

# **Undergraduate Research Collaboration Between Penn State Main Campus and One of Its Remote Campuses**

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## **Abstract**

Undergraduate research has been heavily promoted recently by universities and through local, state and federal agencies. The importance and benefits of this type of research have been well documented in the literature. The general focus of universities without graduate programs is on teaching, and less emphasis is given to research. Consequently, such universities face various challenges to carry out undergraduate research. Some institutes, like Penn State Fayette, The Eberly Campus have only transfer programs for their engineering students. Carrying out undergraduate research in such institutes is very challenging. Creative approaches are needed to undertake such research.

A new collaborative engineering research effort was started between the remote Penn State Fayette, The Eberly Campus and the main University Park Campus of the Pennsylvania State University. In this program, an undergraduate student starts to formulate his or her undergraduate research study at Penn State Fayette during his or her first and second years. The student carries out the research in his or her third and fourth years at Penn State Fayette while he or she studies at the University Park campus. This can be done during school breaks and summer time. This paper outlines the background behind this new collaborative undergraduate research program. It gives details on the pilot project, which started this program.

## **Introduction**

Until recently, undergraduate students were excluded from the business of research. Only faculty and graduate students in the academic circle and research organizations outside academia used to conduct and benefit from research. The Massachusetts Institute of Technology (MIT), a leading research institute ended this practice by establishing the Undergraduate Research Opportunities Program in 1969.<sup>1</sup> The academic community recognized the importance of undergraduate research to the students themselves in particular, and to the society in general.<sup>2</sup> This resulted in an exponential growth in this type of research.

Many universities nowadays promote undergraduate research in one form or another. Several universities like the University of Miami, Duke University, Stanford University, and the University of Central Florida have special programs to support undergraduate research. These programs provide needed funds to carry out such research projects ranging from a few hundred

to several thousand dollars in addition to other necessary administrative support. Several universities offer summer undergraduate research fellowships. This is the case with Ohio University. Other universities hold annual events to promote undergraduate research. For instance, Samford University achieves this by its annual Student Showcase, while Penn State University accomplishes that through its annual Undergraduate Research Exhibition.

The Federal government has created new programs to advance undergraduate research. For example, the National Science Foundation (NSF) is credited for the outstanding Research Experience for Undergraduate (REU) program. Many state governments have established similar programs to promote undergraduate research at their state universities. An example for such programs is the Undergraduate Research Day at the Capitol, which is sponsored by the State of West Virginia.

Annual conferences, workshops, and showcases are held nowadays at the local and national level to support undergraduate research. The National Conference on Undergraduate Research (NCUR) is the best example for the national level, while the Butler University Undergraduate Research Conference is a good example at the local level.

Journals dedicated to undergraduate research are also contributing to the promotion of undergraduate research.<sup>3</sup> Examples of such journals include the Canadian Undergraduate Journal of Cognitive Science.

All of the above illustrates the importance of undergraduate research. This importance pertains to the undergraduate students themselves, to the supervising faculty members, to the institutions at which the research is conducted, and to the private and public sectors. Specific details on this importance are well documented elsewhere in the literature.<sup>4-7</sup>

### **The two ingredients of undergraduate research: students and resources**

Undergraduate students opt to conduct undergraduate research for academic and non-academic reasons. The academic reasons are numerous, but can be classified into two groups. The first group is made of undergraduate students who are mainly interested in getting good grades.<sup>8</sup> The second group contains undergraduate students who are truly interested in conducting research. For instance, some undergraduate students like to do research. Some undergraduate students like to see what research is, and that can help them decide whether to proceed with a graduate degree or not. Some of them know already that they are going to pursue a graduate degree, and they want to start the research process as early as possible. Further, some universities have optional undergraduate programs which require independent research for graduation. The non-academic reasons to conduct undergraduate research are very few. They are mainly financial reasons. Undergraduate students depend on others and on themselves to support their education in most of the cases. Working on a research project in their fields is much better than working in a job outside their intended careers.

Undergraduate research like other types of research requires a suitable environment and resources. The nature and size of these requirements depend on the scope of the undergraduate research itself, and vary from discipline to discipline. In general, a suitable environment consists

of offices and laboratories to carry out the research. The resources include equipment and materials. In all cases, funds are essential to carry out this research. In almost all cases, these funds come from university, local, state, and federal grants. These grants require writing official proposals which can be a long and agonizing process.

