) On the basis of the committee's report, the commission (which typically consists almost entirely of academic administrators from the region) conducts appropriate discussions with representatives of the school and then delivers its verdict. There is a mechanism for appeal.

The entire effort is meant to be self-supporting; participating schools pay annual dues and pay a further fee to cover the cost of evaluation. The normal interval between evaluations is ten years.

Because of the emphasis on global characteristics of the school, and because evaluating committees represent only a few disciplines, there is relatively little stress on details of the separate curricula and minutiae of staff qualifications.

[Sources: W.K. Selden, Accreditation: a struggle for standards in higher education (New York: Harper and Brothers, 1960); W.K. Selden, "Nationwide standards and accreditation," AAUP Bulletin, vol. 50(1964), 311-316; "Federation of Regional Accrediting Commissions of Higher Education" (leaflet) (Chicago, 1968); Northwest Association of Secondary and Higher Schools, "Accreditation procedural guide for higher schools" (Seattle, 1969); same, "Instructions to members of evaluation committees" (Seattle, 1967).]

Specialized Accreditation

Accreditation by one of the regional commissions does not imply that every program in the accredited school meets minimum standards. Partly for this reason, a number of professional societies sponsor accrediting agencies of their own. In general, these are intended to judge the fitness of an institution (in practice, usually a department) to offer degrees in a specific discipline. Cooperative arrangements between these agencies and the regional commissions are not uncommon.

About twenty years ago there were acute fears among academic administrators that accrediting agencies, which had been formed to discourage the proliferation of substandard programs, were themselves proliferating at an excessive rate. A particular problem was the rise of rival agencies in the same discipline. This led to the creation, in 1950, of the National Commission on Accrediting, a body "to accredit accrediting agencies."* At one time the NCA attempted to put an end to specialized accreditation altogether, but withdrew to a more moderate position.

*Seven organizations (the Association of American Colleges, etc.) are "constituent members of the NCA, and over 1400 colleges and universities are dues-paying "institutional members."

The NCA acts as a clearinghouse for information and ideas on accrediting, campaigns for accrediting of higher quality, and publishes a list of "recognized" accrediting agencies.* The most recent such list, issued in September, 1968, lists, besides the six regional associations, thirty-four specialized agencies. The institutional members of the NCA will presumably not invite evaluation by accrediting agencies not so recognized. The Board of Commissioners of the NCA takes a dim view of adding further agencies to the list: "They do not feel that it would be in the best interest of the institutions of higher education to give recognition to any additional accrediting activities at this time, particularly those that relate to the liberal arts fields." Indeed, agencies hitherto recognized are being reviewed with the idea of shortening the list.**

Another organization which joins in discouraging the formation of new accrediting agencies, though not a constituent member of the NCA, is the Council of Graduate Schools in the United States. The CGS does no accrediting itself, but does maintain a Consultation Service whereby institutions interested in getting outside advice on their graduate programs, and in particular with regard to the establishment of new graduate programs, may do so. The expense of this program is borne by the institutions visited by the consultants.

[Sources: NCA, "The Past and the Future: Historical Sketch and Annual Report" (Washington, April, 1965); same,"List of Recognized Accrediting Agencies" (Washington, September, 1968); same, "Facts about the Commission" (Washington, no date); Council of Graduate Schools, Consultation Service" (Washington, February, 1968).]

Certification

The situation as regards current practices of certification is not so simple. We have not been able to find evidence of the existence of any certification counterpart of the NCA, i.e., any centralized office for the coordination or recognition of certification efforts; the field seems to be highly atomistic.

The granting of an academic degree is the most common form of certification, namely certification that the recipient has met minimum standards set by the degree-granting school. About this nothing probably needs to be said here. Certification by outside agencies (usually professional or governmental) may be direct or indirect --indirect in the sense that the school (in the person, say, of a department head) can be authorized to certify on behalf of an external agency, as in the case of chemistry (see below). In effect, certification of this indirect kind tends to coalesce with the awarding of degrees, and authorization to certify is a kind of accreditation.

This leaves direct certification, by which we mean direct endorsement of professional or pre-professional people by an agency that transcends individual schools. For reasons related in part to the variation in relevant state laws, an agency of this kind typically serves only one state. Thus whether or not a person in the United States needs certification, and if so by whom, may depend not only on his intended profession but also on the place where he intends to practice it.

*The criteria for recognition are listed in Appendix I of this report.

**From a letter by Frank G. Dickey, Executive Director, NCA, April 7, 1969.

Part III - Current Practices in Accreditation and Certification: The Experience of Various Disciplines

Accreditation practices

Business

The recognized agency for accreditation of schools and departments of business is the American Association of Collegiate Schools of Business (AACSB). Accreditation of a school or department is necessary and sufficient for membership in AACSB. The primary basis for accreditation is the undergraduate program, but the Association also maintains a roster of approved masters degree programs. The criteria for accreditation include the administrative relation of the business school to the institution as a whole; curricula and course offerings; qualifications of staff and terms of employment (for example, teaching loads must not exceed a maximum set by AACSB); facilities; and freedom from "undue political influence." The current criteria were formulated in 1956, with several subsequent revisions; they are being revised again now.

Evaluation of a program is based on an extensive questionnaire and a report from a Visitation Team, which usually has three members and spends three days on campus. These materials are reviewed by a standing Undergraduate Accreditation Committee, which also meets with representatives of the petitioning school at the annual meeting of the AACBS and then makes a recommendation to the Executive Committee of the Association. The Executive Committee then makes a judgment, and if the judgment is favorable, recommends the school to the full membership for election.

