Evaluating Summer Math Programs

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Introduction

After five years of operation, the National Science Foundation (NSF) asked us to conduct a complete evaluation of the Berkeley Summer Institute of Mathematical Sciences (SIMS) and its predecessor the Mills Summer Mathematics Institute (SMI). We were surprised by this request because the evaluations already in place at that time included mid-program interviews, detailed anonymous end-of-program questionnaires, and brief follow-up surveys to track students after they left the program. Devising a new plan that would provide more convincing evidence of the program's effectiveness was a challenge. Dr. Ani Adhikari[1] and I laid out a comprehensive evaluation plan with a time line for collecting specific types of information from past participants at different stages in their careers. We designed questionnaires to aid comparisons across participants and over years, and in addition to past participants, we found other sources of information on the impact of our program, such as faculty who were in contact with students before and after participation in our program.

The mid-program and end-of-program evaluations that we had conducted for several years were extremely useful in shaping our program. Input from students and faculty led to many improvements of the program. But, the new evaluation better helped us document our program's achievements. Although SMI/SIMS is different from a typical NSF Research Experience for Undergraduates (REU) program[2], we hope that our evaluation plan will be useful to directors of other summer mathematics programs who are interested in devising evaluations that document their programs' achievements.

Why Evaluate?

Evaluations can provide evidence to funding agencies that a program works and should continue to be funded, and they can influence others to adopt successful aspects of a program or to start a new similar program. On a larger scale, the information collected can provide evidence that summer mathematics programs work. This information can help demonstrate to the mathematics community the benefits of summer mathematics programs, and it can shape policy made by the federal government about support for such programs.

In designing our evaluation plan and questionnaires, we sought the advise of evaluation specialists, Assistant Vice Chancellor Barbara Gross Davis[3] and Dr. Flora McMartin[4]. We also found *Evaluating Intervention Programs: Applications from Womens' Programs in Mathematics and Science* by Davis and Humphreys to be extremely useful for figuring out

[1]Visiting Professor, University of California, Berkeley

[2]From 1991 to 1997, SMI/SIMS was a six-week summer program for 20 undergraduate women. While in the program, students participated in two seminars in advanced mathematics, a colloquium series given by research mathematicians, and panels on various aspects of graduate school. For more information on the program see Nolan (2000)

[3]Office of Student Life-Educational Development, University of California, Berkeley

[4]Synthesis Coalition, University of California, Berkeley

what information to collect, who (or what) could provide this information, and how and when to get the information.

To determine what to evaluate, Davis and Humphreys suggest considering these questions:

- Who wants to know?
- What is in your grant proposal?
- What are your program goals and objectives?
- How are similar programs evaluated?
- Are there any unanticipated side effects of your program?

The answers to these questions helped us shape our evaluation plan. In our case, panelists who reviewed our proposal for NSF funding were not convinced of the effectiveness of the program given the data presented. They complained that–

> Program evaluations include the standard testimony of participants immediately at the end of their summary experiences ...

They also raised several comments and questions about the effectiveness of the program, and the NSF wanted them addressed:

> For such an expensive and selective program should the success rates in turning out top notch female graduate students be higher?
>
> Better comparisons with students who did not participate should be provided.
>
> What advantages, if any, does this program have over an REU and for whom?
>
> Do these people [faculty leading seminars] really need a grand a week?

To put these questions in context, we describe a few aspects of SMI/SIMS. The program goals and objectives included preparing students for graduate studies in the mathematical sciences, and motivating them to enter and successfully complete a Ph.D. program. Some of the students in SMI/SIMS were from elite institutions such as Harvard and the University of Chicago. It was our thinking that these women often did not receive the individual attention and encouragement that students at small schools received, and that they could be big sisters for other less mathematically prepared students in the program. Although a few students each year were from these schools, most were not, and roughly two-thirds of all program participants went on to graduate school. A comparison number or numbers would be useful in judging the effectiveness of the program in encouraging its participants to attend graduate school. But, to find meaningful comparisons is extremely difficult. We are not in a controlled experimental setting where we can easily find similar groups of students who did not receive the benefits of SMI/SIMS (or any other summer mathematics program).

Because SMI/SIMS was different in design from an REU, it was placed in the position of defining its effectiveness relative to REUs. We advocated that there can be more than

one model of success for a summer mathematics program. For example, one benefit that SMI/SIMS may have over an REU is that it provides a large number of female peers, graduate students and faculty to serve as role models and mentors. One difference between SMI/SIMS and REUs that caught a lot of attention was the budget. The cost of a student to attend SMI/SIMS averaged $1,000 more than typical REUs. In part this was due to the cost of housing in the Bay Area, but it was also due to the cost of supporting the four visiting faculty who led seminars. These faculty were paid $6,000 for working in the program (a grand a week) along with travel and housing reimbursements. Each faculty member also worked with a paid graduate student assistant.

Although it was expensive to have visiting faculty in the program, we found an unexpected benefit in doing so. The enthusiasm of the mathematically talented students in the program and the nontraditional seminar style of teaching helped the faculty and graduate students develop their teaching skills. The faculty also reported a boost in their research while visiting Berkeley, and they were glad to be part of a growing network of female mathematicians who participated in the program.

Evaluation Questions and Sources

Working from the questions raised by the reviewers, and the goals, objectives, and unexpected benefits of the program, we devised a set of evaluation questions. With these questions to guide us, we determined how to collect data.

