Comparing Network Centrality Measures of Non-Traditional Students in an Introductory Physics Class

Emily N. Sandt  
*Wright State University - Main Campus, sandt.2@wright.edu*

Adrienne L. Traxler  
*Wright State University - Main Campus, adrienne.traxler@wright.edu*

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Emily N. Sandt, Dr. Adrienne L. Traxler
Department of Physics
Email: sandt.2@wright.edu, adrienne.traxler@wright.edu

Goals
• Compare different models of network influence for students
• Research questions:
  1. How do common centrality measures compare when ranking students’ network influence?
  2. Do centrality values of non-traditional students show different trends than traditional students?

Motivation and background
• Social Network Analysis utilizes several different measures to describe a node’s centrality position [1].
• Non-traditional students (age 22+) tend to have fewer on-campus connects and lower retention rates than traditional students [2].
• Social connections toward other students have consequences for long-term retention [3].

Methods
• Data: pre- and post-course survey question:
  o “Who do you work with to learn physics in this class?”
• Course: Calculus-based physics I, lecture format with use of peer instruction, approximately 220 students
• Alluvial diagrams are useful for depicting flow of students between variables [4].

Network representation:
• Students are nodes (i,j,k).
• Undirected links (Rij) between nodes indicate either student reported the pair as study partners.
• Geodesics (dij) are the shortest paths between nodes i and j.
• Links are connections used in centrality calculations:
  o Degree [5]: \( C_D(i) = \sum_{j \neq i} R_{ij} \)
  o Betweenness [5]: \( C_B(i) = \sum_{j<k} \frac{d_{jk}(i)}{d_{jk}}, i \neq j \)
  o Closeness [5]: \( C_C(i) = \left[ \sum_{j \neq i} d(i,j) \right]^{-1} \)
• PageRank [6]: \( C_{PR}(i) = c \sum_{j} C_{PR}(j), i \neq j \)
  • indicates node i’s connections are well-connected

Preliminary results
Pre- and post-course alluvial diagrams of various centrality measures are below. Each diagram shows the shifts in student rankings between the different centrality models. Colors indicate non-traditional (age 22+) and traditional students. Percentiles are binned based on the data’s natural breaking points for low centrality values.

Work in progress
• Determine if non-traditional students’ centrality ranking behavior varies differently from traditional students’ centrality behavior.
  o If so: Is this due to non-traditional students lower overall centrality at pre-course?
• What do the pre/post-course alluvial diagrams and associated centrality distributions look like for other instructors and course formats (smaller class size, SCALE-UP classrooms, etc.) and classes (calculus-based general physics II)?
• What are the implications of large variances for correlating network position with course outcomes?