

Promising Practices in STEM Education
National Academy of Science
The Role of Undergraduate Research in Student Retention, Academic Engagement, and the Pursuit of Graduate Education
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The University of Michigan is a large public research university with an enrollment of 25,000 undergraduate students and 10,000 graduate students. Located 45 minutes from Detroit, our campus gained national attention over the past decade in our fight to preserve affirmative action. Prior to a recent state ballot initiative that bans the use of affirmative action in the State of Michigan, the University had developed a major strategic plan to increase diversity and to improve the retention and academic success of historically underrepresented students on our campus. The Undergraduate Research Opportunity Program was developed in 1988 as one of several campus initiatives designed to close the retention gap between historically underrepresented students and white students by engaging diverse first and second year students in research with faculty. Today the program designed around retention, has grown from a small pilot initiative for 14 first and second year historically underrepresented students to a broader program serving over 1000 first and second year students annually with a continued focus on engaging historically underrepresented students in research as well as young women in the sciences.

In our efforts to address student retention, UROP also became one of the first programs nationally to engage first and second year students in research believing that early engagement has many benefits including retaining students in STEM fields; encouraging more students to pursue graduate education; and improving student's academic performance overall. The program and the results of our longitudinal assessment and evaluation have also served and continue to serve as models for several campuses around the country interested in both the early engagement of students in research and the role of undergraduate research in the retention of diverse students and the pursuit of graduate education.

Why Research?

UROP began in 1988 specifically as a program to improve the retention and academic success of historically, underrepresented students on our campus by engaging first and second year students in all fields and disciplines in the research activities of faculty. Like most campuses across the country, we had been aware of and concerned about the differential retention rates between historically underrepresented students and white students. Several initiatives already existed on our campus to address the retention gap including supplementary instruction, remedial courses, and mentorship programs, but the gap still existed. Our decision to use undergraduate research as a mechanism to improve retention was based on findings from several important studies which have identified key factors critical to the success of diverse students especially on predominantly white campuses. These factors include: (1) the nature of a student's peer group; (2) the quality and quantity of student interaction with faculty outside the classroom; (3) the integration of a student's academic and social lives; (4) experiences that make coursework more relevant and develop skills and knowledge that can be transferred to the classroom setting; and (5) integration into the campus culture and academic mission of the institution. (Astin 1993, Kuh 2005, Pascarella and Terenzini 2005). Our decision to focus on first and second year students was also strategic as we knew that diverse students are most likely to leave our institutions and/or leave the STEM disciplines they originally intended to pursue during these critical first two years. Undergraduate research by its very nature addresses many of these key factors that have been identified as critical to the academic success of diverse students. Through our research seminars, peer advising program, and peer interaction in the research setting the program provides opportunities for students to develop social networks that are different from those they might typically create; the research laboratory provides significant interaction between students, faculty, graduate students and postdoctoral fellows in a non-classroom setting and develops and affirms students' critical thinking and other skills in ways that gateway courses do not; research provides clear applications of basic scientific principles students often struggle with in the classroom; and reinforces knowledge presented in the

classroom; and students become integrated into one of the most important activities at a research university.

These factors include: (1) the program's initial very specific goal to increase the retention of historically underrepresented students through to graduation; (2) the alignment of the program with one of the key missions of our institution-research; (3) the ability to draw upon numerous campus partners including postdoctoral fellows, graduate students and research scientists and to articulate the mutual benefits of participation for both our partners and our students; (4) the development of a set of carefully designed program components that reinforce each other and contribute to the success of the research partnerships for both students and faculty participants including peer advising, research peer groups, and research skill building workshops ; (5) the use of work-study funding to enable the participation of diverse students and expand the program; (6) the careful adaptation of the program to serve not only historically underrepresented students but majority students well and (7) the implementation of a rigorous and carefully designed longitudinal assessment of the impact of the program on historically underrepresented students as well as an ongoing formative evaluation to address faculty and student concerns and needs and continually develop and improve the program.