### **Undergraduate research at universities with graduate programs**

Universities with graduate programs have the highest potential to conduct undergraduate research for several reasons. These institutes are classified unofficially into two categories. Many universities are recognized as research institutes<sup>2</sup> because they promote research heavily besides teaching. Many other universities emphasize teaching while carrying the necessary research for their graduate programs. Accordingly they are known as teaching institutes. Undergraduate students in both types of universities conduct research, but the research institutes have an edge over the teaching institutes.<sup>2</sup> Universities can engage undergraduate students in existing research projects. Undergraduate students and graduate students, as well as the faculty in charge of such research projects, benefit from this process. In other cases, research is completely conducted by undergraduate students under faculty supervision without the involvement of graduate students. Universities with graduate programs have the suitable environment to initiate and sustain undergraduate research. They have the means needed to write official proposals to agencies at all levels. Typically, granting agencies give preference to these universities<sup>2</sup> because of their high potential to succeed. In summary, universities with graduate programs have the best chances to initiate and conduct undergraduate research.

### **Undergraduate research at universities and colleges without graduate programs**

The main mission of universities without graduate programs focuses on teaching. That is, research is not in their lists of priorities. At such institutes, individual faculty members do not have enough time in their busy schedules to conduct research projects<sup>9</sup>, and undergraduate students do not have high motivation to carry out undergraduate research. Further, research funds are limited in this case.<sup>2, 9</sup> Nonetheless, universities without graduate programs have a potential to carry out undergraduate research projects. Faculty members who teach in these institutes engage in research to fulfill their scholarly activity requirements, and for their own professional growth. Some undergraduate students in universities without graduate programs share the same motivation to carry out research with undergraduate students in universities with graduate programs. This was explained above. All universities and colleges in this category have one of the main ingredients to carry out undergraduate research. This main component is students. Many of these undergraduate universities and colleges have resources to carry out research. For example, the Department of Geology at Hamilton College has research funds to carry out undergraduate research. However, many others in this category lack this support. This is especially true with small universities and colleges.<sup>9</sup> In summary, universities and colleges without graduate programs have fair chances to initiate and conduct undergraduate research.

### **Undergraduate research at community colleges**

Community colleges are a major participant in the higher education system.<sup>10</sup> Further, community college instructors have a high potential for research contribution.<sup>2</sup> “Unfortunately,

opportunities for students attending community colleges to conduct scientific undergraduate research are rare.”<sup>10</sup> There are three main reasons for this disparity. First, faculty members have heavy teaching loads<sup>9</sup>, and therefore they are not expected nor required to carry out research scholarly activities. Second, students are not generally interested in research during their education at the community colleges. Third, funding is very limited in this case.<sup>2</sup> This is despite the fact that several agencies have research opportunities for community college students. For instance, the Community College Institute (CCI), which is a program at the Office of Science at the U. S. Department of Energy, offers such opportunities. Nonetheless, these opportunities are still limited and only for short periods. In summary, undergraduate research at community colleges is very difficult.

### **Undergraduate research at university campuses which offer transfer programs to a main campus**

Some universities like the Pennsylvania State University are composed of a main campus and several other campuses. These campuses are usually widely scattered over their state. These campuses have various and diverse roles. One of these roles in some of these remote campuses is to offer transfer programs. In these programs, undergraduate students spend the first two years at the remote campuses, and finish their last two years at the main campus. Most of these campuses have laboratories and other resources to carry out limited research. Faculty members are generally motivated to carry out research for their own satisfaction. Further, they are required to be engaged in research scholarly activities for promotion and tenure purposes. Nonetheless, undergraduate research is limited in such institutes for one main reason. Undergraduate students transfer out of these campuses after their first two years. Undergraduate students conduct research in their senior year in many cases. Occasionally, junior students conduct some research activities. Undergraduate research in the first and second years is not common. In other words, undergraduate students needed to carry out undergraduate research are not available to these institutes. These institutes need to and may be able to find innovative ways to go around these difficulties. In summary, undergraduate research at university campuses offering transfer programs is difficult but possible.