A petitioning school pays fees totaling $250 plus the expense of the Visitation Team.

[Sources: AACSB, "Constitution, Bylaws, Accreditation Standards" (St. Louis, 1968); same, "Baccalaureate Program: Accreditation Questionnaire and Application Guide" (St. Louis, 1966).]

Chemistry

Although the Committee on Professional Training of the American Chemical Society (ACS) avoids the word "accreditation"--one is to speak instead of a "list of approved schools"--it has been involved in accreditation since the mid-thirties, when the competence of many of the alleged chemists then flooding the market was questionable. Only undergraduate programs are considered for approval; extension of the system to graduate programs has been extensively discussed, but finally rejected on the ground that the inevitable and desirable diversity of graduate programs in chemistry makes evaluation by any single set of standards dangerous, if not impossible.

The procedure is fairly simple. Consideration is requested by the chief administrator of the school; forms are sent to and completed by the chemistry department; these are reviewed by the Committee, which then meets with the head of the department at one of the major ACS meetings; if this leaves unresolved doubts about the adequacy of the program, the Committee arranges a visit to the school by a "highly

regarded" chemist called a Visiting Associate; approval is granted, deferred, or denied on the basis of the information thus obtained. Once approved, a department is expected to submit triennial reports similar to the original application.

As of April, 1969, 395 of the approximately 700 departments offering a major in chemistry were on the list of approved schools.

Approval is intended to mean that the program is adequate to prepare professional chemists at the baccalaureate level; graduates of approved programs may be certified as such by the department head, and thereby become eligible for full membership in the ACS two years after graduation, instead of five. The criteria for evaluation emphasize faculty qualifications and terms of employment, facilities, and especially the curriculum for chemistry majors. An inadequate course offering is the most frequent cause for the withholding of approval.

The whole operation is funded by the ACS, with an annual budget of about $40,000. There is, however, a considerable investment of time offered gratis. The Committee of nine, plus office executives, meets seven days a year, and this does not include the reading of applications or the visits of the Visiting Associates. Neither the Committee members nor the Associates receive honoraria.

During the preparation of this report, the members of the College Teacher Preparation Panel discussed the good and bad effects of the ACS accreditation program with several chemistry professors (from approved departments). These discussions give the impression that according to grass roots opinion in the field, the ACS's Minimum Standards have been extremely useful as a yardstick by which chemistry departments may judge the strength and suitability of their undergraduate programs and have been instrumental in raising the level of chemical education. At the same time, the Standards seem to them to be overextensive and overspecific, thus threatening the smaller and less opulent schools and tending to rigidify curricula and discourage innovation. The ACS Committee on Professional Training is well aware of these problems, but its occasional advice to interpret the Minimum Standards and the approved list with corresponding qualifications in mind tends to be overlooked.

In practice, approval seems to serve the purpose of reassuring members of the profession about the standing of chemistry departments not otherwise known to them. Approval is largely irrelevant to the status of a well known chemistry department.

[Sources: E. L. Haenisch and E. O. Wiig, "The American Chemical Society and training in chemistry," Association of American Colleges Bulletin, vol. 42(1956), 321-336; ACS, "Minimum standards used as criteria in evaluating undergraduate professional education in chemistry" (n.p., October, 1965); consultation with Dr. Cheves Walling, Chairman, ACS Committee on Professional Training (April 19, 1969).]

Engineering

The recognized agency for accreditation in engineering is the Engineers' Council for Professional Development (ECPD), representing eleven professional societies and institutes and the National Council of Engineering Examiners. The program was inaugurated in 1936.

The ECPD, through its Engineering Education and Accreditation Committee (EEAC), evaluates programs leading to a first professional degree in engineering. Judgments are based on an extensive questionnaire and the report of an ad hoc visiting committee chaired by the regional chairman or vice chairman of the EEAC, who makes tentative recommendations to the ECPD; the final decision is made by the ECPD. Accreditation is expressed by the inclusion in an annually published list of accredited engineering curricula. Accreditation is for a specified term, usually two to six years.

Criteria include administrative structure, history of the institution and of the program, admission requirements, teaching staff, facilities, finances, and curriculum. Of these the last looms by far the largest, although there is the usual disclaimer of rigidity: "In any case in which the Engineering Education and Accreditation Committee is convinced that well-considered experimentation in engineering is under way, it shall give sympathetic consideration to departures from the criteria [concerning content of the curriculum]."

The accreditation program is supported in part by fees assessed the schools being evaluated, although the constituent societies underwrite administrative expenses. The annual budget has recently run around $50,000.

Through another committee, the ECPD accredits programs in "engineering technology"; these programs are more technical and less scientific than standard engineering curricula, and include certain two-year programs at junior colleges.

[Sources: ECPD, "36th Annual Report--1967-1968" (New York, 1968); NCA, "Accreditation in Engineering" (Washington, May, 1968).]

Geology

There is no recognized accreditation agency for geology. However, the American Institute of Professional Geologists (AIPG), through its Professional and Scientific Standards Committee, is gradually developing a program of "cooperative evaluation" of graduate degree programs in geology which is informally called accreditation and involves a pre-visit questionnaire and a visit to the petitioning department by an ad hoc three-man committee. Explicit criteria have not been formulated, and growth of the program is impeded by shortages of "time, manpower, and money." In fact, at present the committee members not only do not receive honoraria but are not reimbursed for travel expenses.

