Research Engineer Network: A Network Analysis of Graduate Student Relationships

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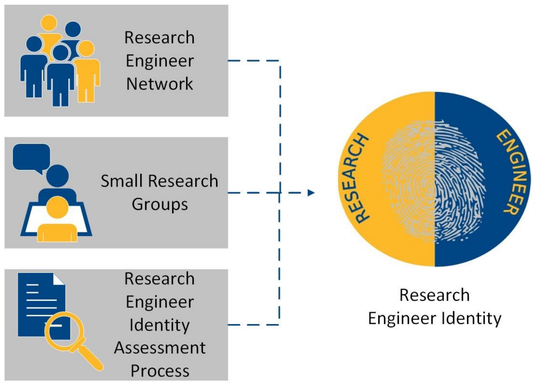
THE GRID PROGRAM @ NCAT

Innovations in Graduate Education (IGE)



Graduate Research Engineer Identity Program

- Initiative stemming from our NSF IGE funding.
- Lectures and activities designed to prepare graduate students for research-based careers.
- Includes seminars on research skills development, networking, mentoring.
- Primarily for engineering students; open to all graduate students, though.

RESEARCH QUESTIONS

Q1. Is there a relationship between **the network relationships** between students, **their bridging and bonding social capital**, and their **sense of identity as research engineers**?

Q2. Do students who participate in **larger cliques** also showcase higher levels of research engineer identity scores?

SURVEY ADMINISTRATION

Pilot study over three waves.

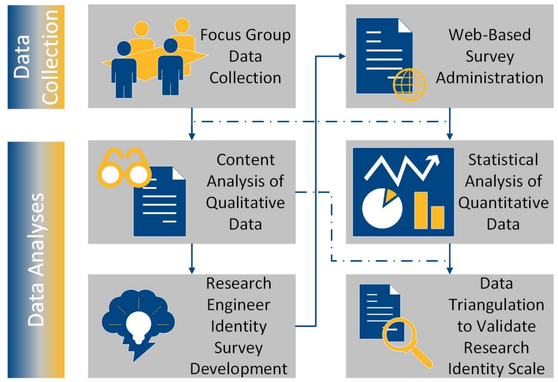
1. Sample 1: from mentoring program.
2. Sample 2: from Fall 2020 GRID.
3. Sample 3: outside GRID, but with matching characteristics.

- Total: N=86; Response rate: 51%

METHODS

Measure development

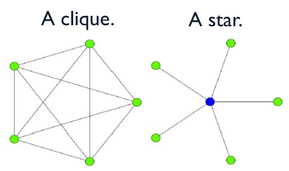
- Goal: develop a **Research Engineer Identity Scale** (REIS).



- 7 focus groups with 51 Research Engineers from academia and industry.
- Identified key themes related to self-meanings associated with being a research engineer.
- Created pool of 36 items; PCA was then used to identify a subgroup of 6 items measuring one dimension of REI (α = .929).

Network analysis

- **Centrality** & **Structure** participation study.
- **Centrality**
  1. Degree.
  2. Betweenness.
  3. Eigenvector.
- **Structures**
  1. Clique.
  2. Induced stars.



$$\begin{aligned} \max \quad & \textstyle\sum_{i \in V} x_i \\ \text{s.t.} \quad & x_i + x_j \le 1, \quad \forall (i,j) \notin E, \\ & x_u = 1, \\ & x_i \in \{0,1\}, \quad \forall i \in V. \end{aligned}$$