### **A testimony on undergraduate research**

In 1998, the Council on Undergraduate Research<sup>2</sup> has written a powerful testimony for consideration by the House Science Committee’s National Policy Study. It stated that 90% of the federal research and development funding went to only 6% of the 2200 U. S. higher education institutes in the recent years preceding the date of the testimony. It called for a stronger involvement by and support for teaching universities and community colleges. While MIT was the pioneer in undergraduate research<sup>1</sup> as stated earlier, this testimony specifically states:

“While many research universities such as MIT and CalTech pay a great deal of attention to undergraduate research, it is often the Primarily Undergraduate Institutions that are the test-bed for ideas in undergraduate research.”

## **Undergraduate research in engineering**

Engineering research is different from many other disciplines in various ways. Engineering research can generally be classified into either analytical or experimental research. Both types of engineering research require extremely elaborate equipment and expensive materials in many cases. Typically, it takes a long time to plan, initiate, and conduct research in engineering. Data analysis is also a long process. These factors tend to make undergraduate engineering research even more complex and much more difficult than undergraduate research in other disciplines.

## **The engineering transfer program at Penn State Fayette, The Eberly Campus**

The Pennsylvania State University has a complex structure. The University Park Campus is the main campus in the town of State College in the center of the Commonwealth of Pennsylvania. The University has more than twenty other campuses all over the Commonwealth of Pennsylvania. Some of these campuses deal with only one discipline like the College of Medicine at the Penn State Milton S. Hershey Medical Center in Hershey, and the Dickinson School of Law in Carlisle. Most campuses offer full undergraduate programs in many fields. Some campuses even offer some graduate programs besides undergraduate programs. Almost all of these campuses offer transfer programs.

Penn State Fayette, The Eberly Campus in Uniontown in the southwestern tip of the Commonwealth of Pennsylvania is one of the campuses of the Pennsylvania State University. It offers its students a variety of degrees in various fields, from business to nursing. It offers associate degrees in different engineering technology programs. It does not have an engineering program, but it offers a transfer program to engineering. After spending their first two years at Penn State Fayette, undergraduate students transfer to the University Park campus to complete their engineering education.

## **The Shreyer Honors College at Penn State University**

Penn State University has a special program for its best students. Undergraduate students who have high academic standing can be enrolled in the Shreyer Honors College. One of its requirements is to conduct a thesis. That is, undergraduate research is an essential requirement to graduate with this honor.

## **The undergraduate research interaction between the University Park and Fayette Campuses**

Faced with the limitations and difficulties as cited above, the engineering transfer program at Penn State Fayette put in place and started a pilot program for undergraduate research. Almost all of the engineering students at the Fayette campus are from Fayette County and a few nearby counties. This is indeed the reason for them for choosing the Penn State Fayette campus. They wish to stay as close as possible to their families in their first two years of college education. Upon transferring to the University Park campus, undergraduate students still keep their ties with their families. They visit their families in sporadic weekends and during university breaks and holidays. Most of them spend their summer time doing internships in Fayette County. Some of

them visit the campus in which they studied for two years. Some of these students have high qualifications to be accepted to the highly recognized Shreyer Honors College at Penn State University. This honorary program requires them to conduct a thesis. The faculty at the engineering transfer program at Penn State Fayette Campus saw this as a great opportunity to conduct undergraduate research. Both the engineering transfer program and the students benefit from this process. Students prefer to conduct their thesis during breaks and holidays and in the summer while enjoying visits with their families. Additionally, with the help of new diverse communication technology, parts of such research projects can be accomplished remotely between the two campuses. Further, faculty members at Penn State Fayette frequently visit the main campus for various university functions. Meetings with the undergraduate students conducting the research can be arranged to coincide with these visits.

### **The pilot undergraduate research project in the area of civil engineering materials**

The pilot undergraduate research program started with an honor undergraduate student with a project in civil engineering. The project was financially supported by an ORSAF grant which is a local funding program at Penn State Fayette. Additional funding was made available from the Office of the Dean of the Commonwealth College, which belongs to Pennsylvania State University.