There are three other important geological societies: the American Association of Petroleum Geologists, the Geological Society of America, and the Society for Economic Geology. The AIPG, although far from being the largest of the four groups, seems to be going it quite alone with its program of "cooperative evaluation." One gets the impression that most rank and file geologists, when they know about the program, are unenthusiastic about it. However, one informant believes that some system of registration or certification of geologists is probably inevitable, if only because so many geologists become more or less independent consultants and therefore in some respects are as much in need of official endorsement as practitioners of medicine, law, accounting, etc.

[Sources: Letter of May 21, 1969, from Truman H. Kuhn, Chairman, AIPG Professional and Scientific Standards Committee; private conversations.]

History

While history neither has an accreditation program nor is a close academic relative of mathematics, a current issue among historians may be relevant to this report. The situation is complex, but in outline is somewhat as follows: After considering the question of accreditation for some time, the American Historical Association decided not to undertake a program of accreditation but did decide to prepare a list of Ph.D. programs in history not meeting certain published standards. The NCA learned of this, and with the concurrence of the CGS protested on the ground that the publication of any such list would be accreditation in fact if not in name, and urged that the matter be discussed further before any definitive action was taken. At about the same time, the American Historical Association received objections to the proposal from a number of strong history departments whose Ph.D. programs presumably would not be on the list. More as a result of the latter objections than because of the protests of NCA and CGS, the plan is again being reconsidered. Our informants in history suggest that the displeasure of the NCA does not carry much weight in their considerations.

[Source: Private communications.]

Physics

There is no accrediting agency for physics; if there were, it would probably fall under the Commission of College Physics or the Education Division of the American Institute of Physics. A spokesman for the latter group explains the nonexistence of an accrediting program on the following grounds:

(a) At this late date, the evaluation of the more than 800 physics degree programs in the country would be an undertaking of prohibitive size.

(b) The effectiveness of both of the groups named above in encouraging pedagogical innovation in physics would probably be reduced if they also played the role of judges and thus posed a threat to the reputations of the various programs.

(c) Many of the ultimate objectives of an accreditation program are being achieved by current positive efforts in promoting the improvement of physics teaching and publicizing successful efforts.

The same spokesman concedes, however, that current activities "provide essentially no pressure to achieve minimum standards for those schools which have weak programs and inadequate resources for improvement."

[Source: Letter of April 16, 1969, from A.A. Strassenburg, Director, Office of Education and Manpower, American Institute of Physics.]

Teacher Education

The recognized agency for accreditation of elementary and secondary teacher training programs is the National Council for Accreditation of Teacher Education (NCATE), formed in 1956. It is a powerful organization, and its short history has been stormy.

NCATE evaluates programs (baccalaureate or advanced) for the training of elementary teachers, secondary teachers, and administrative "school personnel." The criteria now in use date from 1960; they are entirely qualitative, and fall under the headings: statement of objectives, organization and administration, student personnel programs and services (admission, advising, placement), faculty, curricula, professional laboratory experiences (including student teaching), and facilities and instructional materials. Programs are eligible for evaluation only if they are within schools that have received general accreditation from a regional commission.

The Council itself takes final action on recommendations from the Visitation and Appraisal Committee, which in turn bases its recommendations on a self-study report from the institution and on the report from a five-to-seven person visiting team. An unusual feature of the procedure is that team and committee members are instructed not to offer any advice or reactions directly to the school being evaluated, but merely to inquire.

Responsibility for evaluating standards and developing new ones is allocated to the American Association of Colleges for Teacher Education (AACTE). This organization is in fact in the process of drawing up a new set of standards. A draft, Standards and Evaluative Procedures..., based on a long process of opinion gathering, was published in December, 1967, and has been the subject of a number of conferences; it was tested in eight pilot schools in the academic year 1968-1969 and may go into effect in 1970.

The proposed standards are much more specific and fully detailed than the current ones. One of the significant ways in which they differ is that they deal separately with advanced degree programs, including "all programs beyond the master's level for the advanced preparation of teachers." Later, however, the document explicitly asserts that these standards "are not to be applied to programs for the preparation of college teachers..." Thus it appears that the only possible intersection of NCATE's activities with any program of accreditation in mathematics would concern programs for the training of pre-college mathematics teachers.

[Sources: John R. Mayor, Accreditation in Teacher Education: Its Influence on Higher Education* (Washington: NCA, 1965); AACTE, Evaluative Criteria for Accrediting Teacher Education (Washington, 1967); AACTE, "Standards and Evaluative Criteria for the Accreditation of Teacher Education: A Draft of the Proposed New Standards, with Study Guide" (Washington, 1967).]

*Appendix III of the Mayor report is a useful summary of the procedures of all the recognized specialized accrediting agencies.

Certification Practices

Actuaries

The Society of Actuaries sponsors an elaborate program of examinations "leading to professional recognition as a qualified actuary." These begin with "preliminary examinations," offered jointly with the Casualty Actuarial Society, on undergraduate mathematics and statistics. Subsequent examinations lead to the titles of Associate and Fellow of the Society. Detailed syllabi are available for each examination, and the examinations are given regularly (at least once a year) at widely distributed "Centers."

Anyone who wishes to take one of the examinations must apply a month or more in advance, and presumably there is an occasional ruling of ineligibility to take an examination. A fee ($15 for the preliminary examinations) is collected at the time of application, and cash prizes are awarded to those who score highest on some of the examinations. A number of universities (e.g., Northeastern, Nebraska, Michigan) offer advanced degree programs in actuarial work whose curricula follow more or less closely the syllabi of the Society.

[Sources: Society of Actuaries, "Preliminary actuarial examinations," 13th ed. (Chicago, 1968); publicity from the universities mentioned.]

