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Structure and Dynamics of Students Interactions on Online Discussions: A Network Perspective

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- Goal, Background, and Purpose
- Methods and Datasets
- Network Diagrams and Network Measures
- Hypothesis testing: dyadic, node-level, and mixed dyadic/nodal
- Limitations, insights, and conclusions

Goal

Examine patterns of student-to-student interactions on online discussions (comprised of students in 3 graduate nursing programs) to provide insight on design of effective:

- Facilitation mechanisms
- Student teams
- Evaluation mechanisms

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Background (1)

- Effective online discussions are interactive [1]
- Influence of group characteristics
  - Familiarity influences information sharing/integration [2]
  - Communication clusters often are based on comfort [3]
- Importance of communication dynamics [3, 4]
- Communication networks and healthcare outcomes [5]
  - \+ associations between outcomes and density
  - \+ associations between outcomes and centrality
  - — relationships between clustering and outcomes

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Background (2)

- The need for evidence
  - –Few social network analyses (SNA) of online discussion
    - Impact of scaffolding on AOD interactions [6]
    - Associations between network structures and social construction of knowledge [7]
  - – One study of interactions in AOD in health care [8]
  - – Very rare studies of SNA in nursing or nursing education [9]

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Background (3) – an Example Study

Waters & Gasson (2012) [3]

Independent Variables:

Level of instructions (general vs. structured),

posts by instructor

Level of instructor moderation ((low vs. high)

Dependent Variables:

Number of messages and participants in threads

Maximum depth of threads

Behavioral measures :

Peer-to-peer versus broadcast messages

Student-student vs student-instructor interactions.

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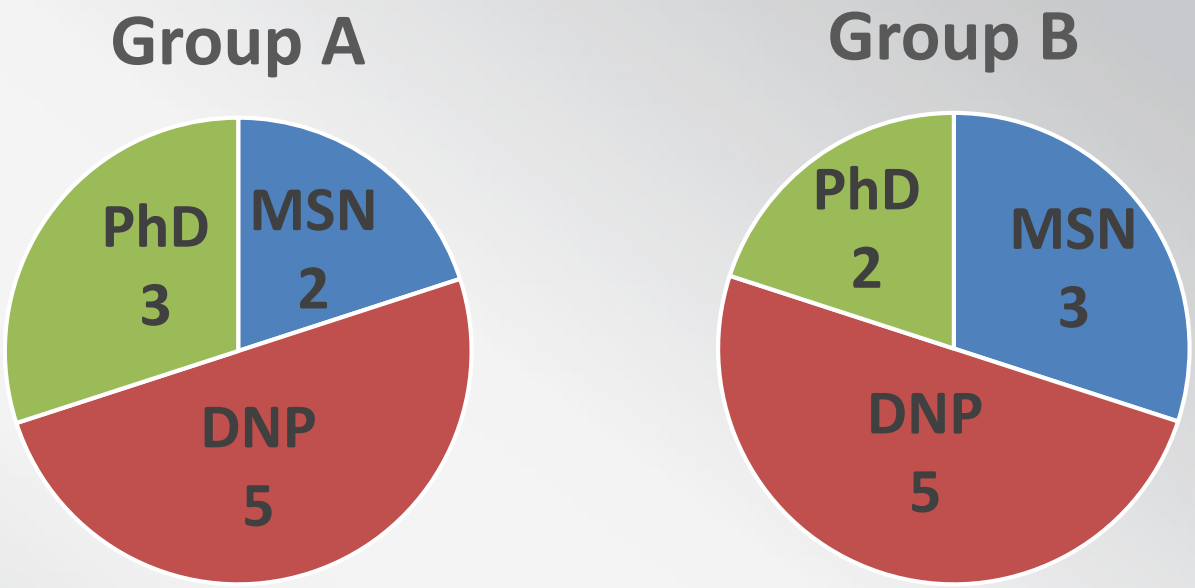
Purposes

1. Describe network structures across the teams' discussions during weeks 2, 3, and 4.

2. Examine the influence of student's membership in a specific nursing program on (1) each student's network characteristics, and on (2) student's commenting interactions.