Specifically, the project was in the area of materials. The main objective of this scientific research study was to establish the cracking patterns and intensities of concrete made with different proportions of silica fume with and without curing compounds. Silica fume is a fine material added to concrete to increase its durability especially its resistance to chloride permeability. Figure 1 shows various forms of this additive material. Silica fume concrete is used in various concrete applications, from bridges to dams. Figure 2 shows a multi-story parking garage made with silica fume concrete.

Due to its fine nature, silica fume makes concrete more susceptible to cracking. Investigating and documenting the cracks in several test slabs would establish a cracking pattern based on the proportions of the silica fume used in making the concrete. This study was an experimental investigation. Several large concrete slabs were constructed. Each slab had a different proportion of silica fume ranging from 3% to 12% cement replacement by weight. Figure 3 shows one of these slabs.

This paper is focusing on the educational aspects of this pilot project. The current plan is to present and publish the complete experimental details as well as test results with data analysis in one of several national conferences on concrete in the near future.

### **Educational objectives of the pilot project**

The main educational objective of this study was to influence the engineering education of the involved undergraduate student in positive ways. Most of this influence was in an agreement with Criterion 3 (Program Outcomes and Assessment) of the ABET Criteria for Accrediting Engineering Program.<sup>11</sup>



Figure 1: Various forms of silica fume  
*Photo courtesy of the Silica Fume Association*



Figure 2: A silica fume concrete structure  
*Photo courtesy of the Silica Fume Association*



Figure 3: A silica fume concrete slab used in the pilot project

This research study was a pilot experiment. No exams or other quantitative assessment measurements were collected. Future projects may include some of these elements for quantitative assessment. Nonetheless, qualitative assessment can be made as follows. The project gave the student the ability to apply some of her civil engineering knowledge about concrete to the specific use of silica fume, which was a real-life application (Criterion 3a)<sup>11</sup>. This was an experimental study, which involved data collection and analysis (Criterion 3b)<sup>11</sup>. The project required the creation of a system of concrete slabs to meet the specific need for the experiment at hand which was measuring the cracks resulting from the use of silica fume (Criterion 3c)<sup>11</sup>. The unique situation in which the student studied at the main campus, while the research experiment was physically conducted at a remote campus was a challenge (Criterion 3e)<sup>11</sup>. Because of the long distance between their locations, the student and the faculty member needed to communicate with each other remotely using the latest available computer technology (Criterion 3g)<sup>11</sup>.

Prior to the start of this project, the student showed an interest to obtain a graduate degree in civil engineering. This project was then partially designed to give her a head start in this direction. It

introduced her to the research process in concrete, which is one of her areas of interest. This study contributed positively in this regard.

Another equally important objective for this project was to create a model for other students. It was a learning experience. Improvements and modifications will be made in future projects. The faculty member had his own scholarly objectives as well.

As mentioned earlier, the findings of this project are projected to be presented and published at a future concrete conference. Many conferences are available for this purpose, but a specific meeting has not been identified yet. The faculty member will encourage the student to present this work, and publish it. This future activity on this project will be used to assess the achievements of its stated objectives.

### **Future undergraduate research**

Subsequent similar projects are in the planning stages at this time. The same approach will be taken but on a wider scope. Funding from state and federal agencies will be sought. The Research Experience for Undergraduate (REU) program by the National Science Foundation (NSF) is at the top of the list. Future projects will include other topics in the area of materials and on other topics in civil engineering as well. The experience from the first pilot project will be very helpful in conducting subsequent undergraduate research projects.

### **Conclusions and recommendations**

Undergraduate engineering research can be challenging at some university campuses for several reasons. One of these reasons is the absence of junior and senior engineering students. Penn State Fayette, The Eberly Campus is one of these campuses. A pilot project was conducted at this campus in the area of civil engineering materials. Collaboration with the Penn State University main campus made this project possible. The junior/senior undergraduate student was from the main campus while the faculty member who supervised the project was from the remote campus. The bulk of the research project itself was carried out at the branch campus.

This pilot project shows that undergraduate research can be initiated and conducted at campuses, which do not usually carry out undergraduate research. Similar campuses are strongly encouraged to use this approach as a model. Faculty members at community colleges are also invited to try this approach with nearby universities.

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## Biography

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