Chemists

There is no national agency which directly certifies professional chemists (with the exception of the Registry of Medical Technologists, which certifies chemists for laboratory work in medical technology; see below). We have already described above the system of indirect certification related to the accreditation scheme used by the American Chemical Society.

Health Occupations

Practitioners of the most common health professions must ordinarily, by law, be licensed by state agencies. This practice dates back to the eighteenth century, when however authority to license was usually delegated to state medical associations. It is now done by variously formed state boards. Licensing constitutes at least authorization to use some professional title, and usually is necessary for legal practice of the profession in the state.

A number of health-related professions maintain nationwide certification or registration programs.

Criteria for licensing vary widely. Typically there are requirements concerning age, citizenship, and the like; good moral character; length and kind of college education and graduate training; and experience (internships, etc.). Applicants satisfying all these requirements are eligible to take an examination which is with rare exceptions required. The board usually assumes full responsi-

bility for the setting and grading of these examinations and deciding what constitutes a passing performance. An examination may have written, oral, or practical (clinical) parts, or combinations of these. National examinations such as those prepared by the American Public Health Service are sometimes used.

Fees collected from license applicants (typically $25 to $50, but up to $100) cover the costs of the work of the licensing boards in about 60% of the cases, but the remaining boards are supported partly or wholly from state general revenues. Board members usually serve without honoraria.

For some of the health professions there exist national organizations coordinating the corresponding boards. For example, there exists a National Association of Boards of Pharmacy, which among other things assists in working out reciprocity arrangements between the state pharmacy boards.

Some state boards will accept a certificate from a national board of examiners in place of a state examination. Such national boards exist for seven of the health occupations, including physicians and dentists. These groups expect certification from them to be an increasingly important factor on the medical scene, especially as the federal government, which often requires it, becomes more extensively involved in programs which are incidentally or primarily medical in nature.

For example, the American Association of Bioanalysts supports an American Board of Bioanalysts, which certifies directors of bioanalyst laboratories (only two states license bioanalysts). Criteria for eligibility to apply include a suitable academic degree and a number of years of experience which depends on the highest degree held, and possession of a valid state or federal license where applicable. Applicants with satisfactory credentials may take a written examination, on the basis of which the Board decides whether to certify. Certification must be renewed annually. The fee for taking an examination is $75; costs of the certification program are covered by these fees.

Another example is the Registry of Medical Technologists of the American Society of Clinical Pathologists which, since 1928, has certified medical technologists (by way of a nine-man board) with or without specialist certification. The Registry also awards certificates in histologic technic (sic), chemistry, microbiology, blood banking, cytotechnology, and nuclear medical technology. Certification as a medical technologist is normally based on graduation from a School of Medical Technology accredited by the Council on Medical Education of the American Medical Association or by the Board of Schools of Medical Technologists, but there exist alternative routes. Certification in histologic technic, etc., is based on varying credentials and examinations which include written and in some cases practical or oral parts. The fee is $25, and there is an annual renewal fee. The program is supported by the revenue from these fees.

Approximately 3000 medical technologists are certified each year.

[Sources: "State licensing of health occupations," Public Health Service Publication No. 1758 (Washington, 1968); "The Registry of Medical Technologists of The American Society of Clinical Pathologists" (brochure), 48th ed. (Muncie, Indiana, 1969); American Board of Bioanalysts, "Information Pertaining to Accreditation of Bioanalysts (brochure)(St. Louis, Missouri, n.d.); letter of July 16, 1969, from Harold G. Levine, Director of Education, American Society of Medical Technologists.]

Teachers

Responsibility for setting criteria for certification of public school teachers is in the hands of the state legislatures, although authority to certify usually rests with a state board of education and is sometimes delegated, for instance to schools of education in colleges and universities. Because of the local origin of the criteria, there is much diversity, but typically (say for a high school teacher) they include graduation from an accredited teacher-training institution, course requirements being fairly minutely prescribed as regards both major and minor subject areas and "professional" (i.e., education) courses. Certificates are ordinarily endorsed to authorize the teacher to teach certain subjects. Most states certify elementary teachers, secondary teachers, school librarians, and various categories of school administrators and counselors.

Nine states certify junior college teachers in one way or another, although in some cases this amounts merely to acknowledging a master's degree. A few states go farther. For example, in California an applicant for the "standard teaching credential with a specialization in junior college teaching" must have completed a master's degree at an approved institution (a master's degree in education is expressly excluded) with a curriculum that satisfies one of several major-minor requirement patterns. For example, such an applicant intending to teach mathematics must have the master's degree in mathematics; in this case no minor is required. There is also a general requirement about knowing the provisions and principles of the United States Constitution. The certificate is good for life.

The character of teacher certification is in constant evolution, partly because of local pressures and partly because of the efforts of such bodies as the National Commission on Teacher Education and Professional Standards, an arm of the National Education Association. In general, the drift of late has been toward requiring greater subject-matter competence.

[Sources: E.H. Woellner and M.A. Wood, Requirements for Certification..., 33rd ed., 1968-1969 (Chicago, 1968); T.M. Stinnett, Turmoil in Teaching (New York, 1968); California State Department of Education, Bureau of Teacher Education and Certification, "The Standard Teaching Credential with a Specialization in Junior College Teaching," leaflet Z-3, March, 1966.]

