Enhancing Undergraduate Education through Research and Independent Study

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I will post this Ppt talk:
http://carbon.cudenver.edu/~bstith/
My talk is divided into 3 Sections

1. Defining Undergraduate Research
2. Assessment
3. “How To” for Undergraduate Research
1. Defining “Undergraduate Research”? 

Using Google... # of hits for 

- "undergraduate research" - ~2,870,000 hits 
- “undergraduate research grant program” - 64,400 hits 
- “Director of Undergraduate Research” - 20,800 hits..."Directors” now common... 
- It is ONE OF THE “HOTTEST” “NEW” PROGRAMS IN HIGHER EDUCATION
Council on Undergraduate Research — see www.cur.org.
also see their new book: Developing and Sustaining a Research-Supportive Curriculum (2007)
T. McDorman’s major concerns for Undergraduate Research in Rhetoric

1. Since research can be personal, solitary and very individualistic, how can students be involved?

2. How can the project be broken into parts for groups of students?

3. It is difficult for the students to understand advanced concepts necessary for a paper

4. Student writing skills low
McDorman’s Program:
(Wabash College)

1. Weekly meetings (small steps)
2. Students read original literature
3. Students write SHORT criticisms (5-7 pages)
4. Faculty feedback
5. Faculty and students write paper (line by line reviews)
6. Present paper on campus (Undergraduate Research Symposium)
7. Next semester: submit (2 SEMESTER PROCESS)
8. Address journal concerns
9. Resubmit or submit to new journal
Undergraduate Research in the Humanities...CUR Quarterly 2007...by Laurie Grobman (Penn State Berks...)

- Lists of where to publish (if it is not published, is it research?)
- It is not a term paper: not collecting info and then passing it on...not paraphrasing reference works...Students move beyond “synthesis of others’ research, ....”performing my own original research.".. possibly 2 semesters...
- It involves: many drafts with peer review, **field research**, first person voice, different media/subjects/genres with multiple perspectives, **primary sources**, where the student defends every statement.
Problems to overcome; Making History...David Wittner, Utica College) (CUR Q: fall 2007)

- Problem: Students frustrated with lack of progress and understanding of the material...lose motivation...students have limited research abilities...need to examine many sources to obtain little bits of relevant information

- Solutions: Require at least 10 sources...take a methods course before...teach word processing...SHORT WEEKLY ASSIGNMENTS...PEER review powerful...use an OUTLINE...students need to answer “why, so what and who cares?”
In Research Experience or Independent Study: Students can...

- Develop hypotheses based on a reading of background literature
- Apply logic and critical thinking skills to defend or criticize the hypotheses
- Design and Conduct Experiments
- Collect Information (data) and Interpret the Information
- Write, Graph, and Present their Results
Benefits of Und Res/ Indpt Study

- Enhance the student’s creativity in overcoming obstacles,
- Increase confidence in the subject (thus increasing retention),
- Learn original literature (which is more challenging to students than the use of textbooks)
Benefits Cont’d

- Learn by doing - ”hands on” approach to learning (“see” a method or fundamental concept)
- Enhance oral and written presentation skills. Students teaching others (best way of learning is through teaching)
- Facilitates career decisions (do I want to get a Ph.D.?)
Benefits cont’d; It Enhances

- ability to work in groups,
- career opportunities (Pat Ayres letter),
- development of regular work habits- real world skill
- critical thinking skills
Teaching and Undergraduate Research

THESE ACTIVITIES ARE ALL TECHNIQUES OF “ACTIVE LEARNING”
J. Handelsman et al., 2004.

“Research is the finest form of Teaching”
(L. Hoopes, 1993)

We give Bachelor’s degrees in “tennis,” but never allow the student play “tennis” -they only read about it
“Research at a PUI (Primarily Undergraduate Institution) is not a lower-level version of research at a (Research 1 institution).”

