Connecting the dots: Student social networks in introductory physics labs

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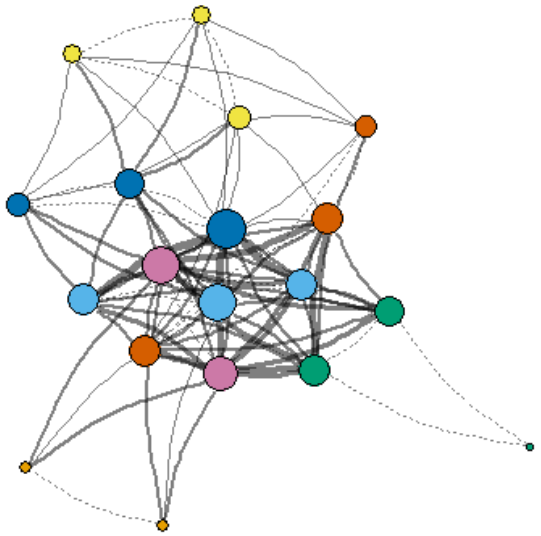
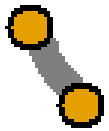




Learning is social

- Learning is intrinsically social in nature (Vygotsky, 1978)
- “Learning [...] occurs as people participate in the sociocultural activities of their community, transforming their understanding, roles and responsibilities as they participate” (Rogoff *et al.,* 1996)
- Prior work in PER has found correlations between students’ positions in their physics social network and:
  - Grades (Bruun and Brewe, 2013)
  - Self-efficacy (Dou *et al.,* 2016)
  - …
- Social network analysis (SNA) has compared network topologies between traditional lecture, modeling instruction (Brewe *et al.,* 2010), and peer instruction classes (Commeford *et al.,* 2019)

Present work

- Undergraduate physics labs provide ample opportunities for students to work together and build a community of learners
- Data:
  - Four weeks of data
  - Groups of 2-3 students that worked at separate lab benches
- We examine the development of social networks over time using **video data**

Study goals

Investigate best ways to analyze video data to extract social network information

