Assessment Case Study:
University of Delaware’s
Undergraduate Research Program
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UD Program’s Purpose and Design
Students learn through research apprenticeships with faculty
- Open to students in every major department and class.
- About 600-700 students per year participate.
- Involvement lasts typically 1-3 years; summers important.
- Students gain increasing independence and responsibility.
- Students present work at symposia and poster sessions
- Seniors in university thesis program prepare research proposals, present work-in-progress to peers, give an oral defense of their theses.

Faculty Mentors
About 2/3 of UD faculty provide undergraduate research opportunities
- Over 90% in engineering, physical, and life sciences
- Over 80% in social, behavioral, economic sciences
- Over 60% in humanities
- Over 55% in arts
- Over 50% in mathematical sciences

Board of Senior Thesis Readers
20 faculty members facilitate the University-wide senior thesis program and serve as outside readers on thesis committees.

Undergraduate Research Program Services
- Solicit UR opportunities from faculty and publicize.
- Help departments & other units to develop UR opportunities.
- Directly advise about 300 students per year.
- Provide funds for UR project supplies and expenses.
- Provide summer and winter term UR scholarships.
- Arrange summer UR residence and enrichment programming.
- Coordinate University-wide senior thesis program.
- Mount poster sessions and symposia for UR presentations.

Program Staff:
- Faculty coordinator
- Professional coordinator
- Administrative assistant
- Graduate assistant

Program Facility:
- Student reading & computing room/presentation practice space
- Conference room
- Staff offices and workroom
**Why Assess? Why Now (1997)?**

Funds for large-scale study potentially available
- NSF RAIRE competition

Visibility desirable
- We anticipated the results would be strongly positive.
- It would benefit our own institution and higher education to demonstrate and analyze accomplishment.

**Stakeholders’ Influence on Assessment Design**

NSF requested a *summative* assessment:
- Answers to our research questions must be of interest to the general public and the U.S. Congress
- Studies should yield assessment models adaptable for use by other research universities

UD would also like *formative* information:
- What could we learn from these studies that would benefit our own future student and faculty program participants?
- Could we also possibly contribute new methods of assessment (conduct research *on* assessment)?

**Challenges to Be Met**

- Articulation of, and agreement upon, the research questions
- Researching possible methods and instruments
- Organizing existing sources of data (e.g., creating an alumni data base from paper files)
- Securing staff to help with data gathering and specialized analyses
- Obtaining subjects’ participation, esp. longitudinally
- Finding enough time to complete the studies

**Program Factors Influencing Assessment Design**

**Age of program**
- Alumni available
- 20 years of student and faculty evaluations available

**Central administration support**
- Institutional research expertise available

**Faculty support**
- Faculty readily called into service

**Role of Advisory Board**

- Adds unique perspectives on undergraduate research experience
- Assists with writing / obtaining grants
- Provides oversight of assessment efforts
- Acts as liaison with faculty as a whole
- Adds leverage with administration
- Increases dissemination of results

**UD Advisory Board**

- **Chemical Engineering**
  - Andrew Zydney
  - Roy McCullough
- **Physics**
  - George Watson
  - Harry Shipman
- **Chemistry / Biology**
  - Hal White
  - Deborah Allen
- **Math/Science Education**
  - Barbara Dach
### Perspectives on UG Research

- Director of University’s Undergraduate Research Program
- Faculty who actively involve undergraduates in their research programs
- Faculty with non-traditional approaches to incorporating research in the classroom
- Asst Dean for Student Affairs
- Others (?)

### Grant Writing

- Strong Advisory Board looked impressive to funding agencies
- Well-defined role of Advisory Board strengthened overall proposal
- Faculty provided critical input into proposal based on personal experiences
- Editorial Assistant provided hands-on assistance with actual grant preparation

### Oversight of Assessment

- Are we asking the right questions?
- Are we using assessment tools that will give useful (and believable) results?
- What correlations should be explored?
- What confounding factors need to be examined?
- How do we interpret the data?
- What conclusions can we draw and defend?