“(We do it) because it is the best way of teaching…”

Scott Gilbert, Swarthmore College
Based on studies of how students learn, faculty in physics have found that “traditional lecture, laboratory, and recitation courses, are relatively ineffective” as compared with “courses including active, inquiry-based, and collaborative learning, assisted by information technology”

Benefits for Faculty

- Enhance careers (I have received almost 2.5 million $ in grant funds)
- Increase job satisfaction
- Increases connections with local/national/international faculty
- Keeps faculty intellectually vigorous
- Enhances the quality of classroom teaching
- Engages faculty in original scholarship and new methodology

(help from Jill Singer, Department of Earth Sciences and Director, Office of Undergraduate Research, Buffalo State College, Buffalo, NY)
Benefits to the Department and Institution:

- Intellectually vigorous faculty
- Engaging academic environment
- Supports academic activities (symposia, seminars)
- Enhances fund raising and national profile
- Enhances students progression to graduate/ professional programs

(help from Sally Koutsoliotas, Bucknell University)
HOLD ON! WAIT A MINUTE!

At this point, some will say (correctly)

ARE THE STUDENT BENEFITS REAL?
WHERE IS THE PROOF?

(MOVE ON TO PART 2 OF TALK)
2. Assessment of undergraduate research: 4 Types

1. Student tracking - where did the students go? (a more successful career path?)
2. Enhanced retention rates?
3. Surveys -- large numbers of students with carefully designed survey instruments, developed by social scientists experienced in survey methodology
4. Measure Student skills
Survey conducted by SRI International (Henry, 2005a)

- Undergraduate Research motivates and encourages students to pursue an advanced degree
- Gains were largely independent of the mentor's race or sex.
- Students report increased confidence and independence.
Undergraduate Research increases confidence in the subject - thus increasing retention
Gains in:

- CONFIDENCE
- COLLEGIALITY
- RESPONSIBILITY
- UNDERSTANDING OF HOW SCIENCE WORKS
- COMMUNICATION SKILLS
- RES EXP DID NOT INCREASE NUMBER OF STUDENTS GOING ON TO SCIENCE CAREER

(76 students interviewed; Seymour et al., 2004)
Largest Survey*- SURE Survey
(Lopatto, 2004; 2007)

Students Report Very High Gains in:

1. Understanding the Research Process
2. Readiness for more demanding research
3. Tolerance for Obstacles
4. Learning to Work Independently
5. Skill in the Interpretation of Results
6. Ability to Analyze Data
7. Felt part of the learning community
8. Increased Self-confidence

*1135 students in summer research programs at 41 institutions
LOPATTO CONT’D

- Influenced Career Choice (but increase in students choosing science career was balanced by those who dropped out)
- Minority students gained as much as non-minority students
- Higher Gains correlated with Higher Positive Social Interaction (with faculty and fellow students - students should work in teams)
- College, Master’s Univ, and Research University Students Showed Same Gains!
Other surveys* report undergraduate research students have:

- Higher rates of satisfaction with their education
- Greater understanding of the scientific method
- Greater gains in critical thinking skills
- Increased skills in leadership
- Increased ability to work independently

*summarized in Rueckert, 2002
But many surveys do not involve a “randomly selected" group of students or a control group…

- One study did: Nagda et al., 1998
- The randomly selected group that had a research experience showed increased retention
  - spent more time talking to professors
  - contributing to class discussions
  - less time socializing, sleeping, eating than other students
The need for more studies.....

- Surveys use “self-reporting” by the student and may not be accurate

- Need direct test of student skills in before and after a research experience...then

- compare to control group

ONE SUCH STUDY HAS BEEN COMPLETED
Rauckhorst et al. (2001) Tested for Increased thinking skills after a Research Experience

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(Lopatto 2004 confirmed these results)
So its is valuable, but there are concerns with Research/Independent Study as a teaching tool...

- Few students accommodated (only 1 out of 4 who want to get involved, can - Education 83:37, 2005)
- Very time intensive for faculty
- Can involve high quality research, but very slow rate of publication (1 paper every 2 years?)
- Can be costly for lab supplies, computers, building space, travel to distant museums/libraries...
- Requires significant investment from administration

So, let’s move on to the 3rd portion of the presentation...
3. “How To” - Undergraduate Research -- The MOST SUCCESSFUL PUI Researcher is a...