Methods

Scan method

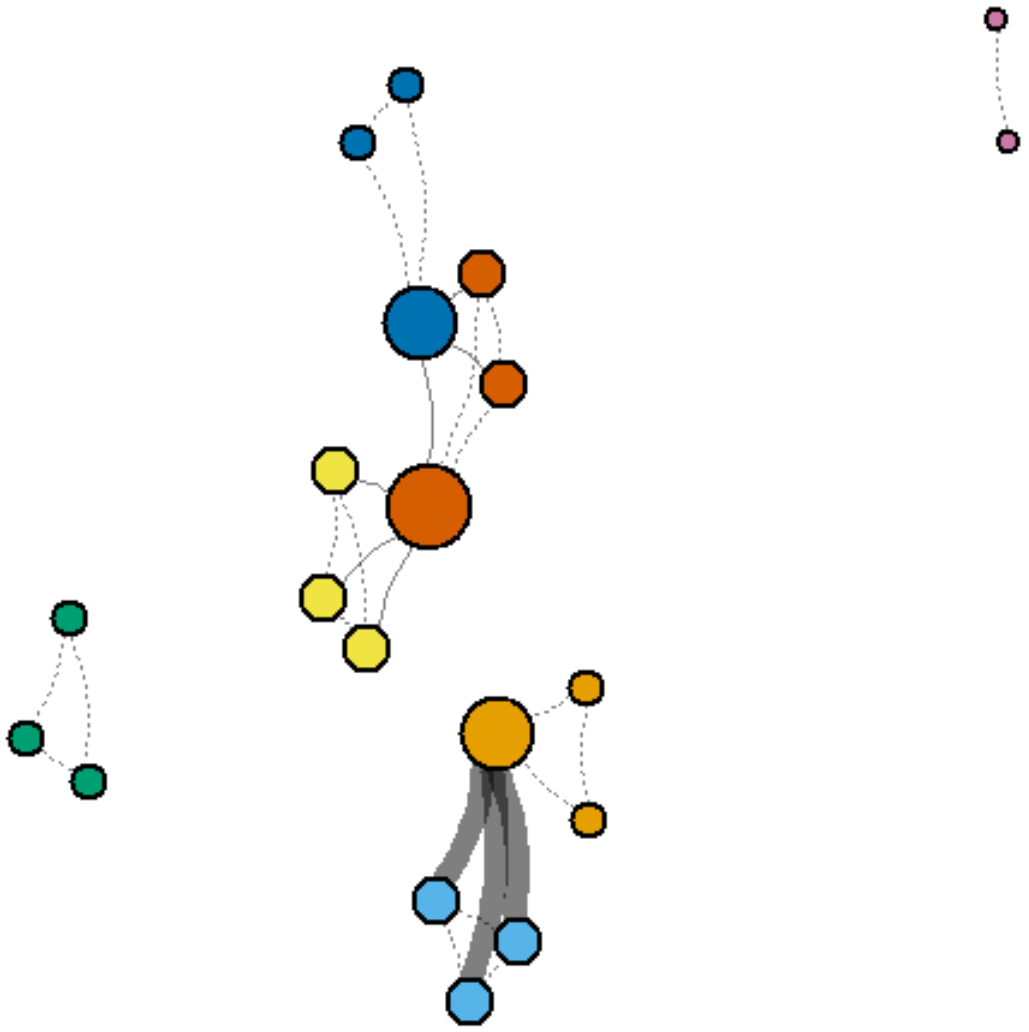
- Scanned through videos of lab session
- Recorded when students moved to a different lab bench
- Students that were physically located at the same lab bench were coded as having "interacted"
- Interactions were recorded in units of time (e.g., minutes)

Skip method

- Recorded which students spoke to each other in 15 second window
- Skipped ahead two minutes, and repeated coding from above
- Only instances where students both spoke to each other were coded as "interactions"
- Interactions were coded in units of counts (i.e., number of interactions)

