

Institutionalizing Undergraduate Research

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Introduction

This document is the result of a workshop, Directing Undergraduate Research that was held at Virginia State University 29-30 March 2007. The workshop was organized as a part of an NSF HBCU-UP grant and was supported by the Virginia State University Academy of Faculty Development.

The goal of the workshop was to formulate a plan for university-wide undergraduate research that would help move the university as a whole toward a culture of research and an eventual change in Carnegie classification.

Goals of undergraduate research

It was decided that before outlining a plan for a comprehensive undergraduate research program, a list of goals for undergraduate research was needed. We decided to construct three separate lists of goals, based on the goals of the administration, those of the faculty participating in the research, and those of the students.

The reason for listing these goals is so that as a program is developed, we make sure that each element in the program moves us toward one of our goals and that each interest group below is recognized as playing an important role and therefore needs their goals to be addressed. Also it is important to keep in mind that some goals are achieved indirectly or on different time scales than others.

Here the goals are listed by category. The lists are by no means exhaustive and overlap significantly.

I. Administrative Goals (University, College, Department)

- A. Generate research funds and indirects
- B. Encourage perpetuation of research
- C. Recruit good students to the university / college / department
- D. Recruit good faculty to the university / college / department

- E. Increase retention of students and faculty
- F. Increase reputation of the program / university
- G. Build infrastructure
- H. Achieve desired Carnegie classification
- I. Improve student outcomes
- J. Ensure future accreditation

II. Faculty Goals

- A. Strengthen individual research
- B. Improve undergraduate teaching
- C. Encourage interdisciplinary interaction
- D. Increase reputation of department / university
- E. Attract more quality students to individual's research
- F. Have another set of hands – increase productivity
- G. Bring in fresh ideas – student sounding board for research
- H. Open funding options
- I. Recruit higher quality students

Faculty goals for students:

- J. Increase knowledge and skills
- K. Prepare students for graduate school
- L. Integrate ethics training of students
- M. Move toward thought oriented learning
- N. Improve marketability of students
- O. Teach an appreciation of the research process

III. Student Goals

- A. Prepare for graduate school
- B. Finish school in a timely manner (summer course credit)
- C. Strengthen resume
- D. To be involved in a creative endeavor
- E. Gain empowerment
- F. Learn specific techniques
- G. Apply knowledge from classes
- H. Have new experiences
- I. Travel to new places
- J. Networking for future job opportunities
- K. Get a good letter of recommendation
- L. Get paid without working at McDonalds (now and later)

Outline of a vertical and horizontal research program

In order to change the culture of a university, students need to be exposed to that culture from the very beginning. Students cannot be expected to shift gears mid-stream. Any integration of a research program should begin with freshmen and carry them through to graduation. It is not expected that every student should participate equally, in part because there are just not enough resources. For every student to do an extended independent research project with a faculty member is impractical at most institutions. Most faculty members do not have enough time to mentor more than a few students, far below the faculty to student ratio of their university. How many students that can reasonably participate will vary widely from institution to institution. Below, we have outlined a very general plan for a vertically and horizontally integrated program.

Keep in mind that some activities are expected in every course in the university, regardless of whether the course is for majors. In this way, students will learn not only about research in their own field but in the fields of their peers as well. Students also will begin to see connections between research methods in different fields and appreciate the commonalities and differences in the approaches used in different areas of study. In addition, because students see elements of research in every class, the amount of research needed in any individual class need not be burdensome. Since research methods in different fields are frequently similar, students will benefit in their own field from research experiences in all of their classes. A student taking five classes each semester would have five different research experiences each semester, even if each faculty member just had one element in a class. This has the potential for keeping faculty workloads from becoming unreasonable.

I. Freshman year

A. Read research papers - General scientific literature or review papers

This activity is done to get students used to the idea that reading research is a normal part of learning and that the information in textbooks comes from prior research. This will also include a discussion of the fact that research is the source of the creation of knowledge. This is an activity that every class can be expected to incorporate to contribute to the overall success of the program.

B. Introduce research concept – what is research?

The ideas of research should be discussed in the first year, including the critique of materials. Students should understand that not all research is good research, even when

done by someone with good ethics. It is also clear at this stage to students that data and results can be framed to support different motives.