Program Membership and Interactions in Online Discussions



Instructors purposefully assigned team membership

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Team Discussion Student-to-Student Interaction Matrices

	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	1	0	1	1	0
2	1	0	0	1	0	0	0	0	1	1
3	0	1	0	0	0	0	0	1	1	1
4	0	1	1	0	0	0	2	0	1	0
5	1	1	0	0	0	0	0	0	1	0
6	2	0	1	0	0	0	0	1	1	1
7	0	0	0	1	0	1	0	0	0	0
8	2	1	1	0	0	0	0	0	1	0
9	0	1	0	0	1	0	0	1	0	0
10	1	0	3	2	1	0	0	0	1	0

Team A ↑

Team B →

	11	12	13	14	15	16	17	18	19	20
11	0	0	2	2	2	1	2	3	0	0
12	0	0	1	0	0	0	0	0	1	0
13	2	0	0	0	1	2	1	0	0	0
14	3	0	1	0	2	3	0	2	1	0
15	0	0	1	2	0	1	2	2	0	1
16	1	0	1	4	1	0	2	0	1	0
17	2	0	0	1	1	2	0	0	1	1
18	2	0	0	0	1	1	1	0	1	0
19	1	0	0	1	0	1	0	1	0	0
20	0	0	0	0	1	1	0	1	0	0

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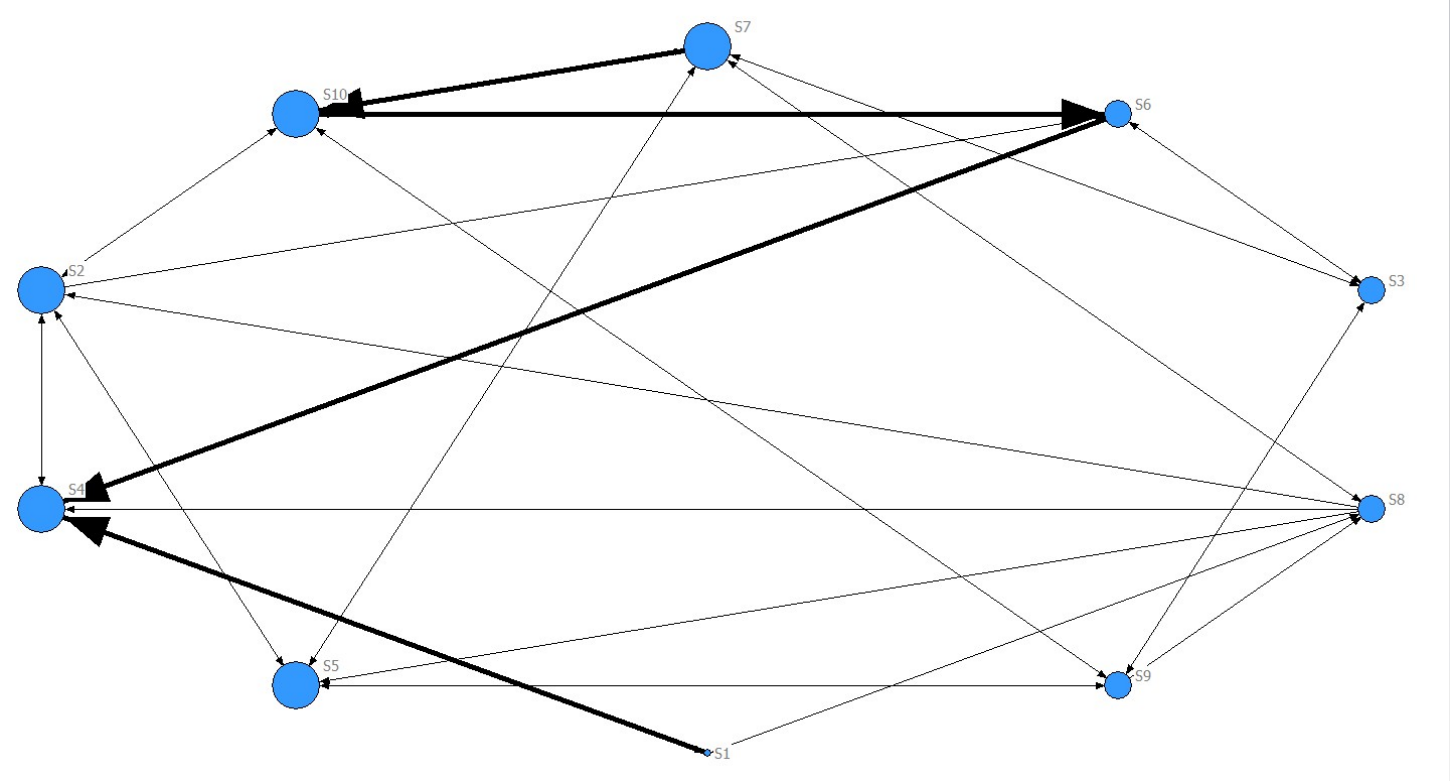
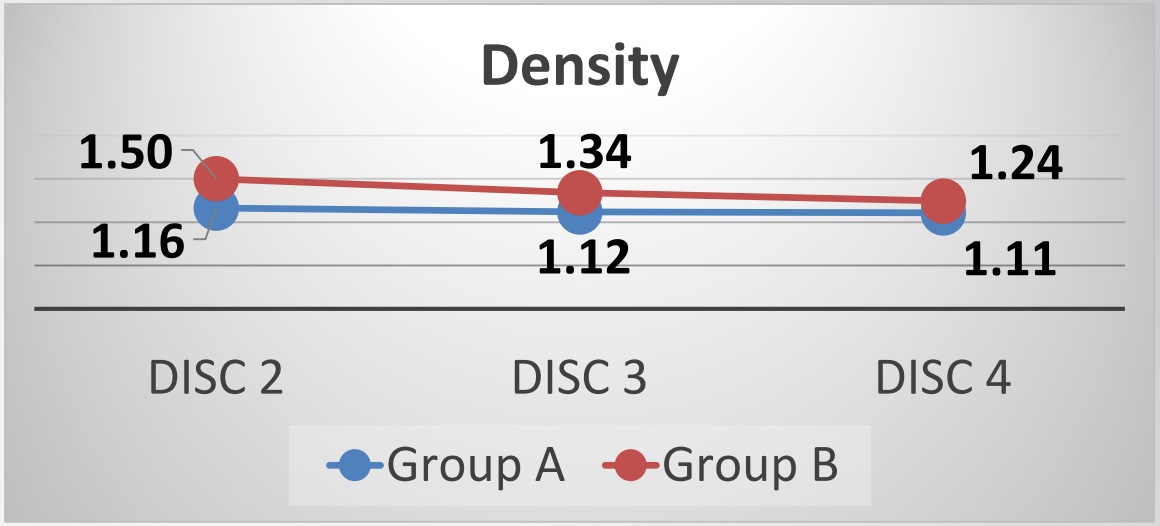
Social Network Analysis

