PURDUE UNIVERSITY
Discovery Park

How do Summer Undergraduate Research Experiences Compare to Other Models?

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Outline

- Introduction
- The problem
- The study
- Method
- Analysis, findings, implications & future directions

What is URE?

- URE means different things to different people depending on the discipline, scope of work, purpose, etc.

- **Most common definition:**

  "URE is an inquiry or investigation conducted by an undergraduate that makes an original intellectual or creative contribution to the discipline" (Halstead, 1997)

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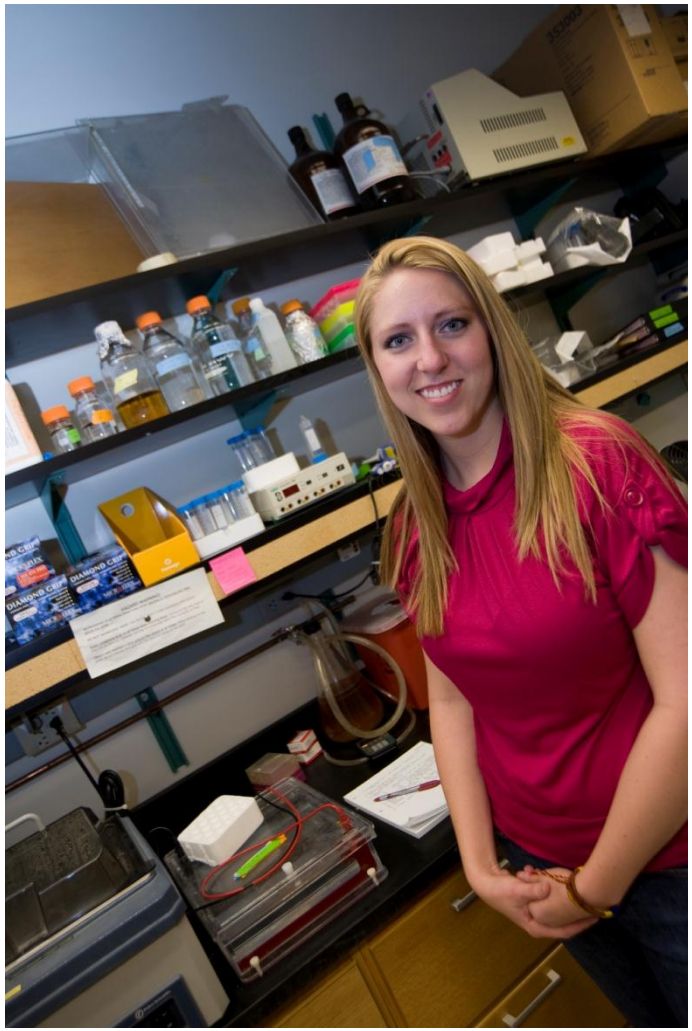
Benefits of UREs

- Enhanced research skills, research self-efficacy & understanding of scientific processes
- Expansion of the STEM pipeline
  - *Retention & graduation of racial and gender minority students*
  - *Enhanced interest in graduate education and careers in STEM areas*
- Enhanced communication & critical thinking skills



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Gaps in the evaluation of URE programs

- Lack of rigorous evaluation
  - Focus is more on outcomes and less on process
  - Black-box models of evaluation
- Evaluation strategies that do not account for differences in program:
  - aims, goals and expected student &institutional outcomes
  - contexts, structures and processes
  - models, components and dynamics
  - duration

Examples of factors influencing gains to students

- Degree of immersion in the culture of research
  - Extent of socialization into research activities (e.g., authoring journals)
- Duration of research experiences
- Types of research activities involved in
  - Menial or “real” research
- Contextual differences
  - Discipline/field
  - Model of URE employed

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Examples of URE Program Conceptual Models

- Mentor-colleague model
  - Student develops a close one-on-one working relationship with the faculty
- Hierarchical model
  - Student is supervised by a researcher who is supervised by the faculty
- Contractual model
  - Faculty “specify tasks in advance with deadlines clearly delineated”
- Apprenticeship model
  - Student (novice) studies under the tutelage of a faculty expert)

Current Study

- Examine & compare gains & benefits among 4 groups :
  - Summer only
  - 1 academic semester
  - 2 academic semesters
  - Full calendar year

- Nonequivalent pre-post control group design to compare outcomes
  - Non-random (self) selection into groups
  - 122 participants in two URE programs

Design & Procedures

- Description of programs
  - Similar in structure & requirements
    - GPA of 3.0 or greater
    - Seminar class in the academic semesters
    - Peer or faculty led discussions in the summer
    - The same assessment instruments
    - CPIP built on DURI model
    - Administered by the same research center

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Program Differences

	Program A	Program B
Duration	Twelve month internship	Academic/summer session with potential to extend for 12 mths.
Focus	Interdisciplinary cancer research	Interdisciplinary STEM research in general
Add-ons	Service learning component	NA
Other	Formal interactions with graduate students	Informal interactions with graduate students

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Participants (N=122)

Descriptions		n	%
Gender	Male	58	47.50
	Female	64	52.50
Academic standing	Sophomore	20	16.40
	Junior	39	31.90
	Senior	63	51.60
Academic major	Engineering & Technology	45	36.90
	Sciences (including health Sc. & Ag.)	65	53.30
	Liberal Arts & Social Sciences	12	9.80

