PERSPECTIVES ON APPLYING SOCIAL NETWORK ANALYSIS TO STEM EDUCATION RESEARCH

Host: Melissa Rasberry, EdD
Principal Education Consultant

Moderator: Kyle Fagan, PhD
Researcher

Panelists:

María González-Howard, PhD
Assistant Professor in STEM Education at The University of Texas at Austin

Susan Yonezawa, PhD
Project Research Scientist at UC San Diego–CREATE
Welcome!

*Take a moment to introduce yourself in the chat box.*

Please tell us: your name, organization, and affiliation with the DRK-12 program (e.g., principal investigator [PI], project team member, evaluator, aspiring PI).
DRK-12 Research Methods
Webinar Series

Host: Melissa Rasberry, EdD
Principal Education Consultant
American Institutes for Research
Learning outcomes

In this webinar, participants will:

• Gain a better understanding of the science, technology, engineering, and mathematics (STEM) research questions that can be addressed using social network analysis.

• Learn about the knowledge generated by using social network analysis.

• Learn about common challenges researchers face when using social network analysis.
Today’s webinar

75 minutes

http://cadrek12.org/
Today’s webinar

• Listen-only mode
• Use chat pod to submit content and technical questions at any time
• Opportunity for Q&A at the end of the session
Today’s webinar

• To see this most clearly, you may want to use the “Full Screen” button in the upper right of the presentation pod.

• To submit a question, you will need to click the “Full Screen” button again to resume normal view.
Panelists

María González-Howard, PhD
Assistant Professor in STEM Education
The University of Texas at Austin
mgonzalez-howard@austin.utexas.edu

Susan Yonezawa, PhD
Project Research Scientist
University of California San Diego – CREATE
syonezawa@ucsd.edu

Moderator

Kyle Fagan, PhD
Researcher
American Institutes for Research
kfagan@air.org
Webinar 1. Social Network Analysis: An Introduction


- Introduced and defined key components of social network analysis.
- Described common methods for collecting social network data.
- Presented common measures for analyzing network- and actor-level characteristics.
Webinar 1. Social Network Analysis: An Introduction

**Poll:** Were you able to attend or watch the recording of the first webinar, *Social Network Analysis: An Introduction*?
Introduction to social network analysis

Social network analysis (SNA)

• A way of thinking about social systems that focuses on the relationships among the actors that make up a system.

• A set of methodological techniques that aim to describe and explore patterns apparent in social relationships that individuals and groups form with one another within a given context.
Research spotlight

María González-Howard, PhD
Assistant Professor in STEM Education
The University of Texas at Austin
mgonzalez-howard@austin.utexas.edu
Publications referenced in overview
How have I used social network analysis?

• To capture and characterize the complex, social dimensions of scientific argumentation. Questions I have examined include:
  
  • *How can SNA be used to visualize the interactional nature of argumentation discussions?*
  
  • *What interactional patterns emerge around “critique” during argumentation discussions?*
  
  • *How does the way a teacher frames an argumentation discussion align with students’ engagement in this science practice?*
Conceptualizing scientific argumentation

Structural component

The framework of an argument includes a claim that is supported by evidence and reasoning.

Dialogic component

This component encompasses questioning and critiquing the strength of competing claims, as well as the revision of claims.

This research was funded by National Science Foundation grant DRL-1119584.
Creating sociograms

Step 1
Broke the transcripts into utterances

Step 2
Coded the utterances across the structural and dialogic components of argumentation, as well as ties between turns of talk

Step 3
Created valued, directed matrices

Step 4
Inputted all matrices into UCINET 6, and then used NetDraw (a visualization tool within UCINET 6) to create sociograms

This research was funded by National Science Foundation grant DRL-1119584.
Creating sociograms (Step 1 and Step 2)