### Liaison to Community

- Critical for effective communication of results to broader faculty
- Provided “believability” to faculty and administration
- Assisted in preparation of papers and presentation of results
- Increased visibility of assessment effort both on- and off-campus

### Conclusions

- Strong Advisory Board is critical to overall success of assessment activities
- Composition of Advisory Board should be based on goals of assessment effort and identification of key constituencies
- Active participation of Advisory Board requires strong leadership (and persistence) from director of assessment effort

### First Steps for UD Assessment Official

- Become familiar with nuances of Undergraduate Research Program, its faculty and its students
- Think, plan, develop preliminary methodology skeleton
- Collaborate with Advisory Board
  - Discuss what was to be measured
  - Articulate major issues, questions
  - Discuss potential measures and methods
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**Major Questions That Emerged**

Does participation in undergraduate research:
- Sharpen ability to think critically, creatively, synthetically?
- Develop problem-solving, leadership, teamwork abilities?
- Increase intellectual curiosity and desire to learn?

Do alumni perceive benefits of UR in same ways as current students?

What motivates faculty to participate; what are the obstacles?

What educational outcomes do faculty perceive for students who participate in research?

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**How Did We Come to the Chosen Method and Measures?**

- Clear to me that no one measure would answer the questions
- Important to have non-UR comparison group
- Important that subjects be unaware of the studies’ connection to undergraduate research
- Important to examine data from multiple perspectives—alums, faculty, current students

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**Value of Multiple Measures**

- Some constructs such as cognitive growth are hard to measure
- Academic and psychosocial behavior change are easier but still tough to separate from extraneous factors
- Multiple measures enabled us to look at different educational outcomes affected by UR

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**Non-UR Comparison**

- Important to examine the value-added of UR over and above regular curriculum
- Can help identify where the UR program is meeting its goals, objectives
- Can help serve as a gauge for subgroup findings—gender, major, honors
- Non-UR comparison meant larger sample size needed

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**Value of a Longitudinal Study**

- Resource intensive—but the best way to study student change over time
- Examine individual student growth over time
- Eliminate bias that can be made when comparing students in cross-sectional analyses
- Examine similarities and differences between self-report and objective measures
- Help examine appropriateness of some standardized measures (e.g., critical thinking and reasoning)

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**Important to Consider Use of Resources**

- Comparison group = larger sample
- Large sample = statistical power
- Larger sample = impracticality of more qualitative examination through individual interviews
- High attrition rate would threaten generalizability of study, so follow-up is important
- Larger sample = more personnel time to follow up with nonrespondents
Value of Multiple Perspectives
- Faculty study enabled us to examine levels of UR involvement and what faculty think students learn
- Also enabled us to better understand why faculty participate; in what ways they benefit
- Alumni have the advantage of distance and seeing how educational experiences helped with career or graduate school
- Students can accurately describe their perceptions of their own academic experiences
- Multiple perspectives help tell a robust story

Undergraduate Research Program
Assessment of the University of Delaware’s Undergraduate Research Program

Four Major Components
I. Content Analysis
   - previous years’ formative evaluations
   - science and engineering sophomores
II. Alumni Survey
   - all majors: UR and non-UR
III. Faculty Survey
   - all science and engineering departments
IV. 4-Year Longitudinal Study: Class of 2000
   - UR and non-UR science and engineering students

Content Categories: Perceived Learning
- Increased technical skills………………………………..96%
- Increased independence………………………………57%
- Insight into graduate school…………………………..45%
- Teamwork learned and valued…………………………43%
- Learned to work with obstacles and ambiguities……..37%
- Learned to think creatively/synthetically………………32%
- Increased desire to learn………………………………32%
- Self-confidence gained………………………………..28%
- Communication skills improved………………………24%
- Understanding “knowledge”……………………………24%

Content Categories: Comparison to Course Work
N of letters in which this content category was mentioned:
154/183 (84%)
- Learned more through research: 113 (73%)
- Learned as much through research: 39 (25%)
- Learned more through courses: 2 (1%)
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Content analysis web posting:

University of Delaware’s RAIRE web site
www.udel.edu/RAIRE/

II. Alumni Survey

- Alumni survey containing a large set of questions about the undergraduate experience. Survey completed in spring 1998.
  - Responses from 986 UD alumni
  - Graduating classes of 1982 through 1997
- Respondents from 75 different majors:
  - 59% science or engineering
  - 41% arts, humanities or social science
- Responses fell into three groups related to UR:
  - 418 had been undergraduate researchers served by the URP
  - 213 had conducted UR but had not received URP services
  - 355 had not engaged in undergraduate research

Alumni Survey Results (selected):

- Growth in 8 general cognitive and behavioral skills greater for UR than non-UR alums
  - Carry out research
  - Develop intellectual curiosity
  - Acquire information independently
  - Understand scientific findings
  - Analyze literature critically
  - Speak effectively
  - Act as a leader
  - Possess clear career goals
- Growth in 3 factors greater for URP than non-UR alums
  - Science, math, logic, problem-solving
  - Literature, language, mastery of contexts
  - Personal initiative and communication

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Alumni Survey Results (selected)-2:

- Education beyond the baccalaureate
  - URP alums were about twice as likely to pursue doctoral degrees
- Employment
  - Compared to URP alums, about 1/3 more non-UR alums were employed in a career not related to major

Alumni Survey Results (selected)-3:

- Alumni ratings for benefit of UR involvement:
  - High benefit perceived for even one research semester.
  - Higher benefits perceived by alums who had devoted greater amount of time to research
  - Very highest ratings given by alums who had completed a senior thesis through the URP
- Involvement in non-research out-of-classroom activities:
  - UR alums participated in co-curricular activities and on-campus employment at the same or greater rate than non-UR alumni
  - Internships related to major also rated as highly beneficial by both UR and non-UR alums

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Alumni survey publications:


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III. Faculty Survey

- A survey of 155 science and engineering faculty was completed in fall of 1999.
- Over 90% of UD faculty in these fields participate regularly in UR.
- Objective was to examine:
  - Motivation of faculty to participate in UR
  - Accommodations faculty make to facilitate UR
  - Faculty perceptions of student learning through UR (compared to alumni perceptions)

Faculty Survey Results: Motivation

- Desire to influence career of talented young students
  - 75% said “important” or “very important” motivator
  - Another 20% said “moderately important” motivator
- Students’ contribution to faculty member’s research
  - 50% said “important” or “very important”
  - 78% said students influenced their own thinking about research
- Students’ contribution to faculty member’s quality of life
  - 41% said “important” or “very important”
- Undergraduates’ contribution to graduate students’ education
  - 39% said “important” or “very important” (primarily in engineering)

Faculty Survey Results: Accommodations made

- 46% reported structuring to accommodate undergrads
  - These faculty took more undergrads (avg. 7.95 over 5 years compared to avg. 6.77 for those who made no adjustments)
  - 91% of these faculty had graduate students helping
- Accommodations fell into four categories:
  - Create smaller problems
  - Assign exploratory problems
  - Integrate undergrads into existing lab/project framework
  - Designate money/time for undergraduates

Faculty Survey Results: Student skills gained-1

- Highest-rated skills (by 77-80% of respondents):
  - Develop intellectual curiosity
  - Think logically about complex materials
  - Understand scientific findings
- Also highly rated (by 63-69% of respondents):
  - Synthesize/use information from diverse sources
  - Solve problems independently
  - Approach problems creatively
  - Maintain openness to new ideas
  - Work as part of a team

Faculty Survey Results: Student Skills Gained-2

- Faculty perceptions of student skills gained generally agreed with alumni perceptions.
- Faculty who made accommodations for undergraduates perceived much larger gains in the higher order skills.
- Faculty who supervised undergraduates for two or more years rated gains significantly higher in 9 of 11 skills.
- No correlation was found between number of hours per week spent supervising students and skill gains perceived.
- Faculty for whom quality of life was a strong motivator perceived higher educational gains for their students.

