Five and Ten-Year Strategies for the Future of Penn State:

Increasing Undergraduate Research Engagement

Presidential Leadership Academy

HONOR 301H

Friday, May 3, 2013

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Introduction

"*There is a world of difference between getting a degree and getting an education. Undergraduate research promotes meaningful learning"*- Vice Provost for Academic Affairs, Dr. Blannie Bowen

"Research could be a signature for what Penn State has to offer as part of undergraduate education. It could be how we brand ourselves as an educational institution"- Chair Elect of the Faculty Senate, Dr. Brent Yarnal

"We are a research school and we should encourage our students to do the same" - Penn State President, Dr. Rodney Erickson

As college students, we sometimes feel as if we have no control over our own education. Between prescribed course-loads, inflexible grading rubrics, and multiple-choice exams, it becomes easy to view earning a degree as a passive process. This is why undergraduate research is so important. By designing and conducting research projects, students take responsibility for their own learning and engage in a dynamic, active experience.

Penn State's leaders identify undergraduate research as a priority in both our mission statement and strategic plan. Across the university, there are already several programs that promote undergraduate research: the Schreyer Honors College requires all of its students to

submit a research-thesis, as do honors programs within several academic colleges. Undergraduates can serve as research assistants to Penn State faculty members who are among the top scholars in their fields, often turning this experience into their own independent research project or paper. Unfortunately, these programs only engage a small part of the student population. There is a huge, unrecognized potential for undergraduate engagement in research at Penn State.

Penn State's existing structure to promote student research, though strong in some areas, could be reformed to become more effective. Simply improving current practices, however, is not enough. In order to change the way learning is viewed, Penn State's leaders must take ambitious steps to greatly increase the number of undergraduates who engage in research. Some of our peer institutions have commenced this process already; universities with centralized, mission-driven campaigns to increase student research have achieved the best results. Making undergraduate research a priority will not only help Penn State stay competitive, but allow us to develop our own identity as a top research institution.

Student research and independent projects can take a variety of forms. For the purpose of this proposal, undergraduate research is defined as a project that builds upon the work of others to contribute original analysis and thought in a certain field, completed under the mentorship of a Penn State faculty member. Though a project may be comprised of a variety of components, including a scientific inquiry, a portfolio, or a performance, each must produce an analytic written document. Traditionally, academic disciplines have different relationships with undergraduate research, and with research in general. However, this type of project would be applicable to each of the disciplines taught at Penn State. Though the university should strive to engage as many students as possible in undergraduate research, this paper focuses specifically on

initiatives for University Park; the commonwealth campus face unique challenges in promoting student research and must be considered separately.

In this report, we consider several potential initiatives to increase the number of Penn State undergraduates who engage in research. Ultimately, we recommend instituting a certificate program that recognizes students who complete a three-part research experience: 1.) a three-credit research methods course, 2.) a research project completed during a three-credit research topics or independent study course (294, 296, 494, 496) 3.) a public presentation of the research project and evaluation by project advisor. To implement this plan effectively, Penn State's leaders must encourage student participation by raising awareness about research opportunities and increasing fiscal means to fund projects. Also, because each student will work with a mentor, incentivizing faculty participation is an important part of implementation. By effecting this initiative, our goal is to increase the proportion of students engaged in undergraduate at Penn State to 30 percent in 5 years.

This is an exciting time for Penn State. As a top-tier university, we always challenge ourselves to improve. However, we are currently in the process of an assertive "rebranding" effort to develop our identity as a university. Making undergraduate research a defining characteristic of Penn State could become an essential part of shaping our university's future.

Background Information

The Benefits of Undergraduate Research.

Undergraduate research offers many tangible and intangible benefits for students, faculty and administrators. Scholarship about student research offers both quantitative and qualitative data that suggest the importance of this type of engagement. Across the literature, several key benefits emerge:

1. Improved Critical Thinking Skills: According to the American Physical Society (2013), students who complete a guided research project develop superior skills in "problem definition, project design, open-ended problem solving... and communication of complex evidence-based technical arguments." Participants in a study of four different universities by Seymour et al. (2004) reported that their research experience "improved their ability to present, discuss, or defend their work in the academic realm" (511).