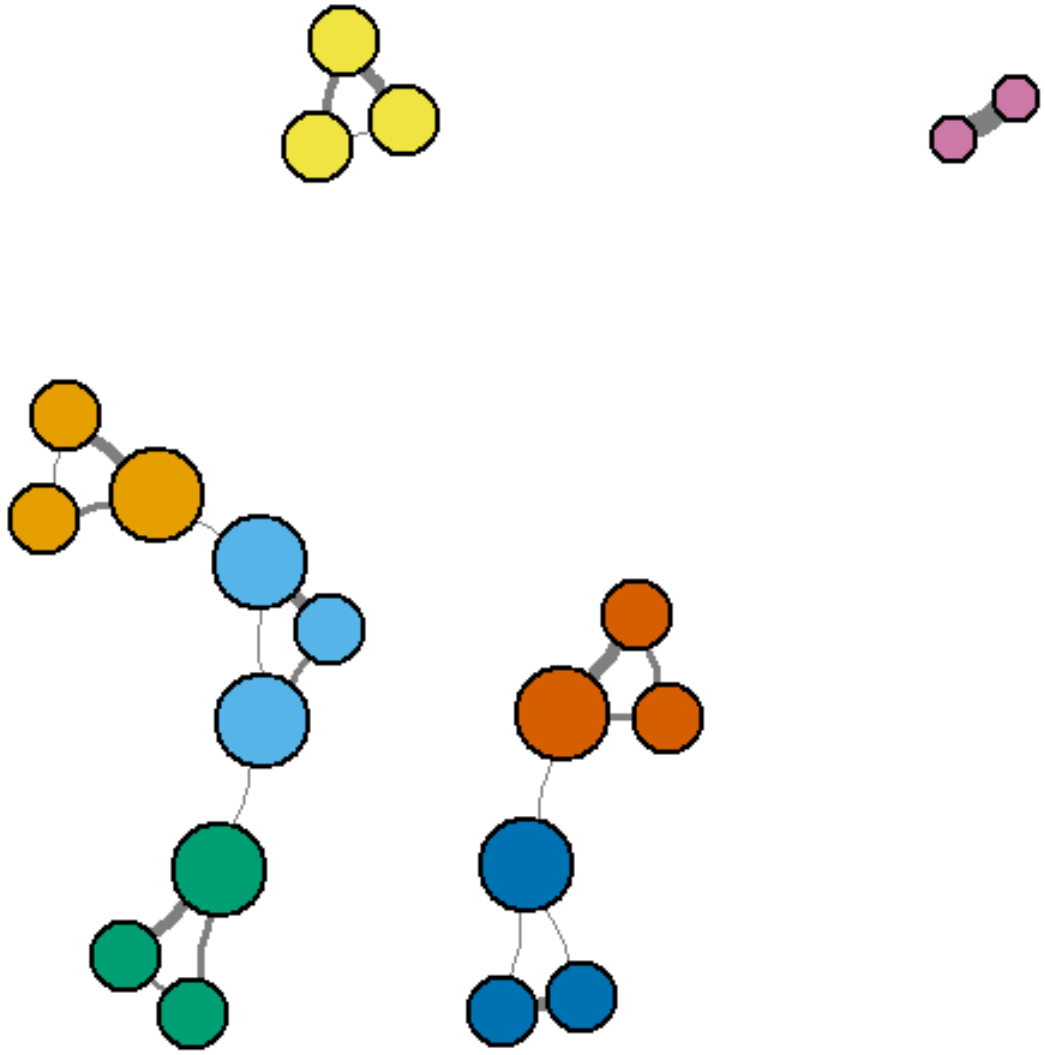
Scan method

- Nodes are students
  - Coloured by group
  - Size proportional to number of connections
- Edge weights are proportional to time spent at the same lab bench
- Set edge weights between group members (dotted lines) to one second



Skip method

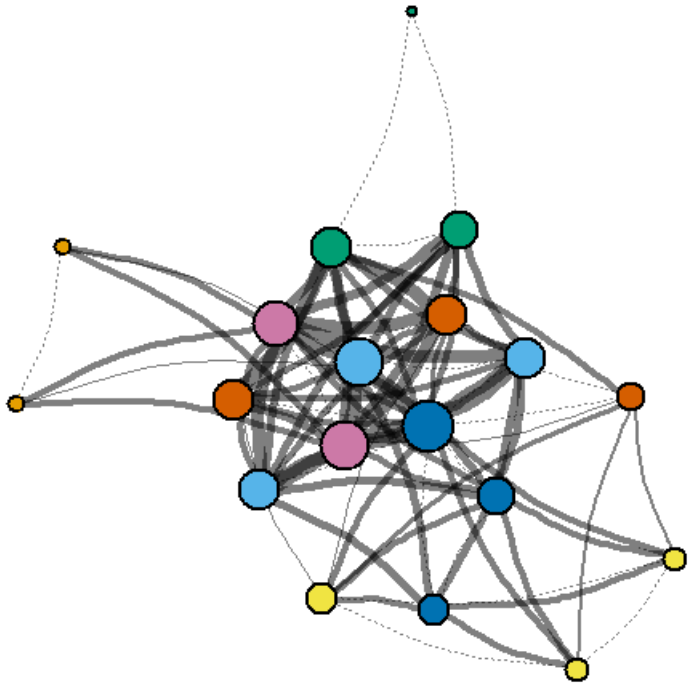
- Nodes are students
  - Coloured by group
  - Size proportional to number of connections
- Edge weights are proportional to number of interactions



Scan vs. *Skip*

Scan

- Advantage: captures most interactions between different groups
- Disadvantage: lose info about who talks to who



