ABSTRACT Novel research education models often fail to propagate widely because they typically only include two of four necessary properties to successfully propagate and maintain their impacts: scalability, adaptability, sustainability, and inclusivity. Furthermore, research education models typically address the unmet needs of one stakeholder at a time. First, undergraduates need greater access to limited research opportunities at research-extensive universities. Second, graduate students and postdoctoral scholars need mentoring and management experience to prepare for leadership roles in the next stage of their careers. Third, faculty need to maximize research productivity and recruit future graduate students with sufficient preparation. Fourth, administrators need to stretch their limited resources to support the competing institutional missions of research and education. The Research-Intensive Community (RIC) model developed at Texas A&M University has the properties that are both necessary and sufficient to propagate broadly at research-extensive universities because it turns the competing needs of diverse stakeholders into opportunities. Briefly, instead of a traditional 1-on-1 research apprenticeship, research is performed by a diverse undergraduate research team led by a graduate student or postdoctoral scholar. Research teams are productive because they leverage each undergraduate's unique assets (talents, skills, perspectives, and experiences) to advance the research of the graduate student or postdoctoral scholar. Team leaders meet monthly to discuss best practices for leadership and mentoring that increase their own research productivity through effective team management. Because team leaders are empowered to run their team by their faculty mentors, economies of scale are leveraged to efficiently centralize program marketing, participant registration, project advertisement, and program evaluation. Since 2016, the Aggie Research Program (ARP) has implemented the RIC model to cultivate mutually beneficial relationships to meet the diverse needs of diverse stakeholders. As the ARP has grown, team leader meetings have become a nexus for specific research leadership programs that are either interdisciplinary or focused on specific life science disciplines. The ARP exhibits the necessary and sufficient properties for successful propagation: 1) Scalability: participation has grown 30% each of the first 5 years to currently serve over 800 participants/year 2) Adaptability: research teams are distributed across diverse disciplines in 12 colleges. 3) Sustainability: administrative costs are limited to $50,000/year. 4) Inclusivity: 41% of participants belong to underrepresented groups (financially disadvantaged, first-generation, disabled and underrepresented minorities), which matches the demographics of the undergraduate student population at Texas A&M University.

The Research-Intensive Community Model has the Necessary Properties for Successful Propagation at Research-Extensive Universities

Christopher M. Quick, Andrew C. McNeely, Sarah N. Gatson

Departments of Veterinary Physiology & Pharmacology and Sociology, Texas A&M University

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Challenge

Characteristics for Successful Propagation

Novel research education programs are difficult to propagate at research-extensive universities, because they cannot simultaneously maintain four critical characteristics:

- Scalability
- Adaptability
- Sustainability
- Inclusivity

Unmet Needs of Diverse Stakeholders

Research education programs impact multiple stakeholders:

- **Undergraduates** need greater access to limited research opportunities at research-extensive universities
- **Graduate students and postdoctoral scholars** need mentoring and management experience to prepare for leadership roles in the next stage of their careers
- **Faculty** need to maximize research productivity and recruit future graduate students with sufficient preparation
- **Administrators** need to stretch their limited resources to support the competing institutional missions of research and education

Need for a New Research Education Model

Traditional 1-on-1 research apprenticeship limits participation

- 1-on-1 mentoring limits total undergraduate research opportunities supported at most research-extensive universities
- High demand for undergraduate research opportunities makes it unnecessary to recruit broadly
- Undergraduates are selected to minimize apparent deficits which encourages "deficit framework"

Professional development can limit research productivity

- Limited timeframe for undergraduate research limits development of the full set of critical competencies, encouraging adoption of inauthentic projects that are "appropriate for undergraduates"
- Research mentors do not realize a favorable return on investment in undergraduate research
- Graduate and Postdoctoral professional development programs can take time away from producing research

Conflicts Inherent in Standard Models

- Poor integration of research and education put them in conflict.
- Meeting needs of some stakeholders come at cost cost of other stakeholders
- Financial incentives turns opportunities into finite resources that must be reserved to those with the most "merit"

Fundamental conflicts make research education programs small, expensive, and exclusive

Approach

Research-Intensive Community Model

Research is performed by a diverse undergraduate research team led by a graduate student, postdoctoral scholar, or junior faculty member. Research teams are productive because they leverage each undergraduate's unique assets (talents, skills, perspectives, and experiences) to advance the research of the Team Leader. Team leaders meet monthly to discuss best practices for increasing their own research productivity through effective team leadership. Because team leaders are empowered to run their team, economies of scale are leveraged to efficiently centralize program marketing, participant registration, project advertisement, and program evaluation.

