

Undergraduate Research in Mathematics at Northern Arizona University

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Outline

- NSF's REU Initiative
- The REU Program at NAU
 - History of the Program
 - What we do – our current implementation
 - What we've learned
- Recent efforts to bring research into the undergraduate curriculum

National Science Foundation RFP:

Research experience is considered to be one of the most effective avenues for attracting talented undergraduates to and retaining them in careers in science and engineering, including careers in teaching and education REU projects involve students in meaningful ways in ongoing research programs or in research projects designed especially for the purpose. REU projects feature high-quality interaction of students with faculty and/or other research mentors and access to appropriate facilities and professional development opportunities...

NSF

...REU Sites are encouraged to involve students in research who might not otherwise have the opportunity, particularly those from academic institutions where research programs are limited.

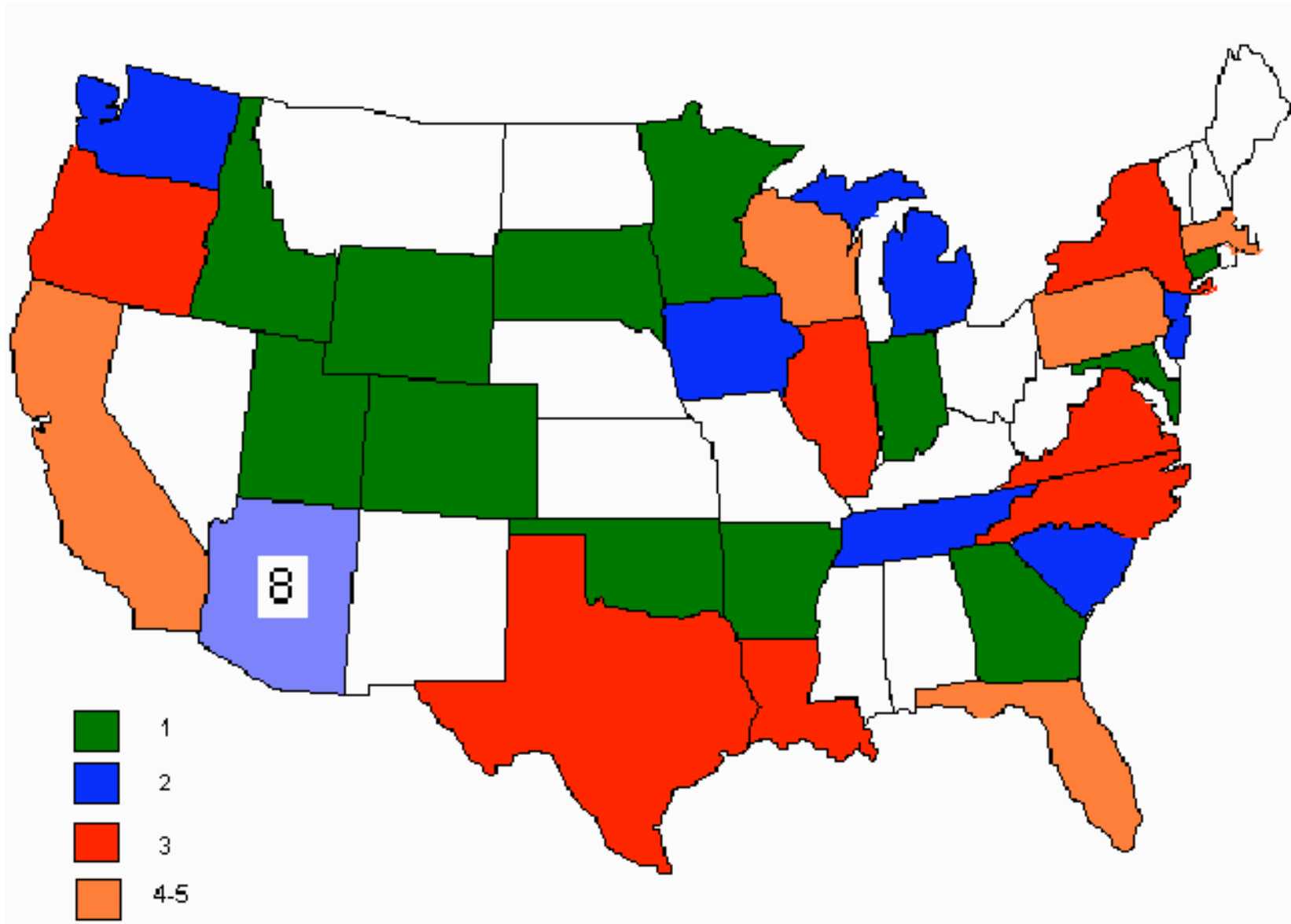
Thus, a significant fraction of the student participants should come from outside the host institution or organization.

The REU Program at Northern Arizona University started in 1994 following Richard Griego's efforts to attract NSF monies to the university.

16* Faculty have worked in the program. A total of 79 Students have taken part. These students come from 31 different states.

The Department currently has 17 Ph.D. Mathematics and Statistics Faculty! Only 5 statistics/actuarial science folks have not been involved.

Home Institutions of NAU REU Students



Plus one in Quebec!