Skip

- Advantage: captures who talks to who, particularly within groups
- Disadvantage: miss many interactions between different groups due to skipping

Reliability of coding

2 independent coders, 1 video

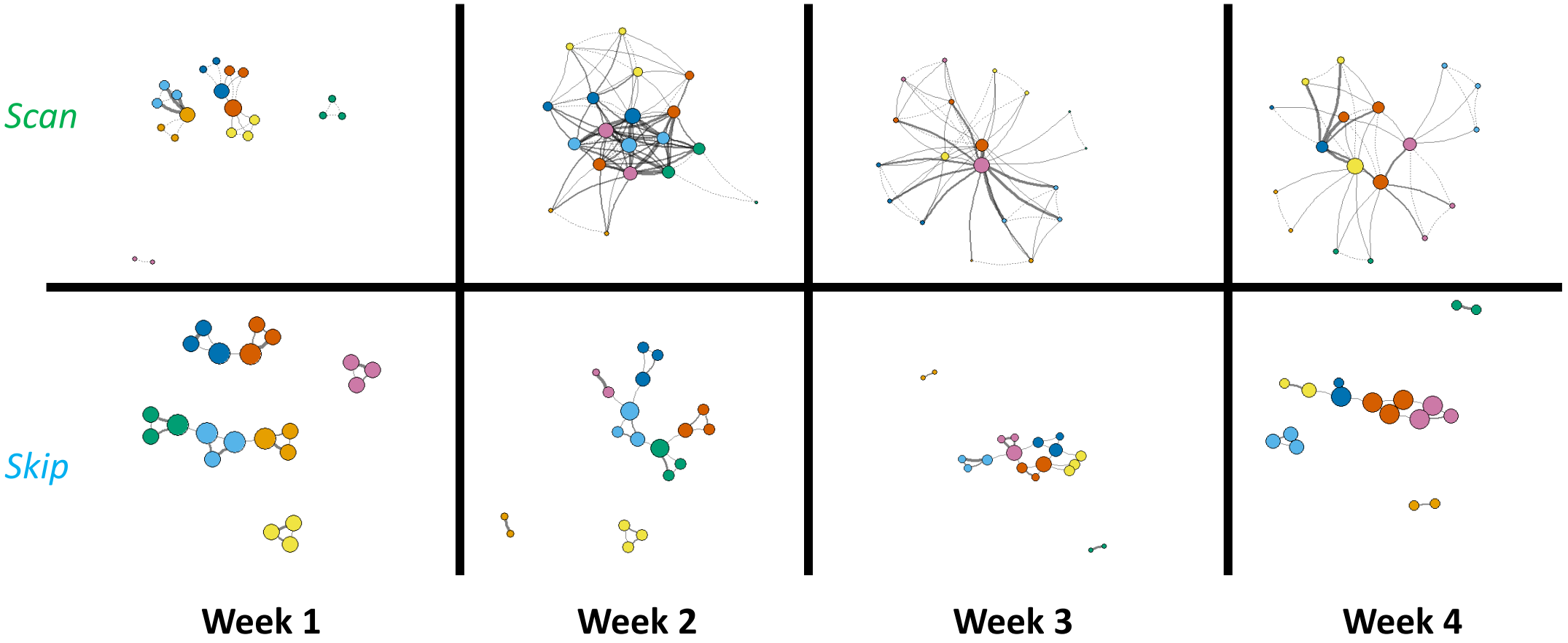
Scan method

- Agreed on existence of 93% of edges
- Agreed on 85% of total edge weights

Skip method

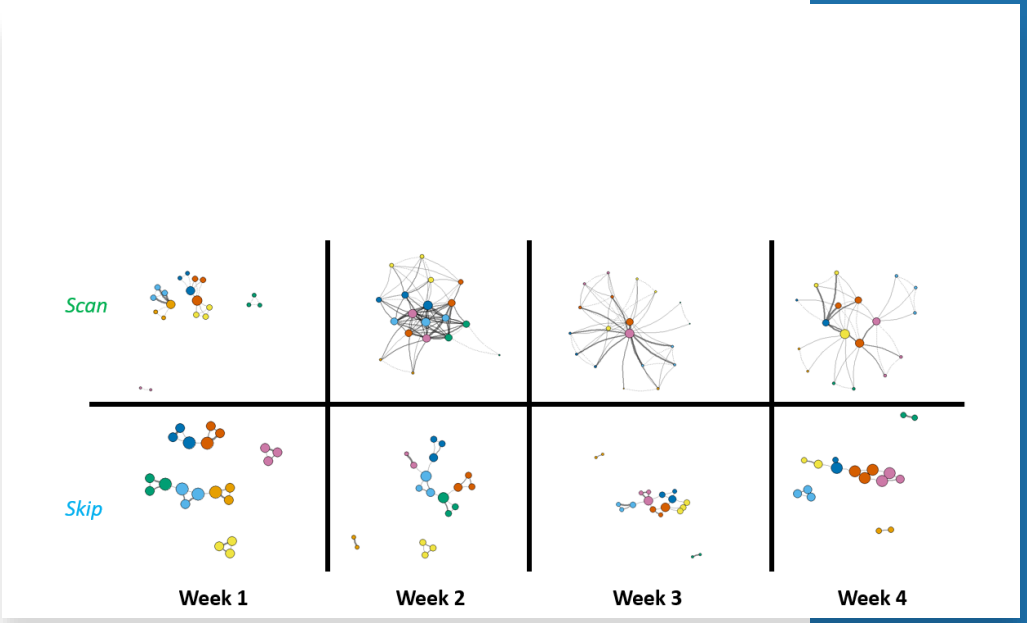
- Agreed on existence of 86% of edges
- Agreed on 83% of total edge weights