2. Increased Retention Rates: Studies show that schools with a high-level of undergraduate research engagement also tend to have relatively high retention rates (Lopatto, 2004). For example, Rutgers, where 60% of students engage in research, has an retention rate of over 90% (Merkel, 2001). Research experience is especially important for at-risk or minority students. A study conducted by Nagda (1998) at the University of Michigan showed an attrition rate of 11.4% for minority students in a research program compared to 23.5% for nonparticipants.

3. More Effective Student-Faculty Relationships: Lopatto (2004) found that students who do research tend to have a high regard for their supervisors, professors and peers. In addition to helping undergraduates learn, these opportunities benefit faculty members. Students assist faculty researchers by completing manual tasks. Professors also have the opportunity to receive special grants from organizations that promote student research, like the National Science Foundation (Regeth, 2001). In addition to manpower and financial support, faculty have cited other advantages of working with undergraduate researchers, including the enthusiasm, energy, and additional insight that new minds can offer (Merkel, 2001).

4. Graduation School Admissions Rates: According to Regeth (2001), research is the top-rated activity for graduate school admission. Graduate schools prefer applicants who have published or presented research, even over those who have completed field experiences and other various non-area-of-study activities (Regeth, 2001). Engaging in research can also help students decide to attend graduate school. In a study conducted by Seymour et al. (2004), 21% of students indicated that performing research as an undergraduate helped them clarify their higher education plans following degree completion.

In addition to these significant benefits, testimonial evidence suggests research experience helps students feel more integrated into their home university. Students affirm that completing a research project built self-confidence in their academic ability, increased their interest in education, and helped them develop useful technical skills. (Penn State University Faculty Senate, 2013)

Undergraduate Research Nationwide.

In 1969, MIT created the first campus-wide program for undergraduate research. California Institute of Technology followed suit by starting their own undergraduate research fellowship program ten years later. Today, many universities have a centralized Office of Undergraduate Research and are implementing initiatives to increase student engagement (Merkel, 2001). A task-force report compiled by Penn State's Faculty Senate (2013) identifies University of Texas, UNC-Chapel Hill, University of Kansas, and University of South Florida as schools who exhibit best practices in encouraging undergraduates to get involved in research. These schools promote research in a number of ways, including: explicitly mentioning

undergraduate research in their mission statements, posting research opportunities online, offering significant funding for research initiatives, hosting informational workshops, offering summer programs, and linking research websites to their university's homepage. Other schools such as MIT, CIT, Stanford and Cornell have successfully increased participation by making engagement with undergraduate researchers a significant part of the tenure evaluation process (Grassmuck, 1990). Overall, initiatives seem to be most effective when they are implemented by central administration and clearly linked to the university's stated mission (Faculty Senate, 2013).

Funding for Undergraduate Research.

There are many different external funding opportunities for students who are interested in completing their own research project. The National Council on Undergraduate Research, which claims 900 members universities and colleges, and the National Science Foundation (NSF) have steadily increased the support they offer to undergraduate researchers. When the NSF began offering grants to undergraduates, roughly 2,000 students participated. Today, that number has exploded to more than 10,000 (National Science Foundation, 2013). The National Science Foundation funds Research Experiences for Undergraduates (REU), offering grants that encourage professors to incorporate undergraduates into their research projects. The REU Site Project offers grants of $500,000 to professors who want to establish programs for extensive undergraduate research. Dr. Brent Yarnal, Chair Elect of the Faculty Senate and Professor of Geography at Penn State, received a REU site grant that allowed him to mentor 53 undergraduate researchers (personal communication, April 15, 2013). There are currently five different REU sites at Penn State (National Science Foundation, 2013).

Undergraduate Research at Penn State.

According to our mission statement (2013), Penn State University seeks to educate students through "integrated programs of teaching, research, and service" ("Mission and Character," 2013). Increasing undergraduate participation in research has been one of Penn State's strategic objectives since the 2003-2004 academic year. In the current strategic plan (2012-2013), the university pledges to "expand efforts to disseminate information about research opportunities for students and provide additional incentives for faculty to participate with undergraduate students, as well as foster more capstone experiences" (1.2). Many administrators see the opportunity for undergraduates to participate in research as one of the defining characteristics of Penn State. "The faculty are doing research that students would never be exposed to if they weren't here," explains Dr. Blannie Bowen, Vice-Provost for Academic Affairs, " that's a big distinction between other universities and Penn State" (personal communication, April 5, 2013). Though leaders of Penn State have repeatedly identified undergraduate research as a priority, there have been few empirical evaluations of how well the university responds to this goal.