Sociogram depicting *responses* to peer(s) initial posts in one team discussion



Structural Measures - Density



Density Definition:

Extent to which participants are concentrated (cohesion)

relationships actually observed/total # possible relationships

Values shown are normalized measures

Density Findings:

Over the three discussions density decreased in both teams

Higher density values are generally desirable

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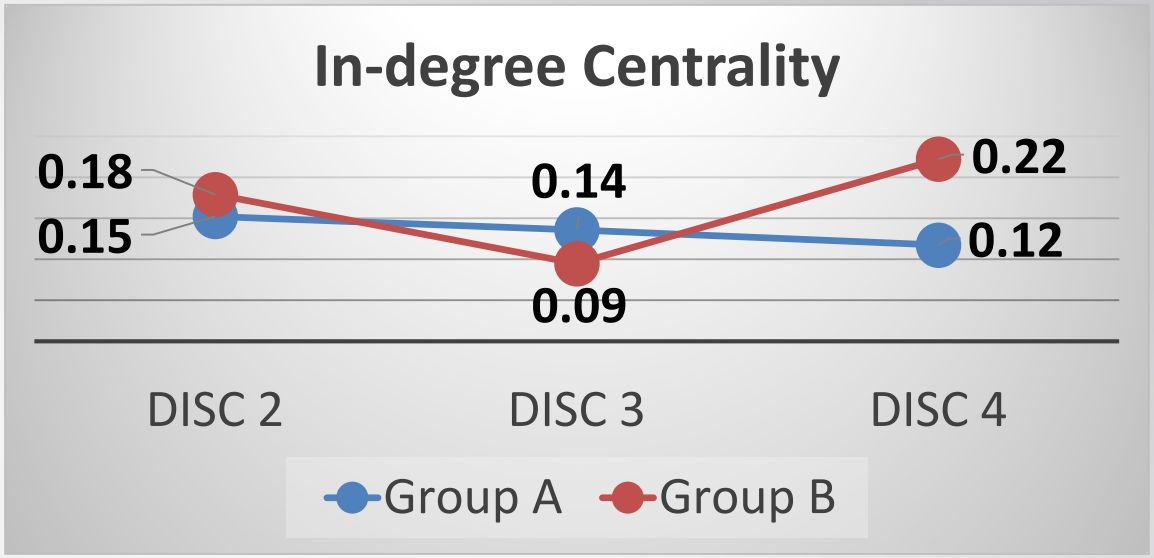
Structural Measures - Centrality