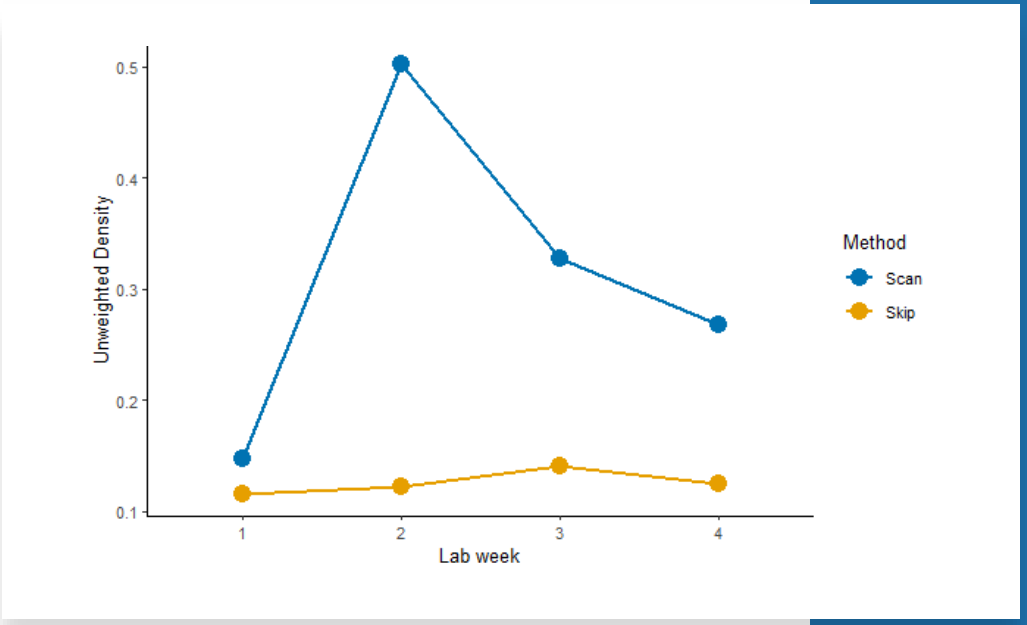
Preliminary data analysis


Scan
Skip
Week 1
Week 2
Week 3
Week 4

Preliminary data analysis

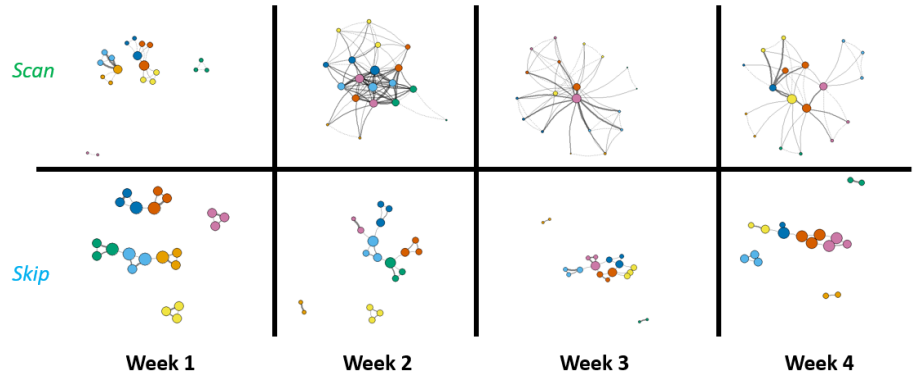
- Network density
  - $\Delta = \frac{number\ of\ present\ edges}{number\ of\ possible\ edges}$
  - **Interpretation:** (Roughly) average fraction of students in the lab that each student interacted with
- *Scan* method captures more interactions
- More student interactions following Week 1

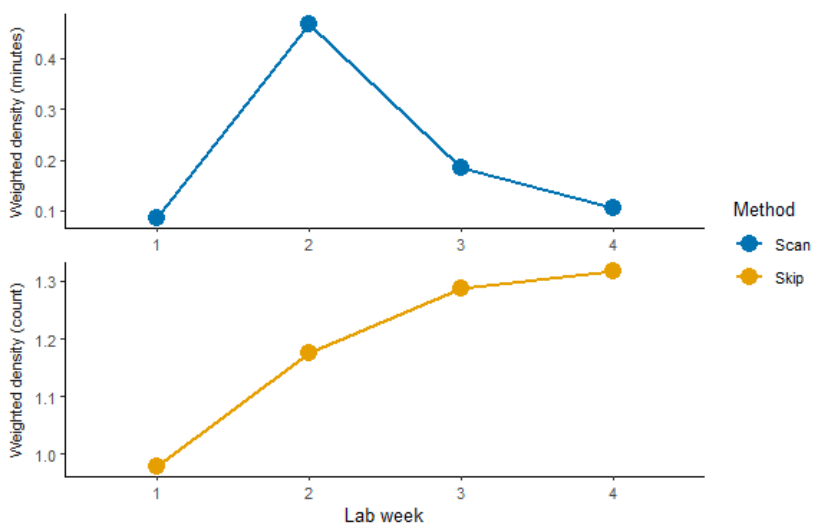




Preliminary data analysis

- Weighted density
  - $\Delta_w = \frac{\sum weight(u,v)}{number\ of\ possible\ edges}$, sum over all pairs of nodes, u and v
  - **Interpretation:** (Roughly) average amount of time that a student interacted with each other student *(Scan* method*)*
  - **Interpretation:** (Roughly) average number of times that a student interacted with each other student *(Skip method)*
- Students are interacting more with their own group members over time (from *Skip* method) and less with other groups (from *Scan* method)





Present and future work

- Focusing on *Scan* method and hybrids of this method due to efficiency and ability to capture larger social structure
- Evaluating development of network topologies over time
- Examining students' positions in the network related to outcome measures