Table 6: Coding Scheme for Dialogic Interactions

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Example¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questioning</td>
<td>Asking about some aspect of the discussion</td>
<td>“Does training to become an athlete cause you to have more mitochondria or bigger mitochondria?”</td>
</tr>
<tr>
<td>Critiquing</td>
<td>Evaluating some aspect of the discussion, which may include feedback</td>
<td>“I think the experiment where your data comes from is flawed... Just because they’re twins doesn’t mean their bodies are the same.”</td>
</tr>
<tr>
<td>Building on someone’s ideas</td>
<td>Recognizing some aspect of a previous contribution and utilizing it to further the discussion</td>
<td>“Both of those are good points, and I actually think it’s those two factors combined. So an athlete’s body is better at releasing energy because of a combination of a larger lung capacity, and more mitochondria.”</td>
</tr>
<tr>
<td>Other</td>
<td>All other utterances not included in the three previous codes for dialogic interactions</td>
<td>“I wasn’t able to complete the simulation test of the athletic and non-athletic twins.”</td>
</tr>
</tbody>
</table>

¹Examples are embedded in the context of the Metabolism science seminar.

This research was funded by National Science Foundation grant DRL-1119584.
Creating sociograms (Step 3)

This research was funded by National Science Foundation grant DRL-1119584.
Creating sociograms (Step 4)
Visualizing scientific argumentation through sociograms
Visualizing scientific argumentation through sociograms

Group 1

Group 2

Size Key

0  17
1  8

Size Key

0  28
1  23
Visualizing scientific argumentation through sociograms

Group 1

Group 2

Size Key

Size Key
Potential use of SNA for future discourse research

• To study change in classroom discourse patterns over time (e.g., exploring the ways sociograms developed from classroom discussions at different time points of the school year change).

• To examine factors (e.g., race, gender, language[s] spoken) and how they might relate to engagement in classroom discourse.

• To support teacher and student learning (e.g., providing sociograms to classroom members to help them examine various aspects related to their own engagement during classroom discourse).
Before we move on, are there any questions?
Research spotlight

Susan Yonezawa, PhD
Project Research Scientist
University of California San Diego – CREATE
syonezawa@ucsd.edu
A social network for regional math teachers

A BMGF-funded project: Yonezawa, Pollock, and Daly
RESEARCH QUESTIONS

1. What are the current state of network connections within and across districts’ mathematics teachers and mathematics leadership?
2. What are the current mathematics struggle points for students and teachers in the elementary and middle school transitional grades; that is, where do kids struggle the most to learn and to retain the mathematics; what are teachers struggling the most to teach well; what are the key leaks in the K–12 “pipeline,” specifically those problems surrounding the elementary to middle school transition point?
3. How can innovative instructional practices and curriculum be shared to improve classroom practice within the network and beyond?
LEARNING TO GROW A NETWORK OF EDUCATORS

• Four-year project funded by the Gates Foundation fostered, tracked, and improved math educator networks across four school districts.

• SDMN learning events engaged hundreds of distinct participants across approximately 30 learning events annually, with many educators returning for multiple events.
SDMN first focused on district “intermediate” resource teachers.

- Network analysis over time revealed that principals were key nodes – seeking and sharing resources and catalyzing teacher participation in learning.
  - **Over time, teachers**, too, emerged in network maps as key influencers in some districts.
<table>
<thead>
<tr>
<th>Network relation</th>
<th>Network question</th>
<th>Interaction scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advice</td>
<td>How often do you typically turn to each individual for advice to strengthen your own mathematics teaching?</td>
<td>Yearly, monthly, weekly, and daily</td>
</tr>
<tr>
<td>Collaboration</td>
<td>How frequently do you collaborate with each individual around strengthening your math teaching (by “collaborate” we mean mutual work, sharing, and exchanging ideas)?</td>
<td>Yearly, monthly, weekly, and daily</td>
</tr>
<tr>
<td>Materials</td>
<td>Please select the frequency of interaction with the individuals from whom you receive instructional materials related to math that you use in your teaching (by “instructional materials” we mean any tangible item you use in your math practice such as worksheets, online tools, manipulatives, assessments, lesson plans, rubrics, or other related materials).</td>
<td>Yearly, monthly, weekly, and daily</td>
</tr>
<tr>
<td>Positive energy</td>
<td>When you interact with this person, how does it typically affect your energy level?</td>
<td>Strongly deenergizing, deenergizing, energizing, strongly energizing, n/a</td>
</tr>
</tbody>
</table>
FINDINGS

As the network became more robust:

• “Instructional support staff” (district office personnel) became the least newly active across the network and had the least amount of growth in interactions.

