

Saunders Mac Lane, *Is this Doctoral Program Necessary?* Notices of the American Mathematical Society **20 (1973), 371 – 372.**

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[A correction of an error in the original article is printed in **RED**.]

In the United States and Canada there were about 250 new Ph. D.'s in 1952 in the Mathematical Sciences. In 1972 there were about 1400. This startling increase came about through a variety of causes: The reaction to Sputnik, the recommendations of government bodies, as in the notorious Gilliland report, the enthusiasm for training more scientists and engineers to support the thrust into outer space, the predictions, by COSRIMS and others, of an intense need for more teachers of mathematics, the development grants offered by the National Science Foundation, and just plain unreasonable desire to start up new Ph. D. programs.

At present many of the new Ph. D.'s have great anguish related to their training; there are some (150 this summer, by a reasonably careful estimate) who have searched for such positions without success. In times the news of these difficulties will get back to the beginning of graduate students and mid – course students: Some will not start and others will give up; still others will continue but with a clearer expectation, knowing they are studying mathematics for its great beauty without sure prospects of their own subsequent employability. Thus in time, as in other human affairs not subject to detailed planning, supply will probably adjust itself to demand — but only at the cost of personal hardship. Under these circumstances, it is only appropriate that those responsible for Ph. D. programs — professors, directors of graduate study, chairmen, and deans — ask themselves some hard questions: Is **our** Ph. D. program necessary?

Here is a possible check list of specific questions.

1. The Ph. D. testifies that its holders have made an original contribution to knowledge; the degree is granted because of hope that its recipients will go on to make additional and more fundamental contributions. Not all Ph. D.'s succeed in this, but any Ph. D. program, after 10 or 15 years, should have some graduates who have really done outstanding work. How many can you list for your program?
2. Outstanding research work is stimulated by visible previous outstanding work. Does the faculty of your program exhibit this? It is not hard to find out: Name the outstanding papers they have written and the reasons why they are outstanding, and specify the national and international invited addresses given by members of the faculty.
3. Adequate graduate work requires a multiplicity of prospects for research: Not just some long list of topics, but a real variety of promising fields of research, with enthusiastic faculty for each. Does your program provide this?

4. Sometimes graduate programs were established at prosperous times for what might now appear to be the wrong reasons. Were the following some of the reasons for your program?
- (a) Graduate students often provide teaching assistants to conduct undergraduate courses. How good are your teaching assistants? Are they chosen for their teaching ability or because they need financial support? How much do they teach; can it be that they are being exploited? Does your program exist in part to provide graduate assistants?
 - (b) Faculty members like to have graduate students, and this for a variety of reasons, some good, some bad. It is sometimes asserted that a research program will go well **only** if students are taking part. If this is really so, each tenured member of the faculty active in research would be likely to “turn out” a Ph. D. every three years or so. With a research career of 30 years, this means that **five to ten** new mathematicians will grow for each present one. Does this make a case for population control? Is your program there chiefly in order to attract faculty? If so, are there alternatives?
 - (c) Innovation is the order of the day, and rightly so. Graduate training should be reformed to give the student a better feel for his [or her] future teaching, a wider grasp of mathematics, and a better understanding of some of the applications. Sometimes Ph. D. programs are set up **in order to** make such a reform. Was your program the child of reform? Is this really an adequate reason for such a program?
 - (d) Was your program established for institutional prestige or for the economic advancement of your region of the country? If so, are these reasons adequate ones and are they really compelling?
5. Do your students know where they are going? Are they aware of the variety of other universities with graduate programs, of the multiplicity of fields of research, and of the uncertain prospects of professional employment? Do you help them to see the situation fully?
6. Mathematical research today is producing brilliant solutions to many basic problems. For example, just in one recent week I learned of **two remarkable advances: Deligne’s solution of the Weil conjectures (with a consequent solution of an old problem of Ramanujan) and the Boone – Higman characterization of finitely generated groups with a solvable word problem.**

Do your graduate students know enough to recognize these problems and so take part and pleasure in the advances of mathematics? A real graduate training provides access to the beauty and wonders of mathematical structures. Does your program do this? If there is doubt, ...