C. How to work in a group

It is frequently true in high school that students work on their own. In the freshman year, students need to understand that working in a team is common in modern research, is an important skill, and takes practice.

D. How to evaluate literature sources

Students need to understand that research reported in the primary literature is reviewed by other experts. Materials found on the web and in the newspaper do not undergo the same level of scrutiny. Students can learn how to evaluate the reliability of sources of information.

E. How to read critically

Here students are asked to criticize written works to find flaws and suggest improvements. Where have authors left out information? What assumptions have not been explicitly stated?

G. Interrelation of the disciplines

Students should be aware that the academic fields are not disjoint and the department unit is an administrative invention, not an academic attribute.

H. Attend research day

VSU has begun an annual research day where students can present the results of their creative endeavors. Students should be made accountable for attending research day, both to support their fellow students and to learn the type of research that their peers are pursuing.

I. Advertise department seminars

Students need to be aware of departmental seminar series. This will make it clear that their teachers do research and presents the opportunity for them to get involved. At this stage, students may not be asked to attend the seminars, but their awareness leads the students to accepting the culture of research in the university.

J. Observing research, visiting a laboratory

For some types of research, it is possible to visit a laboratory or go on a field trip to a location where research is being done. This can help the students understand what it means to do research.

K. Advising

Advisors need to make it clear that research is a normal activity in the undergraduate curriculum. The students should be asked regularly if they have tried to get involved in some research and reminded that this is a good way to get a strong letter of reference later on.

L. Assessment and feedback

At every step of the research development of students, data need to be collected to document what is going on and analyzed to determine the success of the effort.

II. Sophomore year

A. Introduction to the primary literature

At the sophomore level, students have enough background to get something out of reading the primary literature. This is possibly the time to begin introducing some classic papers to read.

B. Recruitment or recommendation from classes

Some students are ready in their sophomore year to begin work on directed research problems and possibly apply for summer research opportunities. Faculty should be on the lookout for strong students. Opportunities for research should be advertised to students in classes.

C. Project or lab and presentation based coursework

In order to find students who are strong in independent thinking and not just completing class assignments, projects or labs need to be incorporated into the curriculum. Students should be asked to present their work in written, oral, and/or poster form.

E. Attend a local and/or regional conference

Near the end of the sophomore year, many students are ready to see what other students are working on and perhaps get an idea what faculty do with “the rest of their time”.

F. Attend department seminars (special first seminar)

Students may not be able to follow all of the department seminars, but this is a good time to start, particularly with general talks (aimed at the entire department). The first “seminar” of the year would be a good time to have faculty introduce themselves and give a short introduction to their interests and advertise any student projects they have ready. This can be useful for both students and other faculty, making everyone more aware of what each other are working on.

G. Attend research day (in a meaningful way)

In the second year, attending research day is not enough. Students should be asked to participate by asking questions of the presenters and critiquing others’ work.

H. Research Methods

- i. Statistics / experimental design (possibly)
- ii. Qualitative / naturalistic experiment (possibly)

If students are to start thinking seriously about research, they need the requisite skills for that task. Departments need to structure the curriculum so that students take the necessary course early enough to make them useful.

I. Assessment and feedback

At every step of the research development of students, data need to be collected to document what is going on and analyzed to determine the success of the effort.

III. Junior year

A. Presentation (oral or poster) of some information or project

No one will ever know how smart you are (or care) if you can’t explain what you have learned. Students in their junior year need experience in presenting technical material. Presentation skills take time to develop.

B. Project or lab and presentation classes – open ended projects

These types of classes lead naturally to senior research projects. Students need to have these opportunities early enough to be able to pursue a topic more fully than a semester class can offer.

C. Continued opportunities for research

Students need continued exposure to research opportunities.

D. Present in research day (some)

Advanced students in the junior year have been doing research for enough time that they should have something to share.

E. Attend a local and/or regional conference

Students at this level are mature enough and knowledgeable enough to appreciate a research conference. Students will get to see first hand current topics of interest and start formulating ideas about graduate school. This should be done early enough that students can alter their final coursework to meet changing goals.

F. Statistics / experimental design coursework

Statistics and experimental design concepts are integral to doing good research in any field.

G. Research ethics

In some required class, students should be asked to address research ethics. There are numerous ways to address this, but students need to be acclimated before their senior year.