Part IV - Specific Types of Accreditation and Certification

There are many aspects of the total program of a Department of Mathematics which may be subject to accreditation and certification. We shall classify them as follows:

(a) Undergraduate programs

(i) Service functions

(ii) Training of Mathematics majors for graduate work

(iii) Training of secondary school teachers

(b) Programs at the level of the First Graduate Component, in the terminology of the Qualifications Report

(c) Programs at the level of the Advanced Graduate Component

(d) Ph.D. programs

We shall begin by describing general procedures and schemes which could be followed in each of these programs. First of all, of course, it is necessary to have a list of standards for the program, standards that have found general agreement in the mathematical community. One could suggest that since CUPM has published detailed curricula for programs in a), b), and general recommendations for c)*, it would not be unreasonable to think that some modification of these would serve as lists of standards. However, there are potential dangers in such a viewpoint: one must always keep in mind that CUPM does not write curricula in order to prescribe what courses a department should teach, but rather to offer generalized models for discussion and to provide the framework for meaningful dialogue on serious curricular matters. Furthermore, some of the CUPM recommendations have intentionally been overambitious, to give mathematical educators goals which are often beyond their present grasp. We shall therefore not treat the CUPM recommendations as templates for possible accreditation or certification standards. It will be convenient, however, occasionally to use CUPM terminology in a suggestive, non-definitive way, as in the case of "First Graduate Component" and "Advanced Graduate Component" above.

As one sees from Part III, the procedures of the various accrediting agencies follow more or less the same pattern. The agency determines whether its standards have been met by studying lists of library holdings, the detailed educational background of the faculty, course descriptions and texts, and copies of problem sets and examinations that have been given in the courses. Other factors which should be considered are faculty working conditions (including teaching loads and salary scales) and, where applicable, the records of graduates of the institution. In some cases a site visit seems necessary. Presumably, the same procedures would be appropriate and natural for any system of accreditation in mathematics. A program of accreditation should include a mechanism for periodic review of accredited pro-

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*For a), these are the PSE, BMSS, Pregraduate, Pale Green, and Teacher Training booklets; for b), the Qualifications Report and the Beginning Graduate Program booklet; for c), the Qualifications Report. Full titles are given in Appendix II.

grams. Should an accredited department be put on probation, the reasons should be made explicit so the department concerned can work effectively for reinstatement.

As an alternative to accrediting, in which a department or program is either approved or not approved, or possibly in addition to accrediting, there is the possibility of grading programs and departments. That is, a scale with some number of subdivisions could be worked out on the basis of accepted standards, and departments would then receive a public or confidential placement on this scale.

Two techniques may be used for certifying individuals who have completed a program of studies. One is to have a system of national examinations, and the second is to empower the executive officer of an accredited program to certify those students who have successfully completed the program. Of course it is not necessary that all students studying at an accredited institution be certified; only those who have fulfilled all the standards of the particular program would be so certified. One might also combine the two methods by providing national examinations for students who complete a program at an unaccredited institution or have prepared on their own.

Now we turn to a detailed discussion of the programs a) - d).

a) (i) Service functions. Because of the rapidly changing needs of the users of mathematics, it may be extremely difficult to draw up programs for the various service functions of a mathematics department. Having done so for engineers and physicists and for students in the biological and social sciences, CUPM has found its recommendations becoming obsolete very quickly. There can be little doubt, however, that it is through the service teaching that the mathematical community interacts most broadly with the rest of the world, and thus most of our problems with non-mathematicians arise at just this point. Accrediting programs for service to physics, engineering, biological sciences, social sciences, etc., should serve to strengthen the offerings by mathematics departments in these areas. Moreover, the existence of an accreditation procedure would testify to the importance attached to the service function by the mathematical community.

Certification of students who complete such a program does not seem to be a reasonable activity because this program will be such a small part of the student's entire education.

a) (ii) Pre-graduate majors. Criteria on the order of the recommendations in CUPM's pale green booklet might be suitable for accreditation in this area. It should be relatively easy to determine which departments make it possible for their majors to learn calculus at the level of the GCMC courses 1, 2, 4, 5, and such material as real analysis and abstract algebra as outlined in the pale green booklet. Students certified by receiving bachelor's degrees in mathematics are not necessarily prepared for graduate study in mathematics. Accredited departments could provide additional certification for students who are. Similarly, accredited departments could also certify students who are prepared for graduate study in mathematical statistics, computer science, etc.

a) (iii) Secondary school teachers. Although the various states already have certification procedures in this area, they do not necessarily ensure either that the content of courses is adequate or that sufficiently many advanced courses are required. It is thus conceivable that departments meeting standards similar to the

Level III or Level IV recommendations of the Teacher Training booklet, say, might deserve special accreditation, and they in turn would certify their graduates.

b) The first graduate component. Very roughly speaking this would mean trying to accredit masters programs, probably including recognition of experience in some program of apprenticeship in college teaching. Certification here is complicated by the fact that one can discern at least four possible future careers for applicants for certification: more graduate work, teaching in a four-year college, teaching in a two-year college, and work in industry. Of course it is possible to emphasize accreditation and certification for only one of these areas and the third is probably the most crucial at the moment. In any case, consideration should be given to separate treatment of two-year college teachers.

c) The all-but-dissertation level of (in the language of the Qualifications Report) the advanced graduate component. Certification might here serve to recognize a degree of mathematical training between the M.A. and Ph.D. without getting into the difficulties involved in establishing a new kind of doctoral degree. Although part of the certification procedure could consist of a national examination to test mastery of suitable strata of mathematics, other aspects of this component (such as successful participation in research seminars and the completion of a suitable apprenticeship in teaching) would of necessity involve accrediting of the program itself so that departmental officers could certify the student.

d) Ph.D. programs. The Ph.D. degree constitutes certification of a student by a department, and because of the great technical diversity of individual Ph.D. programs further direct certification by another agency would at best be redundant. Accreditation of departments to offer the Ph.D. might, however, be undertaken. In addition to the criteria mentioned above, faculty publication records and the quality of dissertations written by graduates of the department would have to be taken into account by the accrediting agency in this case.