Data Source

- Pre- & post participation survey consisting of attitudinal rating scales
  - (Kardash et al., 2000; Russell, 2005; & Bieschke, Bishop & Garcia, 1996)
- Response categories
  - Strongly disagree =1 to strongly agree =4, *or*
  - No confidence =1 to overconfident = 7

Variables

Variables	Examples	Pre	Post
Research self-efficacy *(5 items)*	*"I have the ability to have a successful career as a researcher"*	0.81	0.85
	"I am confident that I can understand research"		
Understanding of research processes *(6 items)*	*Rate your understanding of: "how to formulate a research question;" "how to plan a research project."*	0.88	0.90
Research skills *(13 items)*	*"Documenting research procedures"*	Treated as single item variables	
	"statistically analyzing data"		
Others	*Aspirations, awareness of career options, etc.*		

Analysis

- Group comparisons of gain scores
  - accrued gains = pre- post scores
- DVR (Dummy Variable Regression)
  - Membership in a group= 1 & non-membership = 0
- DVR vs. ANOVA
  - Both produce identical results for group comparisons
  - DVR is better suited to non-randomized and unequal group designs
  - DVR allows for a direct statistical comparison of groups to a reference group (in this case, the summer group).

Results

Variables	Regression Coefficients		
	1 SMST	*2 SMST*	*Full Year*
Research self-efficacy	0.15 *(.02)*	1.00 *(.15)*	-0.37 *(-.05)*
Understanding of research processes	0.64 *(.06)*	1.45 *(.12)*	**3.75* *(.26)***
Desire to pursue graduate education	-0.05 *(-.02)*	0.12 *(.01)*	-0.09 *(-.03)*
Intention to choose research oriented career	*-0.04 (-.02)*	0.20 *(.08)*	0.20 *(.08)*
Awareness of what grad school may be like	-0.21 *(-.06)*	0.29 *(.10)*	0.23 *(.09)*
Awareness of research career opportunities available	-0.15 *(-.02)*	**0.72* *(.25)***	**1.04* *(.29)***
Awareness of research career options you could specialize in	0.08 *(.03)*	0.49 *(.17))*	**1.24* *(.36)***

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Results

Variables	Regression Coefficients		
	1 SMST	*2 SMST*	*Full Year*
Organizing research ideas in writing	0.24 *(.11)*	0.23 *(.09)*	0.80* *(.26)*
Working independently on research projects	-0.22 *(-.09)*	-0.04 *(-.02)*	0.70* *(.22)*
Conducting a search of lit. for research	0.31 *(.13)*	0.35 *(.14)*	1.10* *(.36)*
Writing a literature review	0.27 *(.10)*	-0.09 *(-.03)*	1.65* *(.45)*
Statistically analyzing data using software	-0.46 *(-.16)*	0.19 *(.06)*	0.45 *(.12)*
Following experimental or research procedures	0.14 *(.06)*	0.37 *(.16)*	0.52 *(.18)*
Writing the results of your experiment/research	0.06 *(.02)*	-0.11 *(-.04)*	0.50 *(.15)*
Orally communicating research results	-0.25 *(-.10)*	0.25 *(.10)*	0.55 *(.17)*
Writing a research paper for publication	0.58 *(.21)*	0.81* *(.28)*	1.30* *(.37)*

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Summary of Results

Summer vs. 1 SMST	Summer vs. 2 SMST	Summer vs. Full Year
No statistically significant differences	1. Awareness of available research careers options	1. Awareness of research career specializations
	2. Writing research papers for publication	2. Awareness of research career options
		3. Understanding of research processes
		3. Organizing research ideas in writing
		4. Working independently on R. projects
		5. Conducting lit. search for research
		6. Writing a literature review
		7. Writing a research paper (publication)

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Conclusions

- Longer-term experiences ***may be*** more beneficial
- *Carter & colleagues:*
  - "[Long-term URE programs] "give students a more in-depth view of research" and "the continuous research experience may also lead to the development of culture, relationships" and other program outcomes *(p.442).*
- Russell & colleagues (2007):
  - Significant correlations between duration of URE and positive outcomes including aspiration for graduate education and research careers.

Limitations and Future Directions

- Self-selection bias
  - A problem common to most URE research & evaluation
- Inability to control for other programmatic and individual factors
  - E.g., accessibility and availability of faculty mentors, individual motivation, etc.
  - Administrative & logistic constraints associated with randomly assigning students to URE programs
  - Wish to explore matching and other alternatives

Summary of Results

- Despite the limitations:
  - The study contributes to the understanding of differential outcomes across URE program structures
    - Could be helpful for identifying best practices and effective URE models
  - The DVR method employed is an example of statistical options when ANOVA assumptions are violated

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Implications for UR STEM Education

- Incorporate UREs *(preferably summer + academic terms)* into STEM programs
  - Integral to the program & not just for the summer
  - Continued interactions with research mentors →
    - enhanced student engagement, success & retention
  - Early introduction to UREs is equally important→
    - STEM profession identity & professional networking
    - Opportunities to apply course knowledge to research
    - Enhanced knowledge of methods and research processes for students' majors