- A JUGGLER!! Juggles teaching, research, reading papers, writing grants, committees, faculty meetings, faculty politics. Those at teaching or research institutions have only one job! You may never be an “expert” or specialist in any of the above.

- Sends CV to NSF (or other funding source) & volunteers to review proposals

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Only small percentage of students may be “productive”

Good learning experience but poor productivity

An author on a paper

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Most students stay only a short time

- 1 SEMES: 40%
- 2 SEMES: 50%
- Up to 2 YEARS: 10%
Successful PUI Research Programs:

- Generate significant preliminary data for grant proposals – with undergrads
- Year round effort (although summers may be most important) but not every day/week
- Do not emphasize development of new methods
- Recommend: part time technician (recent grad?)
- Support student and faculty travel (local or...
Successful Research Programs…

- Collaborate with larger institutions
- Do not directly compete with larger labs but have projects that are important and interesting (a niche)
- Break down projects into small packets allowing intermittent work by students
Successful Research Programs…

- PI has a thick skin, driven, stubborn: 10 proposals, one funded
- Have and utilize an older Faculty “Mentor”
- Hire Teaching PostDoc …someone who learns how to teach and works with you in your research
- Reach out to State Representatives and Senators with students from their district
ADMINISTRATORS...

- Attend meetings of CUR to network with other Administrators
- <10 contact hours a week for those faculty who conduct research...
- Main problem: faculty time with students for research:
  - support hiring graders...
  - Support research “in load” ...courses that involve student research (ACTIVE LEARNING) versus the traditional, PASSIVE lecture and listen
MORE TIPS on my home page
www.cudenver.edu/~bstith:

1. **Funding Sources** for Undergraduate Research
2. **Adjusting to a PUI** after a research university
3. **GRANT WRITING** "HOW TO."

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MORE HELP:

COUNCIL ON UNDERGRADUATE RESEARCH (CUR)  www.cur.org

- Support and promote high-quality undergraduate student-faculty collaborative research and scholarship.
- Over 3,000 members, 870 institutions
- CUR works with Congress, agencies (NSF, NIH) and foundations
- CUR assists administrators (MEMBERS)
- Conducts a Grant Proposal Writing Institute (‘how to’)

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Divisions of CUR:

- Psychology
- Social Sciences
- Biology
- Chemistry
- Geosciences
- Mathematics
- Computer science
- Physics/Astronomy
- At-large division
  (includes Best Administrators in nation from PUIs)
- Undergrad. Research Directors
Currently active affinity groups in CUR:

- Arts/Humanities Issues,
- Research University Issues,
- College and University Administration Issues, and
- Environmental Sciences
- Biochemistry
- Engineering
CUR Activities

- Biennial National meeting - numerous programs on funding and undergraduate research.
- *CUR Quarterly* (articles on undergraduate research)

**BOOKLETS:**
- How to Get Started in Research
- How to Mentor Undergraduates
- How to Get a Tenure-track Position at a PUI
- How to Develop and Administer Undergraduate Research Programs
- **Reinvigorating the Undergraduate Experience:** Successful Models Supported by NSF's AI RE/RAI RE Program- esp impt for humanities!!

**Has a LISTSERV** - for questions on lifestyle, teaching, research
External Support for Undergraduate Research at PUIs*

1. **NSF ROA**: National Science Foundation-funding to work in a lab with an NSF grant (very high rate of success…?)
2. **NSF REU Site**: groups of undergraduate faculty work on related project
3. **NSF Course, Curriculum, and Laboratory Improvement** (CCLI); purchase teaching/research equipment.
4. **NSF RUI**: research support; up to ~$100K a year)
5. NSF’s **Div. of Undergraduate Education (DUE)**
6. **AREA**: National Institute of Health (R-15)*
7. Local industry, government?

* UP TO 35% FUNDING LEVELS - ONE OUT OF THREE!!