Centrality Definition:

Indicates members positions of power, popularity & prestige

Value shown is for team as whole (possible range 0-1)

Centrality Findings: Overall remained low, which is desirable;

No indication of a high degree of centralized power or any disproportionate attention to a subgroup

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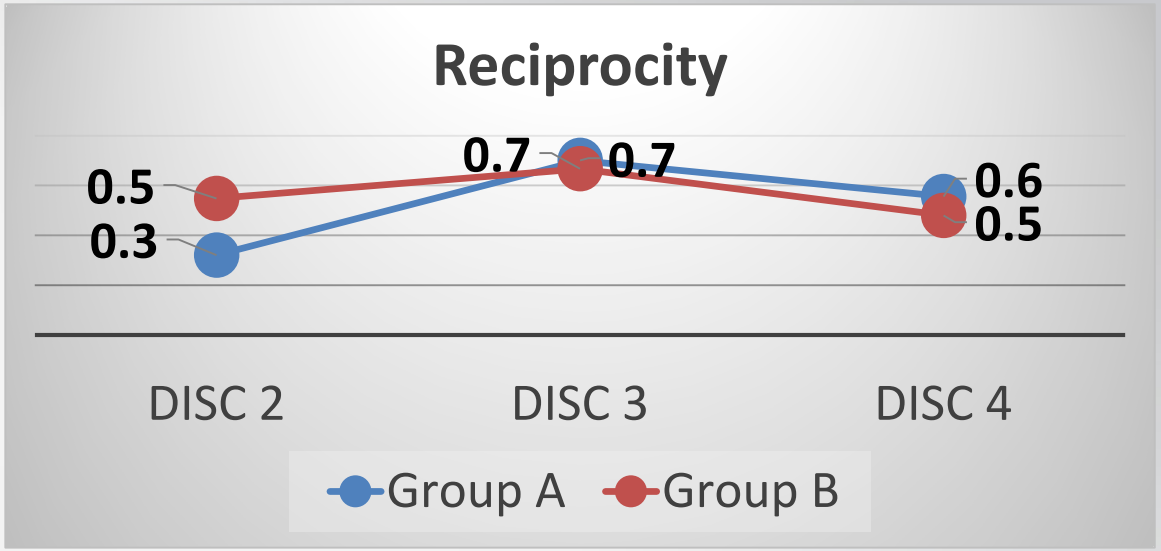
Structural Measures - Reciprocity



Reciprocity Definition:

Extent to which directed relationships are bi-directional (%)

More stable networks have mostly null or reciprocal ties

Reciprocity Findings:

Values in both teams remained moderately high overall

Higher values are not desirable (given our design with no requirement to respond to posts on own thread). Preferable that students engage in meaningful discussion versus only responding to 'those who respond to me'.