H. Inquiry based courses

Students need to begin taking more open-ended courses where there is not a single known answer to each problem.

I. Assessment and feedback

At every step of the research development of students, data need to be collected to document what is going on and analyzed to determine the success of the effort.

J. Apply for summer research experience or internship

Summer research experiences give students submersing experiences where they can really experience a research atmosphere. These experiences frequently shape the future direction of students and in industrial settings frequently lead to jobs.

IV. Senior year

A. Present in research day and/or department seminar (some)

Students, as many as possible, should be encouraged to present their work.

B. Attend a regional and/or national conference

Students will get to see first hand current topics of interest and start formulating ideas about graduate school. This should be done early enough that students can alter their final coursework to meet changing goals. These are opportunities to meet potential graduate advisors and learn about different projects and programs.

C. Individual research (some)

As many students as possible should do this.

E. Present at a research conference (possibly undergrad. conf.)

This extends the students' presentation skills and gets the students involved in the broader academic community. This also gives potential graduate advisors the chance to recruit them.

F. Ability to suggest a hypothesis, plan an experiment, predict outcomes

This is not necessarily done by doing research since not all students can have a research experience (resources). Still, these skills are important and may assist the student in future endeavors such as graduate school or in the workplace.

G. Mentoring of younger students

In order to bring the younger students into a culture of research, the older students need to reinforce the importance of research and set the example. Formal mentoring programs can help, but the presence of more senior students doing research will contribute to the atmosphere.

H. Publications

Having a student publish is a wonderful result of research, but is not necessary to meet the goals at the beginning of this document. While having a few publish each year would be desirable, the more important thing is for students to work on publishable projects (focusing on potential rather than product). Essentially, the emphasis should be put on the experience rather than the end result.

I. Assessment and feedback

At every step of the research development of students, data need to be collected to document what is going on and analyzed to determine the success of the effort.

Faculty Involvement

Once the university decides to adopt a plan for undergraduate research, it will be up to each department to decide how to best implement these features in their curriculum. We imagine that every faculty member will participate in some aspect of the program, while some subset will be integrally involved. With a change in direction for the university, it is unrealistic to expect that every faculty member will take part in every aspect of the program. Instead, it can be expected that every faculty member will contribute to the overall success of the effort by playing a role that makes the best use of each faculty member's interests and expertise.

For example, a faculty member who mentors numerous students in research projects might be considered to have fulfilled most of their university and departmental service responsibilities in doing so. Another faculty member might be involved in very little research with students, but might serve an integral departmental need in other ways such as advising pre-professional students, maintaining the departmental website, or coordinating graduate student teaching.

In particular, faculty members who were hired before the focus on research was increased might (or might not) struggle to re-establish their research programs. These faculty members should be encouraged and assisted in developing research programs if they want and should be allowed to strengthen the overall effort in other ways such as:

- Help organize research day for the university
- Take on larger roles in training graduate students in teaching
- Take on differentially larger roles in advising or service
- Take on consulting roles for students doing research with other faculty

It is also true that there are some elements of the research outline above that every faculty member might be expected to support. Asking students to find, research, and report on primary or secondary literature relevant to every class does not need to impinge on the content of the class, nor does it need to significantly increase the grading efforts of the instructor.

Obstacles and Challenges

Implementation of a broad reaching research program for an institution needs a great deal of administrative support and commitment. Development costs should not be underestimated.

Of utmost importance is the need to consider the social and cultural aspects of the change in focus of a university. Changing a few courses in a department is very different than changing the academic culture. The first time a new course is taught, the instructor will have to put in extra effort work but the students will adapt very quickly to the new methods, approaches, or content. Changing the academic culture of an entire student body along with the faculty is a much more daunting task and will take much longer and take more coordination. Entering freshmen are indoctrinated into the existing culture of a school very quickly. If they see an expectation of research immediately upon entering the first class and have senior students challenging themselves in independent research projects, the students will assume that their expectations are similar. Without the senior mentors and peer leaders, the entering students will need extra support and encouragement. It is likely to take a generation or two of students to change the culture of the student body (4-8 years or more). For the faculty, it may take longer or shorter times depending on the support provided by the administration and the level of resistance or support from senior and established faculty members.