Research-Intensive Community Benefits

Collaborative research teams broadens participation

- Research teams creates a large number of undergraduate research opportunities
- High demand for undergraduate researchers motivates efforts to recruit broadly
- Undergraduates selected for their unique strengths which encourages asset models and leadership

Professional development increases research productivity

- Recruiting undergraduates to replace those that leave allows team competencies to be cultivated over the course of multiple semesters as they work collaboratively to advance the Team Leader's research
- Efficiently mentoring a diverse, multilevel team of undergraduates produces a favorable return on investment may the team leader
- Graduate and postdoctoral professional development increases team efficiency and effectiveness which increases research productivity

RIC Model Resolves Fundamental Conflicts

- Fully integrating research and education make them synergistic
- Stakeholders with complementary unmet needs create mutually-beneficial partnerships
- Financial incentives are unnecessary, and opportunities are expanded for everyone

Resolving fundamental conflicts can make research education programs large, inexpensive, and inclusive.

Impact

ARP
Aggie Research Program

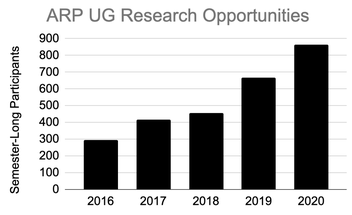
Since 2016, the Aggie Research Program has implemented the RIC model to cultivate mutually beneficial relationships to meet the diverse needs of diverse stakeholders. As the ARP has grown, team leader meetings have become a nexus for research leadership programs.

RESEARCH LEADERSHIP PROGRAMS

- Aggie Research Mentoring Program
- DeBakey Executive Research Leadership Program
- Neuroscience Research Leadership Program
- Genetics & Genomics Research Leadership Program
- Addiction Science Leadership Program

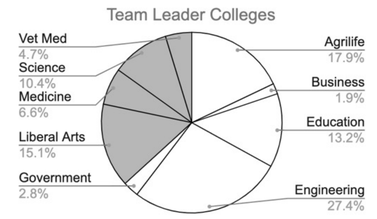
Scalability

Participation has grown 30% each of the first 5 years



Adaptability

Research teams are distributed across diverse disciplines



Sustainability

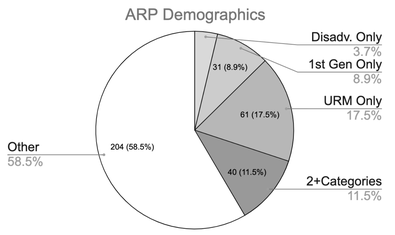
Administrative costs are limited with the activities of Team Leaders

Administrative Cost:
<$50,000/year

Cost per Participant:
<$50

Inclusivity

41% are underrepresented in STEM, matching Texas A&M demographics



Expanding to Other Universities

Besides having the necessary characteristics to propagate, the Aggie Research Program provides infrastructure and support to aid in adoption of the RIC model to other universities.

- Single team leaders at other universities have joined our Team Leader meetings to leverage our existing community
- Graduate students and postdoctoral scholars obtain faculty positions have the working knowledge to reproduce the model
- The ARP Directors Program prepares postdoctoral scholars to reproduce the program at other institutions

REFERENCE: Desai KV, Gatson SN, Stiles T, Laine GA, Stewart RH, Quick CM. Integrating Research and Education at Research-Intensive Universities with Research-Intensive Communities. *Adv Physiol Ed*, 32: 136-141, 2008.

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