Unlike many of our Big Ten and CIC peers, Penn State does not have a central office for undergraduate research. Three Penn State offices--the Office of Student Affairs, The Office of Outreach, and the Office of Undergraduate Education--are responsible for promoting engaged scholarship and thus undergraduate research (B. Yarnal, personal communication). Penn State's website also includes an undergraduate research section, offering information about opportunities for students.

University-wide, there are several initiatives to support students who are interested in completing research projects. The university showcases undergraduate research achievement at an annual exhibition, which began with a performing arts showcase this year. The Office of

Undergraduate Education funds student participation in national conferences and offers 40 Summer Discovery Grants (up to $3000) to support student research projects. Organizations like WISER (Women in Science and Engineering Research) and MURE (Minority Undergraduate Research Experience) offer research funding for specific demographics (*Undergraduate Research*, 2013). Penn State students also receive funding from organizations outside the university, like the National Science Foundation.

The strongest support for student research at Penn State, however, comes from academic colleges and programs. All honors students are required to work with a faculty advisor to complete an independent research thesis in the field of their choice. Honors programs within several academic college have a similar requirement. These include the Liberal Arts' Paterno Fellows Program, The Earth and Mineral Sciences Academy of Global Experience Laureate Program, and the engineering science major. Eberly College of Science houses a Research Office to support graduate and faculty research that creates many opportunities for undergraduates to work with mentors. Eberly reports that 40% of its undergraduates engage in research (*Eberly College of Science,* 2013). Other academic colleges, such as the College of Agricultural Sciences, Smeal School of Business, and the College of Communication, provide opportunities for undergraduate research and funding for student projects, although they do not offer specific programs with research requirements. On the other hand, the College of Arts and Architecture and the School of Nursing place very little emphasis on student research. Overall, there are many distinct structures already in-place to help students engage in research as undergraduates. However, most of these programs cater to certain groups of students. Specifically, they engage high-achieving, self-motivated students in specific fields of study.

When undergraduate participation in research is evaluated university-wide, it becomes clear that this specialization is limiting. Penn State does not keep comprehensive records of undergraduate engagement in research, so it is difficult to determine the exact number of students who author their own projects. In August of 2012, Faculty Senate Chair Larry Backer commissioned a task force to compile more information about current engagement. Most students who conduct independent research with a faculty mentor earn credit by enrolling in either a research topics course (course number 294 or 494) or an independent study course (296 or 496). The report concluded that "when research courses and independent studies are combined, they embody less than 10 percent of the undergraduate students" (2013, p. 11). Because most students are involved in a research project for several consecutive semesters, some students are undoubtedly counted twice in this estimation. On the other hand, students who completed independent projects without enrolling in one of these courses are not included. Though the estimation is not comprehensive, it is reasonable to conclude based on this data that undergraduate engagement in research at Penn State is relatively low.

The task force report also evaluates Penn State's current practices for promoting undergraduate research. Although some individual programs at Penn State are strong, the committee concluded that the university as a whole does not exhibit best practices. " In common with other research universities possessing weaker promotion and support of undergraduate research," the report explains, "Penn State efforts are decentralized and uncoordinated… Unit efforts vary widely, with some units actively engaging in undergraduate research and others having little activity" (p. 12). The task force offered several specific suggestions to ameliorate these problems. First, they recommend fortifying the existing administrative structure by redesigning the undergraduate research website and increasing funding for student projects. A

more aggressive option proposes incentivizing faculty mentorship by creating a fixed-term Professorship of Undergraduate Research, a strategy that has been extremely successful at the University of North Carolina (B. Yarnal, personal communication). These preliminary solutions are promising, but they are not enough to transform the way that undergraduate research operates at Penn State.