Part V - Implementation

We shall follow the format of Part IV in our discussion of the details of implementing various schemes for accreditation and certification.

(a) Undergraduate programs: accreditation

There are approximately 1500 institutions in the United States which offer an undergraduate major in mathematics, compared to about 800 in chemistry. It will be convenient to use as a yardstick the experience of the American Chemical Society in undergraduate accrediting. The administrative apparatus and the costs of operation for the accreditation program of the Engineers Council of Professional Development are similar to those for the chemists, with an increase in complexity in the engineers' procedure because of standard site visits. We recall that the chemists estimate their annual budget at about $40,000. This budget is for an operation which has been streamlined over a number of years and which evaluates about 35 to 40 departmental programs per year.

In mathematics, implementation would probably proceed in stages. The preliminary stage would involve establishment of operating procedures, guidelines for evaluators, and a list of standards to be met by approved departments. The cost of meetings of a "policy board" responsible for these activities, salaries of administrative and clerical staff, and general operating expenses during the first year might come close to $50,000.

The next stage would be promotional. The list of standards and the idea of accreditation would have to find general (not universal, of course) acceptance among mathematicians. The most effective means for accomplishing this goal, in addition to widespread publication efforts, would probably be a series of regional conferences organized by the administrative staff and addressed by members of the policy board. The cost of five large conferences can be estimated at $40,000.

It would be necessary to establish an accrediting board or commission consisting of, say, seven to nine members, preferably representing a variety of mathematical and professional points of view. On the basis of the conferences, a few schools could be invited to participate, at no cost to them, in pilot accreditation projects.

Although a program of accreditation might ultimately become self-supporting, it seems clear that grants from a suitable agency or foundation would have to be sought in order to underwrite the costs of these initial stages of the program.

Once the program is in operation, running costs would depend in part on how quickly it expands. According to the experience of the chemists and engineers, the average cost of accrediting a single undergraduate department would be about $1000 to $1500. Beginning on a relatively modest scale, the board might handle 50 or 60 applications per year, with an annual budget of at least $50,000 to $60,000.

With some 1500 undergraduate institutions now offering a mathematics major, it would be reasonable to assume that this rate would have to be accelerated greatly and that eventually perhaps 200 applications per year might be processed, with a budget in excess of $200,000.

The standing of an accredited program should be reviewed periodically. With some modification, the procedures for review would follow those for initial accreditation. Costs of such re-evaluation are difficult to estimate but should not be overlooked.

No matter what the details of the operation of an accreditation system are, it will involve substantial amounts of effort by numerous mathematicians. The administrator of the program would probably have to give it his full time. The board would have to spend many hours reading applications and training visiting teams. Any visiting teams would probably spend several days visiting a department and additional time in traveling and report writing. Even if there were only 50 to 60 applications a year, this would be a large commitment of man-hours.

Undergraduate programs: certification

National examinations are not entirely new to mathematicians. There are the Advanced Placement, C.E.E.B., and Graduate Record Examinations, to name the most familiar. Examinations on the undergraduate mathematics major could be devised and administered in similar ways. Costs of devising and administering the examinations would be borne by those taking the examinations. This offers a way of certifying individuals without the necessity for accrediting departments.

Alternatively, if an accreditation program were in effect, chairmen of approved programs could be authorized to issue certificates to their graduates. This would involve administrative and clerical expenses which could be recovered by some small charge to the individuals being certified. An additional small cost would be involved in keeping records of certification at some national office.

(b) Graduate programs

A program of accrediting graduate mathematics departments to offer something like the first or advanced graduate component would involve procedures similar to those for undergraduate programs, and the average cost of processing an application would be about the same. However, there are some differences which should be mentioned.

A policy board to establish standards for accrediting programs like the first graduate component would reasonably include several distinguished two-year college mathematics teachers as well as four-year college personnel and university mathematicians. For programs like the advanced graduate component and doctoral programs, the membership of the policy board and visitation teams would be quite different.

Since there are no more than 150 institutions offering doctoral work in the mathematical sciences and a total of approximately 300 offering master's degrees, the total operation would be considerably smaller than that for accrediting undergraduate departments. However, costs at the initial stages would be comparable and perhaps higher, since the policy boards might have more members and the number of working meetings might well be larger.

Certificates for teaching college mathematics at two-year and four-year colleges are already being issued by some states and by some institutions. Requirements for obtaining these certificates do not include detailed stipulations for mathematical competence. As in the case of the undergraduate major, certification of prospective two-year and four-year college teachers might be achieved either by national examinations or by authorizing department heads of accredited departments to issue certificates. Costs would probably be distributed among those applying for certification by means of application fees.

Part VI - Arguments For and Against Accreditation and Certification

A. Accreditation

Advocates of accreditation point out that by setting minimum standards it could give guidance, specific goals, and encouragement to schools which want to improve and put pressure on those that need to improve. Moreover, if a several point scale were used, average or good schools would also have a new incentive to improve. An accreditation program also could give useful information to graduate schools and employing agencies, as well as to prospective teachers and students. If recognized widely, it could help to establish a decent minimum standard among mathematics programs nationally, reasonable work loads and suitable salaries for mathematics teachers, and adequate facilities. The existence of accreditation for graduate programs might help to check the alarming growth in the number of weak master's and doctoral programs.