- What is the impact of the program on the student's decision to apply to graduate school?
- Does the program improve a student's self confidence?
- Does the program increase a student's knowledge about and preparation for graduate school?
- What is the program's success rate for students entering and completing advance degrees in the mathematical sciences?
- How does the success rate compare to other rates of attendance and completion of graduate school?
- Do students use the network of peers, graduate students and faculty?
- How does the SMI compare to an REU?
- What impact does the program have on the faculty and graduate students?

The primary source for answers to questions on the benefit of the program to the students was the students themselves. However, we also found other external sources for answering these questions, and used these sources to validate student responses.

- A professor who wrote a letter of recommendation for a student to attend the program should know the student well, and have the unique perspective of observing her before and after the program.

- The graduate advisor of a past participant who is now in graduate school can offer opinions on how prepared she was for graduate school, and on progress to degree.
- Peers of a participant at her home institution may be able to provide comparison information.
- Published tables on the number of graduates from the home institution that go on to receive Ph.D.s in the mathematical sciences can be used as comparisons figures for success rates.

More ambitiously, by following all mathematics majors at a few undergraduate institutions over time, a profile of mathematics majors and the benefits of summer mathematics programs may be documented. And tracking a sample of Ph.D. students over time could provide valuable information on the effectiveness of summer mathematics programs. Such studies were beyond the time and funding available and beyond the scope of our project.

Evaluation Plan

On the first day of the program, we had students fill in a survey that asked a few brief questions. The purpose was to get a base line measurement on the students. We wanted to find out what students knew about graduate school and funding for graduate school; how sure they were that they were going to graduate school; and which graduate schools they were thinking about applying to for what advanced degree. At the end of the program, in addition to requesting program evaluations, we again asked these questions on plans for graduate school.

We planned to keep in touch with students on a yearly basis to update their directory information. We used email and telephone to contact students, or their parents, to update our files.

A more detailed evaluation was to be completed two years out and four years out of the program. Two years out from the program, students were asked, among other things, about their current status with regard to work and/or graduate school, what mathematics activities they had engaged in over the past two years, and what contacts they had made with program faculty and students after the program. Those that attended an REU, were asked to compare and contrast their experiences in the two programs.

Also at this time, we surveyed the undergraduate faculty who wrote letters of recommendation for the students in the program. Some questions on the faculty survey were the same as those on the two-year participant survey in order to corroborate the students' responses. We found that the faculty were at least as positive as the students were about the program's effect on the student. We also collected from these faculty information about the undergraduate program at their institution, including the size of the major, the number of female students, and the number of students going on to graduate school each year. This information was useful in comparing program participants to peer groups with similar backgrounds.

In the four-year survey, students were again asked what they were up to and, as appropriate, they were asked to reflect on the program's effect on their decision to attend and ability to succeed in graduate school. Those students who were working toward their Ph.D were asked for permission to contact their thesis advisor. The graduate advisors were asked

two open ended questions about the student's preparation for graduate school and progress to degree.

Finally, we also surveyed the SMI/SIMS faculty, and asked them to describe the impact of the program, if any, on their careers.

Survey details

The student questionnaires were approximately two pages long, and the faculty surveys were under one page in length. In addition to several open-ended questions, the questionnaires contained about ten closed questions asking the student (or faculty) to rate some aspect of the program on a scale from 1 (little or none) to 5 (a great deal). Two example questions appear below. We took care in wording the questions to try to avoid bias in the response. Notice the use of the phrase "if any" in the first question, and "From your perspective" in the second. Some questions on the two-year and four-year surveys were the same in order to make comparisons across years and to pool data, and some questions on the two-year and faculty survey were the same in order to make comparisons between a student's perception and her undergraduate advisor's perception.

To what extent, if any, did the program affect your:

self confidence	1	2	3	4	5
motivation to do graduate work	1	2	3	4	5
knowledge about what graduate school is like	1	2	3	4	5

From your perspective, how important was it that the program involved only women as:

students	1	2	3	4	5
graduate students	1	2	3	4	5
faculty	1	2	3	4	5

All surveys were conducted via email. For the student surveys, we employed an assistant to contact the students and collect the data in order to encourage honest responses. Although, Adhikari and I did send reminder emails to students who were late in responding. We also contacted the faculty surveyed. The response rate was very high with 80% of the students and 75% of the faculty who wrote letters of recommendation for students responding. All graduate advisors and SMI/SIMS faculty responded. We were pleased to find that the new data collected were even more positive than our earlier findings and they confirmed to us the success of our program. Some of our findings appear in Adhikari, Givant, and Nolan (1997) and Nolan (2000), and more detailed results and sample questionnaires can be found at `www.stat.berkeley.edu/users/nolan/sims/`.

Summary

We hope that the evaluation plan presented here will provide useful ideas to others planning evaluations of summer mathematics programs. We encourage you to list your evaluation questions and determine new ways to find better, more informative data to answer them. We also encourage you to share your evaluation plan with others. Consider posting your evaluation plan on your website and sending us the url, or send us (nolan@stat.berkeley.edu)

your ideas for evaluation and sample questionnaires. We are interested in collecting these materials on the web to serve as a resource for other program directors.

References

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2. Davis, B.G., Humphreys, S. (1985) *Evaluating Intervention Programs: Applications from Womens' Programs in Mathematics and Science.* New York: Teachers College, Columbia University.
3. Nolan, D. (2000) The Mills College Summer Mathematics Institute & The Berkeley Summer Institute for the Mathematical Sciences. In *Proceedings of the Conference on Summer Undergraduate Mathematics Research Programs.* American Mathematical Society.