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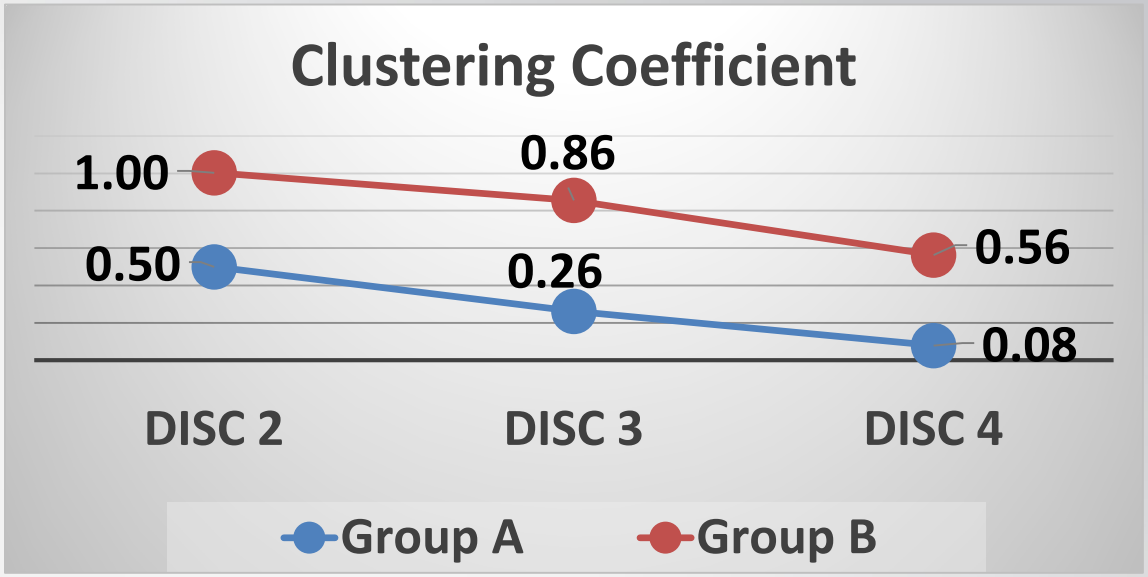
Structural Measure-Clustering Coefficient



Clustering Coefficient Definition:

Identifies cohesive subgroups in a network (possible range 0-1)

Creativity is promoted with a *lower* coefficient

Clustering Coefficient Findings:

Desirable decrease noted in both teams

One team was consistently higher

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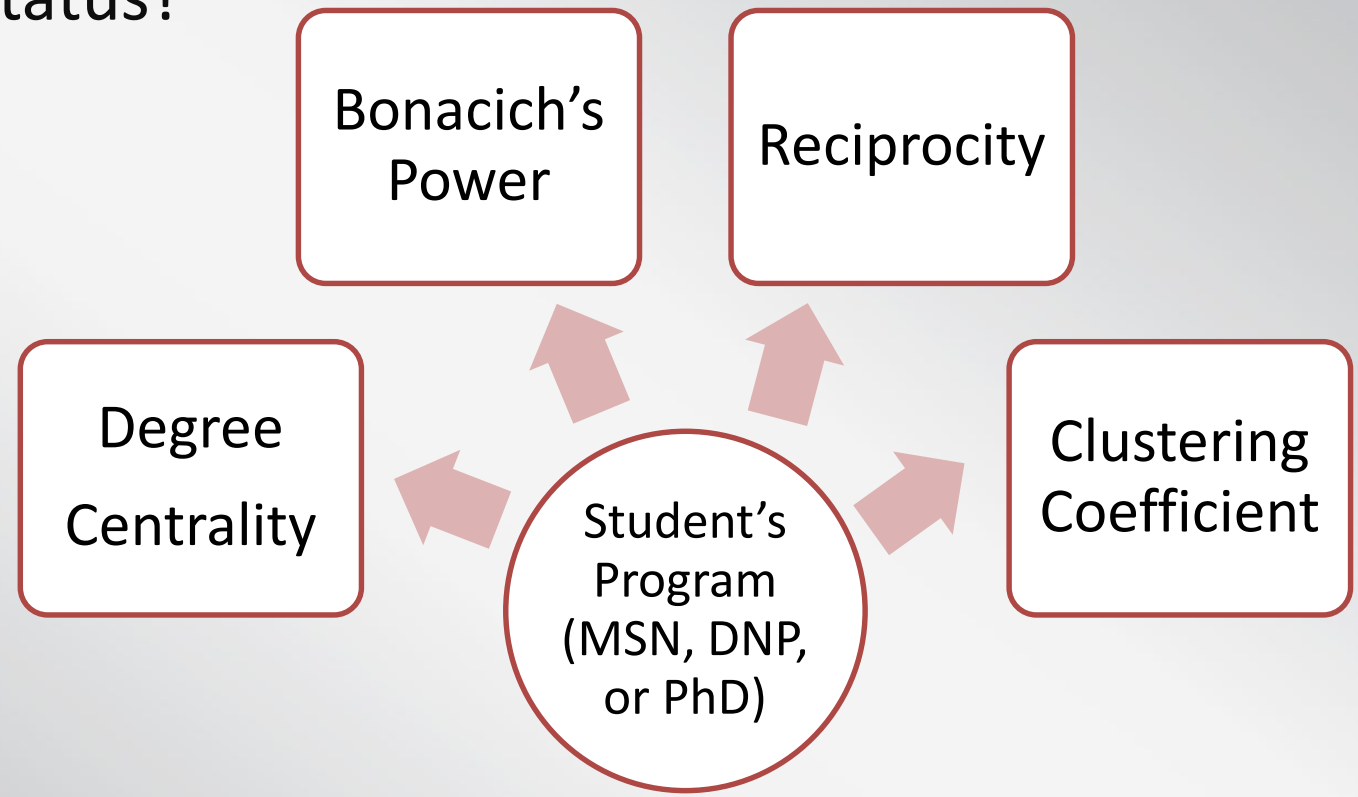
Node-level Analyses (1)