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NSF’S WEB SITE ON UNDERGRADUATE SUPPORT

- Advanced Technological Education
  - Arctic Research Opportunities
  - Centers of Research Excellence in Science and Technology
- Course, Curriculum, and Laboratory Improvement
- Cross-Directorate Activities
- Cross-disciplinary Research at Undergraduate Institutions
- Developing Global Scientists and Engineers
- Evaluative Research and Evaluation Capacity
- Building (ERE) And Research on Learning and Education (ROLE)
- Federal Cyber Service: Scholarship for Service Graduate Research Fellowship Program
- Historically Black Colleges and Universities Undergraduate Program
- Integrative Graduate Education and Research Traineeship Program
- Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences
- International Research and Education: Planning Visits and Workshops
- Math and Science Partnership Program

- Nanoscale Science and Engineering Education
  - National Science, Technology, Engineering, and Mathematics Education Digital Library
- NSF Computer Science, Engineering, and Mathematics Scholarships
- Partnerships for International Research and Education
- Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring
- Research Experiences for Undergraduates
- Research in Disabilities Education
- Research in Undergraduate Institutions
- Robert Noyce Scholarship Program
- Science, Technology, Engineering, and Mathematics Talent Expansion Program
- Teacher Professional Continuum
- Undergraduate Mentoring in Environmental Biology
- Undergraduate Research Centers

http://www.nsf.gov/funding/education.jsp?org=NSF&fund_type=1
For many funding agencies

- There is a new emphasis on integration of research and education

- “The time has never been better for including undergraduates in your research proposals” (Jill Singer, NSF Administrator, Faculty member at Buffalo State College)- I (BJ S) have gotten ~$1.5 million NSF funding in a 14 year period.

- Include students into your grant proposal and work--- reviewers will look for your students to be much more than ‘assistants’
Controversy:
Should the student research project...

- Be initiated by the student- an independent project or
- Should the faculty member suggest a project designed to fit it into the faculty member’s overall research program (with some or without any student input?)
- Most favor the latter
Concerns:

- How use primary literature in large classes?
- How address differences in undergraduate research in science, music, modern languages, art?
- How do you involve Freshman in undergraduate research?
- How involve students who are not at the top of the class?
Some Recommendations:

- Use: “Reading Primary Literature” by Christopher M. Gillen, (Pearson Benj Cummings Publ.; 2007)

- **Include Freshman and Sophomores** in the research program (is it too late by senior year?)

- **Allow for time and Reward Faculty** devoted to this effort (award plaque or financial awards)

- **Use of peer mentors (upper level students)** to help attract students to undergraduate research (Reed College)

- $30-50K for **competitive research grant program for undergraduates** - another program for Master’s students - include support for supplies or travel

- **Research Day** for Undergraduate Posters and platform talks

- Student **Research Club** (support from student fees)
“I benefited most by becoming part of a research team and feeling like I was more connected to my department.”

(from D. Lopatto)
I think one of the reasons why I enjoyed and learned from summer research is that I had good mentors. They set high goals for me so that I was an active participant in the research rather than a mere worker.

(from D. Lopatto)
References


http://www.sciencemag.org/cgi/content/full/304/5670/521/DC1

Henry, CM. UNDERGRAD RESEARCH MAKES A DIFFERENCE; Studies look at the impact of undergraduate research on retention and student outcomes. Chemical & Engineering News. April 25, 2005 (a); 83 (17): 37-38.
http://pubs.acs.org/cen/education/83/8317educ1.html
References cont’d:

- Henry, CM. GETTING A HEAD START: Programs introduce undergraduates to laboratory research in their freshman year. Chemical & Engineering News, April 25, 2005 (b); 83(17), 39-40. [http://pubs.acs.org/cen/education/83/8317educ2.html](http://pubs.acs.org/cen/education/83/8317educ2.html)


McDorman, T. Promoting Undergraduate Research in the Humanities: Three Collaborative Approaches. CUR Quarterly Sept 2004, pages 39-42


