

Case Study of Interdisciplinary Student Research Teams:

Factors, Outcomes, And Lessons Learned



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National Science Foundation Science and Technology Center



Center for Science of Information



Create a Community of Practice of young scholars around the emerging field of Science of Information



Pathways for Student Collaboration

Informal

- CSol Member in our Center Network
- Conferences (poster sessions)
- Summer Schools
- Annual Center Meetings

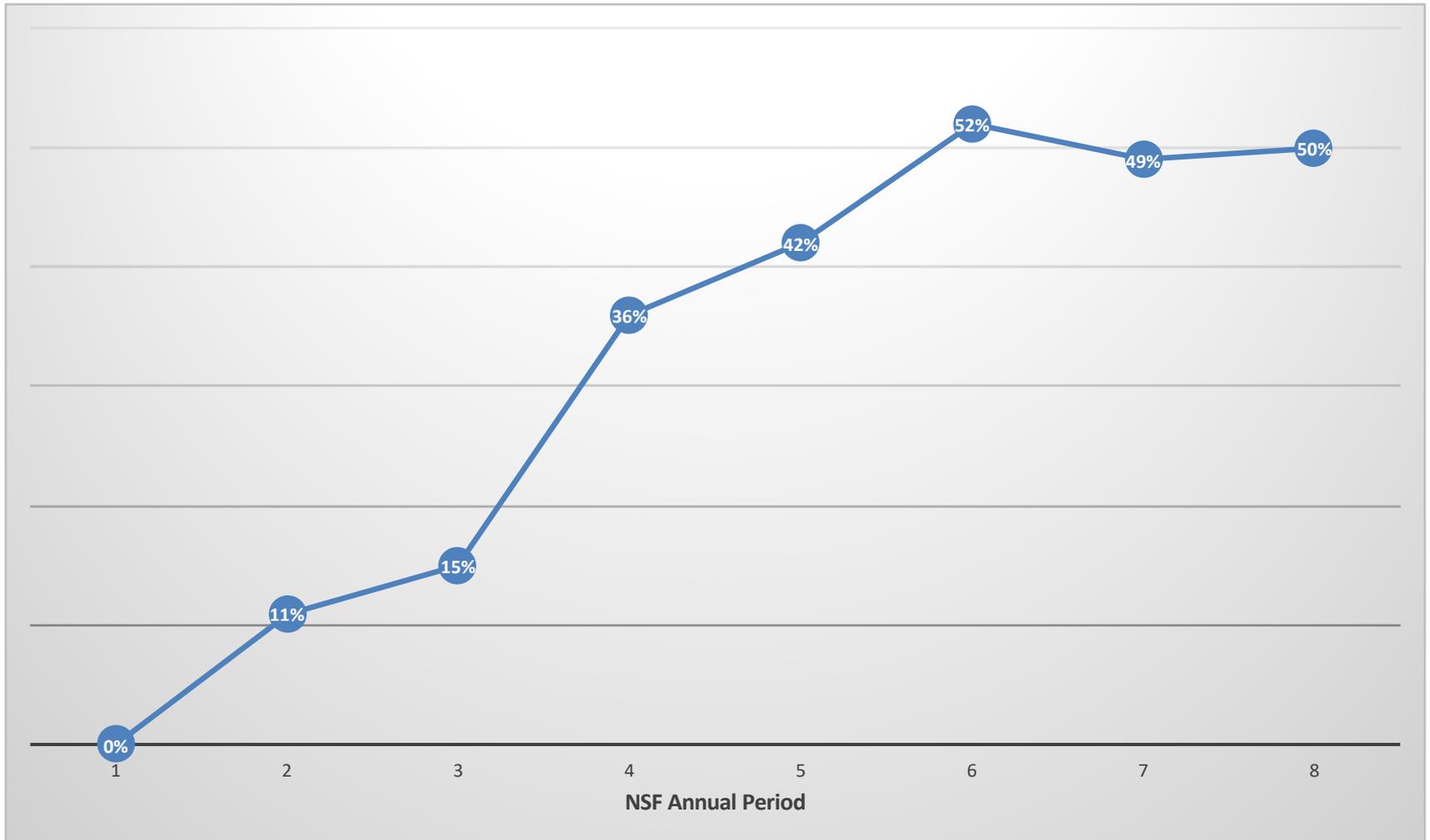
Formal

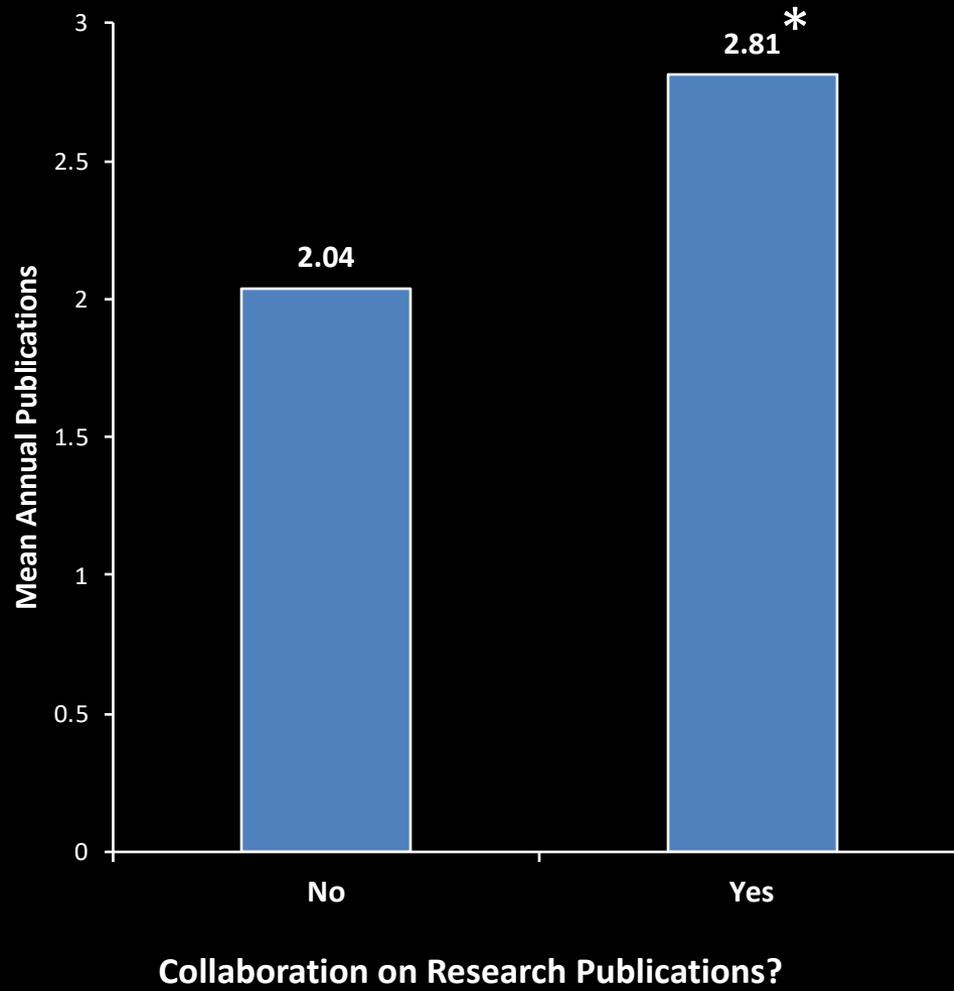
- Faculty Projects
- Co-Advisors
- Student Training Workshops
- Student-led Research Project Teams

Guiding Questions

- Is there a relationship between Center collaboration and scholarly outputs?
- Do factors of funding, university, gender, or length of Center membership influence scholarly outputs or rate of collaboration?
- What can be learned from student research team formation and interactions, and ability to address interdisciplinary questions?
- To what extent can a community of young scholars with large geographic distribution productively collaborate?

Percentage of Graduate Student Members Collaborating on Research with Center members





*n=256, F=11.89, p < 0.001

Factors measured that revealed NO influence on publications

- Funding – whether or not they received their PhD stipends from our Center
- Gender
- University
- Participation Level – number of Center events a student participated in (workshops, schools, seminars, etc.)

Collaboration as Dependent Factor

- None of the independent factors measured revealed any significance in the model

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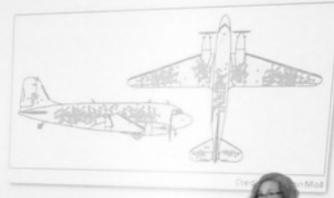
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Training Workshop: Data Science & Interdisciplinary Research Teams



Example



During WWII, statistician Abraham Wald helped the British decide where to add armor to their bombers.