• Meanwhile, educators were doubling or tripling their ties in network cohesion.
• **RISE OF THE TEACHER** – Teachers developed more connections to one another. Everyday teachers of mathematics were connecting to one another more.

• Diffusion of expertise was occurring, and there were more pathways for concentrated expertise to get to teachers... and thus into the hands of more folks.
Table 4: Network Cohesion Measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Fall 2016 (All participants)</th>
<th>Spring 2018 (All participants)</th>
<th>Fall 2016 (Stayers)</th>
<th>Spring 2018 (Stayers)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advice</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Degree</td>
<td>5.2 ties</td>
<td>9.3 ties</td>
<td>3.9 ties</td>
<td>8.3 ties</td>
</tr>
<tr>
<td>Density</td>
<td>7%</td>
<td>11%</td>
<td>7%</td>
<td>15%</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>0.57</td>
<td>0.39</td>
<td>0.75</td>
<td>0.40</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>14%</td>
<td>18%</td>
<td>9%</td>
<td>19%</td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Degree</td>
<td>4.2 ties</td>
<td>6.7 ties</td>
<td>3.5 ties</td>
<td>5.9 ties</td>
</tr>
<tr>
<td>Density</td>
<td>6%</td>
<td>8%</td>
<td>6%</td>
<td>10%</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>0.70</td>
<td>0.39</td>
<td>0.77</td>
<td>0.44</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>13%</td>
<td>21%</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Degree</td>
<td>2.2 ties</td>
<td>3.8 ties</td>
<td>1.6 ties</td>
<td>3.2 ties</td>
</tr>
<tr>
<td>Density</td>
<td>3%</td>
<td>5%</td>
<td>3%</td>
<td>6%</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>0.84</td>
<td>0.74</td>
<td>0.88</td>
<td>0.74</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>9%</td>
<td>13%</td>
<td>9%</td>
<td>13%</td>
</tr>
<tr>
<td><strong>Positive Energy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Degree</td>
<td>3.6 ties</td>
<td>5.1 ties</td>
<td>2.3 ties</td>
<td>5.1 ties</td>
</tr>
<tr>
<td>Density</td>
<td>5%</td>
<td>9%</td>
<td>4%</td>
<td>9%</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>0.51</td>
<td>0.36</td>
<td>0.78</td>
<td>0.36</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>23%</td>
<td>27%</td>
<td>20%</td>
<td>27%</td>
</tr>
</tbody>
</table>
SAN DIEGO MATH NETWORK

ADVICE, COLLABORATION, AND MATERIALS NETWORKS
Before we move on, are there any questions?
Discussion
Discussion

• What **key things should researchers consider** when designing research using social network analysis?

• What **challenges did you face** using social network analysis, and what guidance would you give someone for **how to address such challenges**?

• What are some **resources or tools** that helped you learn and apply social network analysis?

Add your questions in the chat pod!
Looking forward
Looking forward

Please fill out a feedback survey following the webinar.

Recording will be available soon on the CADRE website.

Look for webinars this summer on systematic literature reviews and meta-analysis.

http://cadrek12.org/
Thank you!

María González-Howard, PhD
Assistant Professor in STEM Education at The University of Texas at Austin
mgonzalez-howard@austin.utexas.edu

Susan Yonezawa, PhD
Project Research Scientist at UC San Diego-CREATE
syonezawa@ucsd.edu

Melissa Rasberry, EdD
Principal Education Consultant
American Institutes for Research (AIR)
mrasberry@air.org

Kyle Fagan, PhD
Researcher
American Institutes for Research (AIR)
kfagan@air.org
THANK YOU
