Rutherford\textsuperscript{1} recently published a sophisticated survey of American university policies and practice in preparing leaders in science education. His study had three phases. The first was to conduct a survey which would provide accurate descriptive information on the standards of admission into doctoral programs in science education, on the programs themselves, and on the employment of successful candidates. The second phase of the investigation was to make value judgments on the conditions revealed by the survey. This was done by comparing the survey findings to a model developed by Rutherford on the basis of a study of the literature of graduate education in general and of doctoral programs in education. The final phase was to try to find the reasons behind the differences found between what the model called for and what the practices actually were, and thereby to identify critical barriers standing in the way of reform.

All that can be summarized here are those central controversial issues found by Rutherford that are equally relevant to mathematics education. These are: (1) the appropriateness of training doctoral candidates to be college science teachers in schools of education and departments of science education, (2) the desirability and feasibility of some kind of postdoctoral internship arrangement in science education, and (3) the importance of concomitant research programs in science education under the guidance of specialists in science education research.

In Rutherford's own words (personal communication), his study happened to come to the attention of science educators at a time when they were struggling to gain recognition as a bona fide professional group. The concern of science educators over their lack of occupational status had increased as they became aware that they had not instigated, led, or much influenced the major science curriculum reforms that began in the late 1950's.

One aspect of this concern was a deepening interest in the question of entry into the profession. Thus, after the above paper was delivered before it, the Association for the Education of Teachers of Science (AETS) appointed a blue-ribbon committee to study further the question of doctoral programs in science education and to draft a set of standards for consideration by the Association. The committee carried out its assignment and one year later presented a statement called \textit{Guidelines for Doctoral Programs in Science Education}. Official AETS adoption of the guidelines now makes it possible to inform every university now offering or planning to offer a doctoral program in science education on what science educators themselves consider the dimensions of a sound program to be.

A Preliminary Survey of Doctoral Training in Mathematics Education

To obtain some information about existing and proposed doctoral programs in mathematics education, a brief questionnaire was sent to 165 institutions in the United States which grant Ph.D.'s or the equivalent; 126 replies were received. Sixty-one institutions indicated that they did not have and did not plan to offer a doctoral program in mathematics education. Thirty-nine had already graduated doctoral students in the area and another 26 are either planning new
programs or have some students in progress. The degrees granted are conferred by schools of education in 35 universities, mathematics departments in three, and graduate schools or departments of education in twelve. It is estimated that about five of the approximately 40 schools, from whom replies were not received, do grant the doctorate in mathematics education.

There were 51 Doctor of Philosophy and 34 Doctor of Education degrees granted during the three year period, 1960–62, and 80 Doctor of Philosophy and 65 Doctor of Education degrees granted during the three-year period, 1963–65, representing an overall increase of 70%. In addition, 448 students are reported to be actively seeking the doctorate. Since these data are not complete, it is likely that the actual numbers involved are somewhat higher.

Although many institutions tailor their programs to individual needs and some of the larger departments have several areas of specialization, it is of some interest to see how the doctoral student spends his time in formal course work. In 17 of the institutions, 41–50% of the course work was in mathematics. This was the mode. Correspondingly, one institution required 0–10%, three required 11–20%, six required 21–30%, ten required 31–40%, seven required 51–60%, eight required 61–70%, and two required 71–80%. As for methods-related courses in mathematics education: twenty-three institutions required 0–10%, fifteen required 11–20%, six required 21–30%, three required 31–40%, and one required 41–50%.

The time devoted to educational psychology, educational research methods, and statistics (e.g., statistics and measurement), was as follows: five institutions required 0–10%, eighteen required 11–20%, fourteen required 21–30%, ten required 31–40%, four required 41–50%, and one required 51–60%. Twenty-four of the reporting institutions indicated that only 0–10% of their course work was spent in miscellaneous areas (e.g., educational philosophy), while eleven required 11–20%, five required 21–30%, two required 31–40%, two required 41–50%, one required 51–60%, and one required 71–80%.

It is possible that these miscellaneous course percentages to some extent reflect uncertainty on the part of those completing the forms as to which of the other categories the courses belonged. In particular, there may have been some uncertainty as to whether a course was or was not "research related." There is some reason to believe that many of the courses listed under research were of a general survey nature rather than at an advanced graduate level. Few of the institutions reported having research seminars devoted exclusively to mathematics education research.

The most frequently mentioned difference between the Ph.D. and the Ed.D. degrees was that the Ph.D. required a demonstration of language proficiency. Less often it was mentioned that more basic research was required for the Ph.D. degree.

Mathematics and Science Education—Similarities and Differences

Except for differences in subject matter, there are many parallels between mathematics and science education. For one thing, mathematics and science educators, broadly defined, have similar functions at a variety of levels. Some leaders in both areas are involved in school supervision, others in teacher training, and still others in research and development. Another rapidly expanding group, often categorized as mathematicians and scientists, are the college teachers. This last group has evolved largely as the result of a need for more undergraduate teachers in the scientific areas.

The problems and basic questions involved in training leaders in these fields are also quite similar. It is quite likely, for example, that a survey of the opinions of mathematics educators in leadership roles would
reveal as much controversy about the issues identified by Rutherford (see above) as was the case in science education.

1. Should college mathematics teachers be trained in departments of mathematics or in mathematics education?

2. Should provision be made for post-doctoral internships—are they both desirable and feasible?

3. Should the university mathematics educator be involved in research—if so, what kinds of research and to what extent? Should all leaders in mathematics education be required to do research or should this be primarily left to specialists?

Whatever the answer to these questions, mathematics and science educators must concern themselves with the question of how such training is to be accomplished.* Should all doctoral students share a common program or should there be opportunities for specialization in such subfields as teacher training and research.\(^5\)

The kind of training given our future leaders in mathematics (and science) education will in large part determine the direction mathematics education will take in the future. As suggested by the survey described above, however, many of the doctoral programs in mathematics education are tailored to meet the immediate needs of individual students. This raises the fundamental question of whether such an approach, by tending to provide leaders for existing positions, will simply tend to maintain the status quo rather than to provide direction.

There are, of course, related practical considerations. Should doctoral training be concentrated in a few of the existing large departments of mathematics and science education as suggested in the Rutherford article? Presumably, such departments have or could have on their staffs experts in all aspects of mathematics and/or science education, including research. If so, what should be the role of the smaller departments, many of which include only one or two people, but which could nonetheless offer equally good doctoral training? Perhaps a partial solution is for these smaller departments to concentrate on some specialty as is often done in the smaller departments of mathematics and science. More important, however, is that the mathematics and science education communities come to grips with these crucial problems.

In spite of the parallels noted above, there are some important differences between mathematics and science education, particularly insofar as research is concerned. Whereas there is no established organization for leaders in mathematics education or an explicit outlet for scientific publication in mathematics education, science educators have had the National Association for Research in Science Teaching (NARST) for over thirty years and The Journal of Research in Science Teaching for four. In spite of the pioneering efforts made earlier during the 1940's by a number of mathematics educators interested in scientific research (as an addition, but not in opposition, to developmental activities), it has only been quite recently that the existing milieu seems ready to support an active research program in the area. Perhaps mathematics educators are, along with their counterparts in science,* becoming more self-conscious of their status both as a profession and as a discipline.

References


* As indicated by Rutherford’s research, science educators appear to have taken the lead in attempting to find solutions.

* See Rutherford’s comment quoted above.