Question: Is there a correlation between the student's program membership and network status?



Node-level Analyses (2)

Degree Centrality

- The extent to which a node receives (in-degree) and posts (out-degree) comments.

Bonacich's Power

- Do I tend to receive comments from students who themselves receive many comments?
- Takes into account not only the number of connections but how well/weak those connections are connected

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Cluster Coefficient
Analysis of Variance - Discussion 2 & 4 in Group B

	Program
s11	DNP
s12	MSN
s13	MSN
s14	PhD
s15	DNP
s16	DNP
s17	DNP
s18	MSN
s19	PhD
s20	DNP

	Program
s11	1
s12	0
s13	0
s14	2
s15	1
s16	1
s17	1
s18	0
s19	2
s20	1

	Bonacich's Power	
	Discussion 2	Discussion 4
s11	1.13	1.13
s12	1.2	0.7
s13	0.62	1.02
s14	0.86	0.36
s15	1.04	0.78
s16	1.16	1.14
s17	1.18	1.43
s18	0.88	0.7
s19	0.32	0.63
s20	1.22	1.5

2B

ANALYSIS OF VARIANCE

Source	DF	SSQ	F-Statistic	Significance
Treatment	2	448844.61	4.8197	0.0456
Error	7	325942.71		
Total	9	774787.33		

R-Square/Eta-Square: 0.579

4B

ANALYSIS OF VARIANCE

Source	DF	SSQ	F-Statistic	Significance
Treatment	2	515339.28	6.4484	0.0218
Error	7	279709.27		
Total	9	795048.55		

R-Square/Eta-Square: 0.648

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Node-level Analyses (3)

Reciprocity

- The extent to which comments are reciprocated

Clustering Coefficient

- The extent to which commentators on a focal student comment on each other's posts.

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Cluster Coefficient
Analysis of Variance - Discussion 2 Group B

	Program
s11	DNP
s12	MSN
s13	MSN
s14	PhD
s15	DNP
s16	DNP
s17	DNP
s18	MSN
s19	PhD
s20	DNP

	Program
s11	1
s12	0
s13	0
s14	2
s15	1
s16	1
s17	1
s18	0
s19	2
s20	1

	Clustering Coefficient
s11	0.6
s12	0.57
s13	0.83
s14	0.53
s15	0.67
s16	0.62
s17	0.71
s18	0.6
s19	0
s20	0.7

ANALYSIS OF VARIANCE

Source	DF	SSQ	F-Statistic	Significance
Treatment	2	0.25	4.5433	0.0218
Error	7	0.19		
Total	9	0.44		

R-Square/Eta-Square: 0.565

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Dyadic Correlations

Question: Are there correlations between discussion matrices and the program membership matrices when compared at dyadic level?