UROP Program Components

One of the things we believe that has contributed to our program's success is a set of integrated program components that support and enhance the student/faculty research partnerships. These components include the following:

Research Activities: Students spend anywhere from 6-15 hours per week engaged in ongoing or new faculty research projects. Projects are solicited from faculty through targeted mailings, departmental presentations, colleague referrals and student referrals.

Peer Advisors: All UROP students are assigned to a peer advisor who is a junior or senior alumnus of the program. The peer advisors provide students with guidance regarding the research culture and faculty expectations, meet monthly with the students to monitor the research partnerships, work with the students on

time management and other transition issues faced by first and second year students, and facilitate bimonthly research seminars. Students are assigned peer advisors based upon common disciplinary interests: Biomedical, Engineering, Physical Science, Natural Science, Women in Science and Engineering and Social Science and Humanities.

Research Seminars: UROP students are required to attend bimonthly research seminars to create a community of young researchers, to teach research concepts, skills and research related issues, and help students develop relationships and friendships in their field. In many cases the seminars provide students with an academic and social support network. The seminars cover a wide range of research related topics including: research integrity and responsibility, cutting edge research in the discipline, research methodologies, multicultural issues in research, and research fieldtrips.

Skill Building Workshops: UROP offers students a series of research skill building workshops created at the request of research sponsors and offered in collaboration with several key campus partners including the libraries and other research centers, archives, computing and technology services. These workshops include library and web research workshops, Mat Lab, IDL, GIS, SPSS and STATA, EXCEL, scientific writing, and poster production.

Research Projects: UROP students conduct research in all fields and disciplines with the majority in STEM fields. Student research tasks and responsibilities include development of research protocols, survey development, conducting experiments, data collection and analysis, simulations, and field observations.

Research Symposia: In the spring, UROP holds an annual spring research symposium for students to share what they have learned during the course of the year and to hone their presentation skills.

Compensation: UROP students can participate in the program for either academic credit or work study funding if the students have work-study as part of their financial aid package. The latter has been critically important in enabling students from diverse socio-economic backgrounds to engage in research.

What we learned about the impact of undergraduate research on students.

Early on, the Associate Dean for Research who first started the UROP, realized that it was critically important to be able to measure the impact of the program on participants for several reasons from obtaining internal and external funding to determining if we were meeting our initial goals of improving student retention and academic success for our targeted student population. It was particularly important to test our hypothesis that early engagement in research would improve the retention and academic success of historically underrepresented students on our

campus and lead to the pursuit of graduate and professional education. Our evaluation was funded by three key grants from the U.S. Department of Education's Fund for the Improvement of Postsecondary Education, the State of Michigan's Office of Equity, and a National Science Foundation Recognition Award for the Integration of Research and Education. These grants enabled us to conduct two major studies using a carefully matched experimental group of UROP students and a control group of UROP applicants but non-participants. Our quasi-experimental design has been cited in numerous articles on undergraduate research and student engagement and was acknowledged in a recent report issued by the President's Academic Competitiveness Council. Our assessment was guided by a set of questions we sought to answer: To what degree does UROP enhance the retention of underrepresented students and graduation rates? To what extent does undergraduate research facilitate student adjustment to college and socialization into academic life and fields of study? What role does undergraduate research play in students' decisions to pursue graduate education? How do the answers to these questions differ by race, ethnicity, or gender?

The entire UROP assessment and evaluation program utilized a mixed methods approach to assessment and evaluation. Quantitative methods were initially used and pre and post surveys were administered to both UROP participants and the carefully matched control group of UROP applicants but non-participants. These quantitative studies were followed by focus groups and experiential sampling of student academic behaviors. Full results of these studies and explanation of the results outlined below can be found in several published studies (Nagda, B.A., Gregerman, S.R., Jonides, J. von Hippel, William, Lerner, J.S., 1998 and Hathaway, R.S., Nagda, B.A., Gregerman, S.R. 2002) and (Taraban, et.al, 2008). However, the following provides a snapshot of some of our key findings from both our published and unpublished studies:

- UROP participation increases the retention rates for African American students and sophomore participants across the board. (81% vs. 65%)

- UROP participation increases degree completion for African-American males (75.3% vs. 56.2% for non-UROP students).
- UROP participation increases engineering degree completion rates for African American and Latina women in Engineering (80.9% vs. 59.8%)
- UROP participants are more likely to see faculty and graduate student instructors as positive influences and interested in their academic success vs. non-UROP participants. (68% vs. 32%)
- Students who participated in undergraduate research were significantly more likely to go on to graduate and professional school (82% vs. 56%) across all racial and gender groups.
- UROP participants were more likely to pursue medical, law, or Ph.D. programs than students in our control group. (81.5% vs. 65.4% overall and 78.5% vs. 56.6% for underrepresented students)
- UROP participants spend significantly more time talking with professors, participating in academic discussions, working, and studying. (65% vs. 35%)

Next Steps

We are particularly interested in developing integrated opportunities for alumni of our first year program to continue in research and explore not only on campus research opportunities but REU type experiences around the country and learn more about academic and professional pathways that are available to them. As part of this interest, our goals are to work with targeted alumni to design pathways to graduate school, conduct workshops on graduate vs. professional education, assist students with conducting research on graduate school selection and financing, personal statement writing, etc. In terms of assessment and evaluation, because our original activities did not focus on learning outcomes as much as on retention and pursuit of graduate education, we are very interested in conducting additional studies to better understand the

differences between in classroom learning and out of classroom learning in the context of research. We have significant anecdotal information that when students have a research experience concurrent with gateway courses two things happen: (1) students see the relevance of concepts they are struggling with in these courses and (2) while students may receive negative feedback in terms of grades in chemistry and calculus for example, success in the research setting and the attendant validation of their intellectual and problem-solving skills in this context helps them persevere in STEM. Another area of research of great interest is the role of undergraduate research in helping socialize a student into the discipline and envision themselves in a particular field. Conducting both academic year and summer research provides unique opportunities for students to learn the culture, language, expectations of a specific field and to envision themselves in this field or discipline in ways that cannot happen in a classroom context. This socialization process is critically important for students who understand what doctors and lawyers and engineers might do but not what scientists may do professionally.

One of our initial attempts to provide this continued pipeline to our students is our Research Scholars Program which is described below. This program is open to students who participated in UROP during their first year on campus.

Research Scholars

Approximately 100 UROP students continue in the program under our auspices for a second year through the Research Scholars Program. About half of the students join new research projects and the remainder continues on their original project. We established the Research Scholars Program six years ago in order to provide continuing UROP students with programming and support as they become more seasoned young researchers. We also wanted to provide continued support to diverse UROP alumni. Prior to the establishment of the research scholars program these students were placed in research seminars with first year students and found the content redundant. In designing the Research Scholars Program we identified, with the assistance of program alumni and faculty, program content designed for students' in their

sophomore year and doing research for a second year. On our campus and others much attention is paid to the first year experience but the sophomore year is often neglected even though it is the time when students must make key decisions regarding choice of major, academic pathways, career focus, etc. Our specific goals for the Research Scholars program are to: (1) help students develop stronger faculty-student research partnerships; (2) provide opportunities for students to develop independent projects; (3) provide students with advanced research skills including writing for publication, advanced data analysis skills, and public speaking; (4) develop coherent academic plans that link their research interests with their course of study; (5) assist students in seeking and obtaining further research opportunities on and off campus; and (6) provide information for students about preparation for Graduate School.

Research Scholars are assigned to interdisciplinary research groups and attend bimonthly research seminars, are assigned peer advisors, do journal and reading assignments, and participate in their own end of year Research Symposium. The Research Scholars, with a year of research behind them are encouraged to consider writing an Honors Thesis, publishing and presenting their research findings at a national professional meeting and/or the National Conference on Undergraduate Research.

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