Many administrators cite undergraduate research as a potential part of Penn State's future development: "As we look to the future of Penn State, Old Main is promoting engaged scholarship. That includes internships, study abroad and especially undergraduate research. Changes in this are going to be an important part of the university moving forward" says Dr. Yarnal (personal communication). President Rodney Erickson suggests that undergraduate research engagement could become an essential element of Penn State's national reputation (personal communication, March 26, 2013), an ideal that is echoed by Vice President of Student Affairs Damon Sims (personal communication, April 3, 2013). The current "rebranding" effort and administrative enthusiasm for engaged scholarship make this the ideal time for assertive initiatives to increase the number of undergraduate researchers.

Proposal

Possible Courses of Action.

Several Penn State offices, the members of the faculty senate, and the deans of many academic colleges are currently discussing actions that Penn State could take to increase the number of students who engage in undergraduate research. Based on insight offered from these groups, we have identified three potentially feasible and effective courses of action:

1. General Education Substitution: Students could be given the option to substitute

research credits for general education requirements. Research courses (294, 296, 494, and 496) are already in place at Penn State, and students would be incentivized to take these classes if they could replace some current degree requirements. Limits would need to be placed on the substitution so students could not completely eliminate the requirement for any one discipline (GH, GA, etc). Consequently, we would recommend that the research credits be distributed between two branches of general education. Though this proposal would likely increase the number of student researchers and incentivize undergraduates who would like to focus more on their respective fields, it does little to promote undergraduate research as a central part of Penn State's educational mission.

2. Mandatory Research Requirement: A more aggressive approach would be to make undergraduate research a mandatory requirement for all students. With the upcoming review of General Education, a research requirement could be added to the core curriculum at Penn State. This is an exciting possibility, but implementation may prove difficult. The requirement would place a heavy burden on departments in disciplines where there is not a tradition of undergraduate participation in research. Even if implemented gradually, a mandatory research requirement would require extensive consideration and administrative support because only a fraction of students currently participate in research. More importantly, making research mandatory takes the choice out of an experience that is supposed to empower students to take control of their own learning. It is likely that the administrative burden and attitudes of some students would lead to a decrease in the overall quality of the undergraduate research projects.

3. Certificate Program: Instead of mandating undergraduate research, Penn State could incentivize students by instituting a certificate program. This program would reward students who complete a research project, providing participation incentives such as funding and recognition events. By promoting this program, Penn State would convey support for undergraduate research to students and to the academic community, reinforcing our reputation as a research-oriented institution.

Implementation.

We believe that option three is the most feasible and beneficial course of action. The proposed certificate program would include three parts: 1.) a course that offers instruction in research methods, 2.) a research project completed with a faculty mentor during a 294, 296, 494, or 496 course, 3.) a public presentation of research results and formal evaluation by the project advisor. The certificate would work synergically with existing research programs; honors students would still be eligible to receive this recognition. Because the certificate program would include instruction in research methods and a formal presentation of research results, it would enhance the experience for students who are already completing a research requirement.

Some research methods courses already exist at Penn State, but they are sparingly distributed between the colleges. The current structure could not support a significant increase in enrollment. Therefore, Penn State would introduce a few new research methods courses in each academic college. During these classes, undergraduates would gain an appreciation for and understanding of the research process, and learn technical skills that would aid them in lab, field, or scholarly work. The courses would be catered to underclassmen to promote meaningful interest in research over the course of their Penn State careers.

As upperclassmen, certificate-seeking students would enroll in a research topics/ independent studies course and work with an instructor or other faculty member to complete an original research project. This project could incorporate a variety of components depending on the student's area of interest; however, each must produce a written document that presents and analyzes the results of the endeavour. The current offerings of research topics and independent study classes are under-utilized (Penn State Faculty Senate). Nevertheless, to match increasing enrollment, Penn State may also need to offer more sections of these courses.

The culmination of this project would be a presentation that shares the results of the students' research with the Penn State community. The Undergraduate Research Exhibition is an excellent venue for presentation, and it could be expanded to accommodate more students. Students could also choose to host their own showcase or presentation, selecting the venue most suitable for their project. To recognize and disseminate student's work, Penn State could establish an undergraduate research journal that would be published by the Penn State University Press and made available nationally. Another aspect of presenting the project would be a formal faculty review. The student would present their work to their project advisor for approval in order to earn the certificate. The deans of the academic colleges would establish the standards for this review within their department, and could consider including other reviewers or asking students to defend their work.