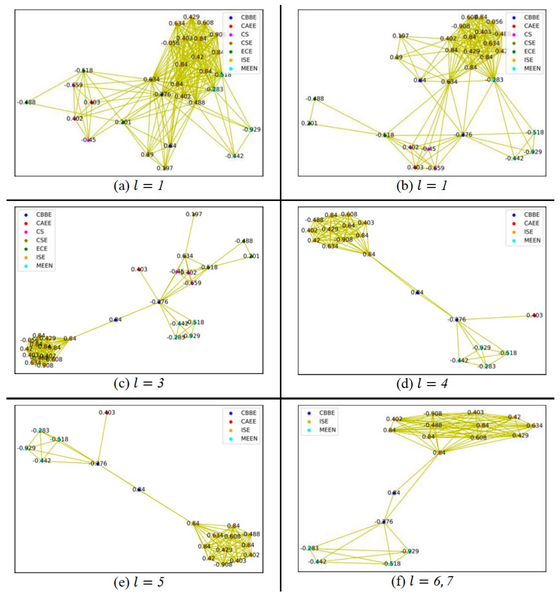
$$\begin{aligned} \max \quad & \textstyle\sum_{i \in V} x_i \\ \text{s.t.} \quad & x_i + x_j \le 1, \quad \forall (i,j) \in E : i \ne u, j \ne u, \\ & x_i = 0, \quad \forall i \in V : (i,u) \notin E, \\ & x_u = 1, \\ & x_i \in \{0,1\}, \quad \forall i \in V. \end{aligned}$$

NETWORK GENERATION

We generate networks $G(V, E)$ as follows:

- V: set of all students that answered 50% of the survey questions or more.
- E: all pairs of students that have registered for at least ℓ classes from the same department.
  - **Indirect** course relationships only.

NETWORKS OBTAINED



RESULTS

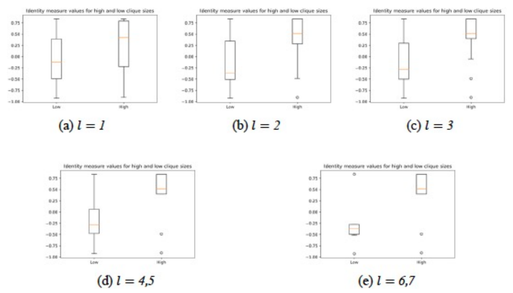
- We calculated the five network analytic values for each of the network setups.
- We then used regression to "predict" the measure of Research Engineer Identity based on centrality & structures.

Structures AIC scores

Network	Star	Clique
$\ell = 1$	55.35	**50.51**
$\ell = 2$	54.85	**48.68**
$\ell = 3$	54.42	**49.77**
$\ell = 4,5$	38.87	**36.20**
$\ell = 6,7$	37.87	**33.86**

Clique always outperforms star for a more parsimonious fit.

Clique

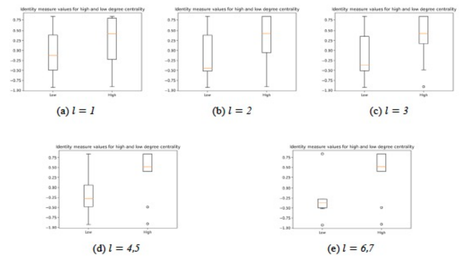


RESULTS (CONT'D)

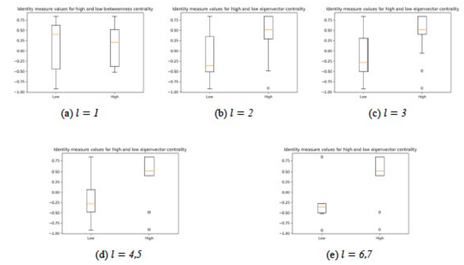
Centrality AIC scores

Network	Betweenness	Degree	Eigenvector
$\ell = 1$	56.36	52.75	**51.23**
$\ell = 2$	55.44	48.99	**47.37**
$\ell = 3$	54.52	50.53	**47.50**
$\ell = 4,5$	38.83	36.22	**34.08**
$\ell = 6,7$	38.11	33.61	**31.97**

- **Degree**



- **Eigenvector**



CONCLUSIONS

- Stricter (larger) values of ℓ lead to better fit models predicting Research Engineer Identity.
- Eigenvector centrality leads to best fit; betweenness centrality to the worst fit.
  - Bonding and bridging social capital together lead to better fit models predicting Research Engineer Identity.
  - Bridging social capital is not sufficient on its own to produce Research Engineer Identity..
- Clique size is a better predictor than Star for Research Engineer Identity.
- **Modeling research engineer identity should have both bonding and bridging social capital considerations.**

Acknowledgment: This research was primarily supported by the National Science Foundation Award # 1856346.