- **Active Learning Based teaching R, other data methods**
- **Focus on their research data**









METHODS FOR
SEPARABILITY OF CLUSTERS

- Can we distinguish between learn conditions using patterns based on brain activity in a region?
- Method: Silhouette Metric for Purity of Clusters
- Compared to random permutation



Professional Development Support

- NSF style proposal
- Roles of each participant
- How does it synergize with their graduate thesis goals
- Blessing and guidance of their respective major professors
- 6K per team for travel and meeting expenses per year

Year-Long Student-Led Teams

- 7 annual workshops
- 14 Student Research Teams
- 21 Universities
- 22 Departments
- 50/50 F/M ratio

Agronomy, Anthropology,
Behavior and Brain Science,
BioEngineering, Biology,
Chemical Engineering, Civil
Engineering, Computational
Biology, Computer
Engineering, Computer
Science, Ecological Science and
Engineering, Electrical and
Computer Engineering,
Electrical Engineering,
Environmental Engineering,
Forestry and Natural
Resources, Geology,
Languages, Mathematics,
Medical, Physics, Sociology,
Statistics



Manak Chowdhury
Stanford University

Flash signaling and noncoherent capacity of wideband SIMO channels

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¹ Stanford University, ² University of Vigo, ³ New York University

Large antenna arrays and wideband channels present challenges for new wireless applications.
 Coherent operation has channel measurement overhead in its operation.
 How does a large number of receive antennas (single input multiple output - SIMO) help in the noncoherent capacity of a wideband channel?
 Do multiplexing independent channels across antennas and frequency bins (channel statistics are known at the Tx and Rx (i.e. multiplexed setting)).
 Channel changes every symbol time (coherence time = 1).

Channel capacity result
 One transmit antenna, or receive antennas.
 Number of active frequency bins B .
 Total power is P , power can be spread over B bins.
 Flash signaling.
 Flash K , large n multiple noncoherent massive antenna arrays.
 Flash n , large B , wideband from antenna array.
 One approach [1].
 large n , large B . One large n and B with $B \rightarrow \infty$.
 For constant $n > 0$.

Flash signaling
 Flash signaling has short bursts of high intensity signaling.
 "Peakiness" captured by the noise power spectral density (NPSD) $\rho(\omega) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \rho(\omega) e^{j\omega t} dt$.

Our results: achieving wideband capacity
 Signal power across all active frequency bins.
 Rate $R = B \cdot C \left(\frac{P}{B} \right)$.
 Two distinct regimes.
 Figure 1 (L-R): Increasing bandwidth B helps.
 Figure 2 (L-R): Increasing bandwidth B does not help.
 Figure 3 (L-R): Increasing bandwidth B does not help.

Flash signaling and wideband noncoherent capacity
 Known results for single input single output (SISO) channel: increasing bandwidth increases capacity for SISO wideband channel.
 In additive noise channels without fading.
 In additive noise channels with fading (known at receiver).
 In additive noise channels with fading (unknown at receiver) - noncoherent channel.
 With non flash noncoherent signaling, increasing bandwidth does not help beyond a critical bandwidth.
 Flash signaling "makes up" for the lack of channel knowledge.
 Needed only when **overspread**.
 Same scaling achieved by restricting bandwidth usage to bandwidth of $\Theta(n^2)$ with **non-flash** signaling.
 For (scaling law) optimal operation in wideband noncoherent channels:
 When wideband massive SIMO channels are **underspread**, use on-off keying.
 If **overspread** with $n > 0.5$, restrict active bandwidth usage to a subset of size n^2 .
 Future work:
 Multicarrier systems, distributed wideband, correlated channels.

Main take-away
 Massive antenna arrays can help reduce peakiness requirements of optimal signaling in the noncoherent SIMO wideband channel.



Ishak Bhatti
Stanford University

Student-Led Research Team Productivity

- 14 Student-Led Research Project Teams
- 44 Co-authored Conference Posters & Presentations
- 15 Co-authored Journal Papers

Conclusions

- Significant positive relationship exists between Center collaborations by graduate students and their scholarly publication productivity
- Given a range of informal and formal pathways that encourage collaboration – graduate students in our community demonstrate capacity to successfully engage in interdisciplinary research
- Given even small amounts of travel and professional development support, our graduate students have successfully formed a community of practice (despite being geographically dispersed)
- This collaborative approach developed during graduate study appears to continue as they matriculate to post-doctoral and faculty positions

Questions?

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Made possible by grant NSF CCF-0939370