The certificate program would be managed by the Office of Undergraduate Education, which is already committed to supporting engaged scholarship. More specifically, the deans of each academic colleges could assume responsibility for promoting and implementing the program within their own college. We aim to increase the number of students who engage in

research from under ten percent to thirty percent in five years. The implementation of this program would involve three distinct steps:

1. Improve Student Awareness about Research:

    - Redesign the Undergraduate Research Website: The Faculty Senate Task Force Report identifies a flawed website as one factor that detracts from Penn State's undergraduate research effectiveness (2013). The current site does not seem to be updated on a regular basis; many of the pages provide limited information and some hyperlinks do not work. Additionally, the site offers only two avenues for undergraduate funding: the Discovery Grant, and funding for participation in international research symposiums. Simply improving and expanding this site would encourage students to pursue research opportunities and show that undergraduate engagement is a priority at Penn State. Dr. Hank Foley, Vice President for Research at Penn State, also suggests that the link to the site should be moved to a prominent position on the top slider of Penn State's homepage to clearly express our dedication to research initiatives (personal communication, April 19, 2013).
    - Engage Current Students: The university could institute an undergraduate research fair, similar to or even in tandem with the involvement fair, to inform students about potential research opportunities. Penn State would also sponsor town-hall-style meetings for students to discuss the role of undergraduate research at Penn State and learn about further opportunities to engage.

- Inform New Students about Research Opportunities : Emphasizing undergraduate research could be a significant part of promoting Penn State to prospective students. Student engagement should be highlighted during orientation, visitation days, college fairs, and other events for students. In addition to providing students with written information about research opportunities and directing them to the newly-designed undergraduate research website, administrators could invite to these events upperclassmen to talk to new students about their research experiences.

2. Increase Fiscal Means for Student Research Projects:

- Increase Expenditure in Under-Funded Areas: For both undergraduate and graduate research at Penn State, funds are disproportionately allocated to defense-related research units. On the other hand, only 4% of funds go to arts and architecture, law, IST, education, business, and communications research combined. To promote research for students across disciplines at Penn State, the university must invest more in these fields (Strategic Plan, 2008, p. 12).
- Employ Micro-Financing: Dr. Foley has already secured $100,000 for grants to fund undergraduate research projects. This resource will fund student projects that expand undergraduate research to entrepreneurship in the local community (personal communication). Penn State could continue to employ this model in the future through a wide variety of avenues.

- Secure an Endowment: An endowment of one million dollars would fund enough new undergraduate projects to reach our target goal of thirty percent of all students engaged research in five years (H. Foley, personal communication).

3. Incentivizing Faculty to Promote Undergraduate Research Projects:

- Train Faculty Mentors: Certain disciplines have a stronger tradition of undergraduate research than others. Some faculty members in the liberal arts and humanities may find it difficult to engage even graduate researchers, so adding undergraduates to the equation would complicate the situation even more. All faculty members will need to be informed about the benefits of mentoring students and the best ways to include undergraduates in their own research. The Office of Undergraduate Education could offer short, optional training sessions for faculty members who are interested in becoming a part of the certificate program, either as instructors of research methods or as faculty mentors. These sessions should be specialized by department, with special emphasis on engaging faculty in disciplines with a weaker background in undergraduate research. Once professors are equipped to engage undergraduates, they can teach their graduate assistants to become mentors as well. In larger labs, graduate students could serve as resources and even advisers for student research projects.

- Make Undergraduate Engagement a Significant Part of Faculty Evaluation: Involvement with undergraduate research is already a part of

tenure consideration, and is noted in annual review of Penn State faculty (B. Bowen, personal communication). However, upper administrators should issue a statement explaining that undergraduate research is a top institutional priority. Deans and other leaders should be encouraged to emphasize the importance of undergraduate research during the evaluation process.