There is supporting evidence from the experience of the chemists. Many chemists feel that the system of accreditation (of undergraduate programs) of the American Chemical Society has helped significantly in establishing good standards in chemistry education, including facilities and faculty working conditions. To a large extent this has resulted from the efforts of college administrations to gain accreditation; thus, the program can be used as a lever by the department in dealing with the administration. This "lever" value does not necessarily cease once accreditation has been gained, because the institution will presumably be anxious not to lose accreditation.

In a sense, college mathematics programs are being accredited by the national accrediting establishment, which accredits colleges and universities as a whole through regional agencies. These regional agencies operate according to their own rules and regulations, are quite influential, and seem to be extremely difficult to influence. They may also accredit a school with a very poor mathematics program, or (theoretically) fail to accredit a school with an adequate one. General accreditation thus says something, but perhaps not very much, about the quality of mathematics instruction at a particular place. Some mathematicians believe that more specific information is desirable.

Opponents of accreditation claim that it would tend to rigidify curricula, to discourage experimentation and creativity. The chemists admit that this is a problem. However, it might be overcome by having a wide distribution of interests among the accreditors, particularly in applied fields; by having accreditors serve in rotation rather than in long terms or permanently; and by periodic review of standards. Opponents also point out the serious danger that unaccredited schools are likely to have so much more difficulty in attracting good staff and students that they will get worse, not better. (Perhaps some such schools would thus be induced to stop offering degrees in mathematics.) In addition to these intrinsic disadvantages of accreditation, there also are some serious difficulties of implementation which should be pointed out: cost (dollars and manpower), opposition of administrators, and potential friction generated among mathematicians.

The opposition of administrators might prove to be a major obstacle to setting up an effective accreditation program. The accrediting establishment has already informed the Panel that it is strongly opposed to any such program in mathematics. College presidents, deans, and other college officials tend to share this view, if

only because of the burden of extra work that such a program would entail for them. They point out, quite correctly, that a field in which there is such a program tends to gain an advantage over other fields; from their point of view, of course, this is not a good thing.

B. Certification of College Teachers

It is natural to consider two kinds of certification of college mathematics teachers:

(1) certification to teach lower division mathematics courses at a two-year or four-year college;

(2) certification to teach all the courses in the standard undergraduate curriculum.

CUPM has issued reports containing some recommendations for the training of teachers in these categories.*

A master's degree, sometimes supplemented by a specified number of additional semester hours of graduate work, has become widely accepted as the proper credential for the two-year college teacher. Sometimes the subject field in which the degree has been earned is not considered to be relevant, and a large number of two-year college mathematics teachers have training falling far short of what, by any reasonable standard, it should be. While this is a deplorable situation, it does not seem to be viewed with any kind of alarm by non-mathematicians. To compound the situation, the wide variation in quality of master's degrees in mathematics makes that degree completely unreliable as a measure of mathematical competence or teaching ability. The introduction of new degrees between the traditional M.A. and the research Ph.D. complicates the matter still further. Yet the hiring of teachers is in most instances done by administrators who have no way of knowing, even with a detailed transcript, how to evaluate mathematical qualifications. An official stamp of approval, in the form of a certificate granted by a national professional organization, might well be accepted by administrators as an accurate measure of the qualifications of the prospective teacher.

It may be well argued (and has been argued in some CUPM recommendations) that a doctor's degree in the mathematical sciences is neither necessary nor sufficient qualification for teaching the courses of the undergraduate curriculum. College administrators usually wish to staff their schools with Ph.D.'s, although in mathematics they have not yet been able to hire enough of them to meet institutional needs. There are many persons, qualified by reasonable standards to teach collegiate mathematics, who have abandoned college teaching as a career because they do not hold doctorates and hence lack "status" with colleagues and administrations. On the other hand, there are some unqualified teachers who hold high positions at their institutions because they have a doctorate in some field other than mathematics.

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*These are the Qualifications Report, the TYC Qualifications Report, and the Beginning Graduate Program booklet (see Appendix II for full titles).

Certification of the two kinds distinguished above could effectively identify qualified teachers. It would help deans and presidents at two- and four-year colleges to make wiser decisions in recruitment, promotion, and the granting of tenure. A program of certification would also help qualified persons without doctorates to find rewarding careers in college teaching.

A system of certification based on national examinations would probably be easier to operate than a national accreditation program and is more likely to be self-supporting. It would still require many man-hours of time, with or without compensation, from members of the mathematical community.

However, certification might have some of the effects of an accreditation program. If widely accepted, the certification examination would tend to uniformize the corresponding curricula. Indeed, some graduate departments might wish to use the certification examinations in comprehensive examinations.

Thus far we have dealt principally with the major arguments in favor of certification. There are serious questions, however, about the possibility of truly gauging an individual's qualifications for college teaching. While it is relatively simple to devise examinations to determine subject matter competence, teaching ability is more elusive and less measurable. Any procedure for certification which disregards ability to apply knowledge in teaching will be subject to severe criticism; yet any procedure which does reckon with teaching ability will probably be very hard to apply.

Part VII - Concluding Comments

Various arguments may be advanced for introducing a system of accreditation or certification in mathematics, and others may be advanced against it. Experience in other disciplines shows that many of these arguments are not merely hypothetical. Some of the favorable arguments are:

(1) The accreditation process itself causes each department to examine its goals, procedures, and resources, measured against recognized standards.

(2) The possibility that accreditation might be denied, or that, once granted, it might be withdrawn, exerts a strong influence for continued improvement of programs and performance.