Faculty Survey Results: Graduate students

- Most faculty (73%) believed that graduate students who helped to mentor UR students gained valuable teaching experience and greater mastery of their subjects.
- Faculty with larger numbers of graduate students also had larger numbers of undergraduate researchers.
- Thus, institutional support for graduate students—when combined with a strongly institutionalized undergraduate research program—could be leveraged to improve undergraduate educational experience.

Faculty Survey Results: Graduate students
Faculty Survey: Some Conclusions

- Departmental/college encouragement was not a primary motivator and had no correlation with perceive skill gains; therefore, the institution’s most effective role appeared to be indirect:
  - Providing student recruitment/advisement network as well as support services and funds for both students and faculty
- Since both length of students’ research commitment and accommodations made by faculty correlated strongly with student gains, the institution should:
  - facilitate long-term student involvement; facilitate faculty’s efforts to adapt their research operation to include undergraduates

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Goals:
- Capture currently enrolled students
- Ensure the impossibility of respondent bias
- Measure change in skills gained over time
- Maintain comparison groups for all measurements
- Compare results from several types of instruments

Longitudinal Study Instruments

- No existing standard instrument can objectively measure the cognitive and behavioral gains that self-report, alumni perception, and faculty observation find in undergraduates who participate in research.
- To have established reliability in the instruments used for our study, we decided not to invent our own instruments.
- Instead, we combined three standard instruments—measuring (1) college student academic behaviors and gains (CSEQ, a self-report instrument), (2) logical thinking (WGCTA), and (3) personality characteristics (NEO-FFI)—with a reliable instrument still under development that attempts to measure (4) “reflective judgment” or epistemological sophistication (RCI).
- UDAES’ goal was to test this combination as a viable method for longitudinal study of learning achieved through undergraduate research.

Select Preliminary Longitudinal Study Results - 1

- Personality: Although overall, students decreased in neuroticism and increased in openness to experience, no significant differences were found between UR and non-UR students
- CSEQ: UR students perceived greater increases for themselves than did non-UR students in
  -- academic effort (this self-reported information was also reflected in students’ course registrations)
  -- scientific and technological skills

Faculty survey publication:

Select Preliminary Longitudinal Results - 2

- **WGCTA:** Biological/Physical Sciences/Chemical Engineering majors with intensive research involvement showed larger increase over 4 years in critical thinking (logic) than did non-research students in these majors.

- **RCI:**
  1. Biological/Social Science majors with intensive research involvement showed larger increase in reflective judgment over 3 years than did majors in these subjects with a smaller amount of research or no research experience.
  2. Women with intensive research involvement showed higher gains in reflective judgment over 3 years than women with a smaller amount of research or no research experience.

Longitudinal Study: Some Preliminary Recommendations

- Conduct similar studies at institutions where there is a larger N overall and especially a larger N of high-achieving students who do not do research.
- Develop a new paper/pencil self-report inventory of general cognitive and psycho-social skills to replace the lengthy CSEQ.
- Add a general test of motivation in the first and final years.
- Eliminate WGCTA, and administer RCI using new test dilemmas with content appropriate to students’ disciplinary interest.

Impact of Assessment -- 1

- Improvements in UG research programs
  - Confirmed emphasis on early involvement
  - Increased participation in Senior Thesis
  - Greater recognition of role of graduate students
  - Increased participation of students and faculty in UG research
  - Added support for PBL and other efforts to infuse research throughout UG experience

Impact of Assessment -- 2

- Development of new/expanded UG research programs at the University of Delaware
  - New NSF REU sites in ChE and CE
  - Delaware Biotechnology Institute
  - McNair, HHMI, others
- Increased funding for UG research experiences at UD

Longitudinal Study--Some Limitations

- Sample size (limited number of analyses with statistical power)
- Only one institution; only science and engineering students (limited ability to generalize)
- Epistemological test dilemmas needed with scientific/technological content (possible limit in ability to engage interest of some students)
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Impact of Assessment -- 3

- Increased visibility of UG research at UD
- Leadership role for UD in national discussions of UG research and assessment
- Enhancement of University reputation
- Benefits for student recruiting
  - Prospective undergraduates
  - New graduate students via REU sites