- Promote a Culture that Praises Faculty Mentorship: Penn State should take steps to reward faculty members who choose to advise students on research projects. One possibility, already implemented at the University of North Carolina with success, is to establish a 3-year professorship of research. The faculty member who assumes the prestigious, paid position would make a commitment to mentor students and lead ambitious projects that incorporate many undergraduates (B. Yarnal, personal communication).
- Increase Fiscal Means: National organizations like NSF-REU already offer grants that reward faculty for working with undergraduates. Penn State could use some funds from the undergraduate research endowment in a similar manner, offering incentives to faculty members who incorporate undergraduates into their research and help them complete related projects independently.

Potential Benefits.

Many of the outcomes of undergraduate research align closely with Penn State's mission as a public research university. Increasing student engagement in research would benefit several different groups associated with the university.

1. Benefits for Students:

- Authoring a research project allows undergraduates to engage in their own learning. David Wormley, Dean of Penn State's College of Engineering, explains that "research is very important for an engineer, but its also important for all undergraduates because it has them apply what they learn in the classroom." He also points out that the uncertain nature of research helps students develop critical thinking and problem solving skills (D. Wormley, personal communication, April 1, 2013). Students create their own project and draw their own conclusions, giving them a sense of control over their own learning that is lacking in other parts of the curriculum.
- Mentorship creates stronger relationships between students and faculty. Faculty mentors offer their undergraduate assistants guidance for their futures, both professional and personal, and are a great resource for letters of recommendation. More generally, connecting with faculty gives undergraduates the sense that they are a part of Penn State's institutional mission as a research university (B. Bowen, personal communication).
- Research projects prepare students for the type of work that is expected in graduate and professional schools. Research experience is often an important factor in admissions decisions (Regeth, 2001).

2. Benefits for Faculty:

- Part of a faculty member's role as a teacher at a research university is to engage undergraduates in his or her scholarly work. Mentoring undergraduates researchers helps faculty connect with their students, and merge their role as a teacher with their role as a researcher (C. Long, personal communication, April 19, 2013). Furthermore, the mentoring process allows professors to contribute to the expansion and development of their respective fields by training future scholars and researchers.
- Faculty members can benefit from various funding opportunities available to those who mentor student researchers, as well as undergraduate manpower to aid them in their own research projects (B. Yarnal, personal communication).

3. Benefits for Community:

- Research responds to Penn State's role as a land grant university. "As a public research university, we have a public purpose. There are many outcomes we can produce for the community using research. For undergraduates working on these projects, this would produce a sense of public purpose," says Dr. Damon Sims (personal communication, A). At the same time, many student research projects have an international focus, contributing to Penn State's identity as a global university (B. Bowen, personal communication).

4. Benefits for University:

- "We think that [research] could be a signature benefit Penn State has to offer as part of undergraduate education," explains Dr. Yarnal. Numerous administrators and faculty members suggested that undergraduate research should be an integral part of Penn State's "rebranding" effort, setting this university apart from its peers in terms of student's educational experience.
- Promoting undergraduate research creates an environment where student creativity and academic engagement is clearly favored. This is the type of atmosphere that aligns with Penn State's reputation as an outstanding academic institution.

The Role of Undergraduate Research in the Future of Penn State.

Promoting undergraduate research is an integral part of Penn State's mission and strategic plan for the future. This goal is closely related to other aspects of the strategic plan. For example, as Penn State works to improve and develop the way that it is perceived nationally, undergraduate research can become one of the defining aspects of our reputation.

Enhancing students' understanding of diversity is another important aspiration for Penn State in the next five to ten years. By definition, research projects help students understanding of new topics. Many student research projects focus on local, regional or international concerns. Students travel to complete research, interacting with people from cultures that are new to them. Certificate-seeking students will then share their research with other people as part of the presentation phase of the program, giving other students the opportunity to benefit from their diverse experiences. Thus, increasing engagement in undergraduate research will also diversify the perspectives of Penn State students.

Overall, there is a huge potential for undergraduate research at Penn State. The benefits for students, faculty, the community and the university are numerous. In fact, assertive but achievable initiatives, like the certificate program, could effectively increase the number of students engaged in research. Taking formal steps to show that undergraduate research is a priority at Penn State would positively influence both the environment within the university, and the way that we are perceived across the nation.

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