(3) The existence of an accreditation program benefits the profession by exerting pressure on administrations to improve teaching loads, faculty salaries, facilities, and the like.

(4) An effective program of accreditation or certification warns the consumer (prospective student, future employer) against a substandard program or its product.

Some of the disadvantages are likely to be these:

(1) Accreditation necessarily establishes minimal standards which assert a strong force toward uniformity among programs and institutions, discouraging experimentation.

(2) Minimal standards tend in practice to become maximal standards, decreasing the pressure on some institutions to improve.

(3) Institutions which are not accredited tend to be weakened further by their inability to gain competent staff.

(4) The tensions and animosities which seem to be inherent in programs of formal accreditation tend to undermine the spirit of cooperation and mutual support between a professional organization and its local constituents on which constructive influence toward continued improvement depends.

It is a particular application of this last point that any agency established for accreditation or certification in mathematics should probably be quite separate from CUPM. Otherwise, the effectiveness of CUPM as a purely constructive force in curriculum improvement would be gravely jeopardized.

A possible alternative to a system of formal accreditation is the development, perhaps through a major extension of the role of the CUPM Consultants Bureau, of a detailed system of self-examination by a mathematics department coordinated with confidential evaluation by a visitation team representing a national mathematical organization. Such an arrangement has the advantage of wide acceptability, but it would not apply as much pressure to improve as accreditation. Furthermore, such a system would probably be as expensive to establish and operate per department affected as an accreditation program.

While there is some support for establishing a certification system in mathematics, e.g., as expressed at CUPM conferences by two-year college faculty members, many mathematicians are hostile to the idea of either certification or accreditation, because distasteful procedures would be involved. A national program of this kind would involve great expense, as well as the cooperation and hard work of a large number of mathematicians, and it would face the almost certain opposition of administrators and the accrediting establishment. It therefore seems that a decision to attempt some such program should be made only after the mathematical community as a whole has been given ample opportunity to consider the matter and express its views, and only after general support within the community (and in particular, from leading departments) is clearly assured.

APPENDIX I.

NATIONAL COMMISSION ON ACCREDITING

Criteria for Recognized Accrediting Organizations

The National Commission on Accrediting will recognize only one organization to accredit institutions in a defined geographical area of jurisdiction and one organization to accredit programs of study in any one field of professional specialization. In seeking recognition by the Commission, and in order to maintain recognition, an organization engaged in accrediting will be judged on the following criteria:

1. It is a voluntary, nonprofit agency serving a definite need for accreditation in the field of higher education in which it operates, and which is responsible to, and controlled by, institutions, except in special circumstances, that are -- or are adjudged eligible to become -- constituent members of the National Commission on Accrediting.

2. In the case of an organization concerned with a particular professional field of study, except in special circumstances, (a) it is engaged in accrediting programs of study offered primarily by institutions which are eligible for membership in one of the regional accrediting associations, (b) it makes continual and reasonable efforts to coordinate its accrediting procedures and information on visits with the several regional accrediting associations, and (c) it limits itself in accrediting to those professional areas with which it is directly concerned and relies on the regional associations to evaluate the general qualities of institutions. Willingness of organizations to communicate and share pertinent information with other accrediting organizations is essential to continued recognition.

3. The organization has an adequate organizational pattern and effective procedures, consistent with the Code of Good Practice in Accrediting in Higher Education, to maintain its operations on a professional basis and to make possible the reevaluation, at fixed intervals, of the various programs of study. Accreditation decisions should be made by groups having an appropriate balance of interests representing the institutional programs, the profession, and the public.

4. The organization has financial resources necessary to maintain accrediting operations in accordance with its published policies and procedures.

5. The organization publicly makes available: (a) current information concerning its criteria or standards for accrediting, (b) reports of its operations, and (c) lists of institutions with accredited programs of study.

6. The organization reviews at regular intervals the criteria by which it evaluates institutional programs of study, in order that the criteria shall both support constructive analysis and emphasize factors of critical importance.

7. The decision making process regarding accreditation should be adequately described, and the appeals procedures should be clearly stated. Both of these processes should be consistent with the Code of Good Practice in Accrediting.

8. The organization provides a means whereby representatives of the National Commission on Accrediting may review and consider with officials of the organization all of its accrediting policies and practices. The recognized organization agrees to file such reports as the National Commission on Accrediting, at its discretion, may require.

9. Except within the stated limits of the Code of Good Practice in Accrediting and items listed under Criterion 5 (above), all data, reports, and actions are confidential information.

10. The professional organization notifies the president of the institution when the organization plans to evaluate a program of study at an institution.

[Adopted April 1, 1967]

APPENDIX II

CUPM DOCUMENTS MENTIONED IN THIS REPORT

Beginning Graduate Program: A Beginning Graduate Program in Mathematics for Prospective Teachers of Undergraduates, 1969.

BMSS: Tentative Recommendations for the Undergraduate Mathematics Program for Students in the Biological, Management, and Social Sciences, 1964.

GCMC: A General Curriculum in Mathematics for Colleges, 1965.

Pale Green: Preparation for Graduate Study in Mathematics, 1965.

Pregraduate: Pregraduate Preparation of Research Mathematicians, 1963, reprinted 1965.

PSE: Recommendations on the Undergraduate Mathematics Program for Engineers and Physicists, 1962, revised 1967.

Qualifications Report: Qualifications for a College Faculty in Mathematics, 1967.

Teacher Training: Recommendations for the Training of Teachers of Mathematics, 1961, revised 1966.

TYC Qualifications Report: Qualifications for Teaching University Parallel Mathematics Courses in Two Year Colleges, forthcoming.