REU Funding is Student Oriented

...As a guide to budget development, student stipends for summer projects are expected to be approx \$400 per student per week, in addition to other participant costs of room and board, fees, and travel. (NSF)

Total project costs are expected to be typically \$600 to \$800 per student per week.

For an 8 week program and 6 students, total funding is around \$34,000. Of this \$24,000 for students, \$9000 for faculty salaries. The director gets \$500.

Program

Three faculty participate getting \$3000 to work with 2 students. (The dollar amount is comparable to teaching a summer course.) Each student has a peer working with the same advisor so that nobody feels too isolated. But each student has their own individual problem.

Faculty may lecture, give homework etc. for the first couple of weeks. Students are then cut loose to work on their own project for 5 weeks. Last week has presentations and papers due.

Also:

- Two seminars per week on a variety of topics. Faculty from NAU talk on something of interest to them. Also outside speakers, e.g. Anne Gelb from ASU.
- Students from ASU's Preparing Future Mathematics Faculty (PFMF) come up and interact with the REU students.
- Students learn TEX
- Regular hikes and potlucks.

Impact on Students

- Invariably all students enjoy the program. They get to see what life may be like in academia. Some remain on the grad school track; for others the experience helps them decide. (Sometimes that they can't see themselves doing this kind of thing for the rest of their lives!)

Impact on Faculty

- Priceless

Important Lessons

Students enjoy doing things from day one – they don't want to have to read a graduate textbook for a month before they start work.

Like any form of undergraduate teaching, it is important to engage students in their own learning.

They will buy into the research process if they can be hooked early. Conversely, if they are asked to just browse textbooks and work the problems contained therein, they get restless!

Mathematical Areas

We've tried

- Stochastic Processes
- Mathematical Statistics
- Real Analysis

But we've had the most luck with (broadly defined)

- Combinatorial Mathematics
- Applied Mathematics

- Combinatorial Problems – be it graph theory or combinatorial games or problems from elsewhere that can be viewed in this way – are easy for students to play with and make simple conjectures.
- Areas such as number theory and algebra have problems that can involve experimentation and conjecture also.
- Applied Mathematics has problems in which students can get involved early – but often these are computer oriented and may require ‘grunt programming’! (This actually appeals to some students!)

Best projects have given the students the most elbow room. It works well if they can play for a while and then choose their own direction.

Rare to have success when a faculty member pushes the student into working within a tight box on something.

The experience must be designed for the student

The faculty member should not use REU as a cheap way of having someone else do their busy work!

Project Goals

Good to have understanding up front as to what the goals are. Some programs set out with the goal that every student publish an article.

Our goals are simpler. To have a student work on a project that matches their own background and interests. For them to experience the research process, including its frustrations, without great loss of self-esteem.

Many students have published, but for us this is a bonus.

REU Recruitment Issues

- Selecting students from small colleges can be risky.

The 'best student in my 20 years here' may not always be as strong as it sounds!

We have learned to be cautious the hard way.

- Good to have some students from bigger institutions too.
- Students from Wartburg College, IA and Elmhurst College, IL have been as good as anyone.

REU Student Issues - unavoidable

- Bruised Egos. Students are often the best math major at their school. They may find out that others in the program are much smarter.

Better to find this out at an REU than in grad school?

This is very difficult for some, and it can be challenging to keep them motivated and on track.

REU Student Issues – dealt with

- Skateboarding down the hallways
- Alcohol in the math building
- Computer hacking
- Many students are between Sophomore and Junior Year – not as mature as graduate students.

There have also been more serious personal issues.

Bringing research into the undergraduate curriculum

Great Idea but there are issues:

- Rewarding faculty for their time and effort.
- Recognizing quality of faculty work.
- Hoping to work with super student X and ending up stuck with weak student Y.

NAU

23 Tenured or tenure-track faculty – 15-21 hrs/year

4 Lecturers - 21 hours/year

9 Instructors (1-year positions) - 27 hours/year

15 Graduate Teaching Assistants - 9-12 hours/year

2 Part Time Instructors - 7 hours total

Courses capped at 35; upper division often with 15 students and graduate classes with 5-10. (25 some)

Little money for graders. **WeBWork helps.**

All Ph.D. Faculty have research expectations and carry the bulk of important Departmental service.

A number of people are active in important university-level committees.

We are BUSY!!

Q: In the past, how have we handled 'Independent Studies' or directing 'Graduate Thesis'?

A: Something on top of everything else that is without recognition or reward.

Undergraduate Research

A faculty member who supervises the research of three undergraduates (one or more semesters per student) over any period of time is **eligible** for a course release.

The Department Chair will grant at most one such release in a given semester, with the **granting** of such release occurring as soon as possible.

This is a Departmental priority and should not be canceled, for example, because another section of quantitative reasoning is needed.

Undergraduate Research

The Department considers the supervision of research work as a form of teaching, and will assess this as such.

Students in the extended major (53+ hours of MAT/STA courses; no minor required) are now required to do 3 units of undergraduate research. [It is unlikely they will do so until at least their junior year – 2007-08.] These are our best students – often those heading for graduate school. Students in the regular major (35+ hours with a minor) can elect to do undergraduate research.

Early Days

Although at this stage no students are required to do undergraduate research, a couple of students are doing so this semester.

Faculty are happy participating in the hope of that course release and that their efforts will be rewarded when Annual Evaluations take place next year.

We shall see...