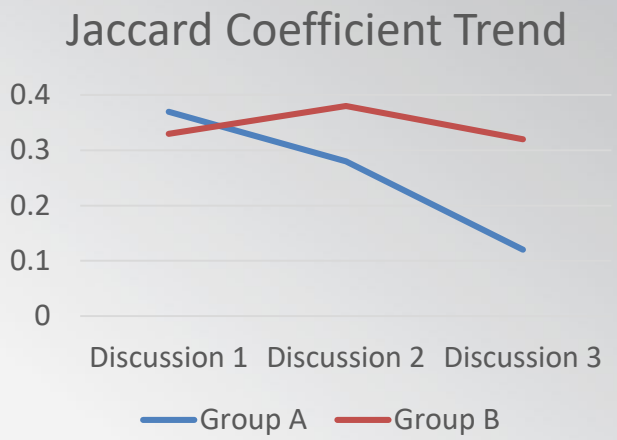
Measure: Jaccard's similiarity coefficient for two binary vectors

- total number of times that an element is 1 in both vectors (J_{11})
- total number of times an element is 0 in one vector and 1 in the other (J_{01} , J_{10})

Jaccard coefficient is then calculated as follow: $\frac{J_{11,}}{J_{01} + J_{10} + J_{11}}$.

Jaccard Coefficient between Program Membership Matrix and Discussion Matrices – Group A	
	Coefficient
Discussion 2	0.37
Discussion 3	0.28
Discussion 4	0.12

Jaccard Coefficient between Program Membership Matrix and Discussion Matrices – Group B	
	Coefficient
Discussion 2	0.33
Discussion 3	0.38 (p=.05)
Discussion 4	0.32



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Mixed Dyadic-Nodal: differences in group tie density

- Structural blockmodel
- Constant Homophily blockmodel
- Variable homophily blockmodel

- Homophily:
  - Tendency of within-group connections:
  - Students within the same group comment on each other's posts.

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Mixed Dyadic-Nodal: Structural Blockmodel

Density Table for Discussion 3 in Group B			
	MSN	DNP	PHD
MSN	0.33	0.67	0.33
DNP	0.67	0.85	0.1
PHD	0.33	0.4	1
Model fit: Adj R-Sqr: 0.19 ; significance: 0.015			

- MSN students have a low probability (0.33) of being tied to one another.
- MSN students have a high probability (0.67) of being connected to DNP students.
- DNP students show strong (0.85) tendencies toward within-group ties.

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Mixed Dyadic-Nodal: Structural Blockmodel

Discussion 2 in Group A			
	MSN	DNP	PHD
MSN	0	0.5	0.67
DNP	0.6	0.35	0.33
PHD	0.17	0.53	17
Model fit: Adj R-Sqr: 0.028 ; significance: 0.4			
Discussion 3 in Group A			
	MSN	DNP	PHD
MSN	0	0.4	0.33
DNP	0.5	0.35	0.4
PHD	0.33	0.4	0.33
Model fit: Adj R-Sqr: -0.059; significance: 0.98			
Discussion 4 in Group A			
	MSN	DNP	PHD
MSN	0	0.3	0.33
DNP	0.4	0.2	0.4
PHD	0.33	0.47	0
Model fit: Adj R-Sqr: 0.004 ; significance: 0.52			

Discussion 2 in Group B			
	MSN	DNP	PHD
MSN	0.5	0.6	0.17
DNP	0.67	0.8	0.3
PHD	0.33	0.3	0.5
Model fit: Adj R-Sqr: 0.1 ; significance: 0.17			
Discussion 3 in Group B			
	MSN	DNP	PHD
MSN	0.33	0.67	0.33
DNP	0.67	0.85	0.1
PHD	0.33	0.4	1
Model fit: Adj R-Sqr: 0.19 ; significance: 0.015			
Discussion 3 in Group B			
	MSN	DNP	PHD
MSN	0.17	0.4	0.17
DNP	0.4	0.8	0.3
PHD	0.17	0.3	0
Model fit: Adj R-Sqr: 0.15 ; significance: 0.11			

Mixed Dyadic-Nodal: constant homophily model

Constant homophily: all groups may have a preference for **within-group ties**, but that the strength of the preference is the same within all groups.

Regression Coefficients

	Coefficient	Significance
Intercept	0.47	0.98
In-group	0.28	0.037
Model fit: Adj R-Sqr: 0.069		significance: 0.06

- There is a 47% chance that students from different programs commented on each others' posts
- If the students come from the same group, this probability is 28% higher, or is 75 %
- The block model of group differences accounts for only 5.9% of pair wise ties. But this is not a completely random result (p= 0.06).

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Mixed Dyadic-Nodal: constant homophily model

Regression Coefficients – Disc 2 A

	Coefficient	Significance
Intercept	0.47	0.1
In-group	-0.18	0.1

Model fit: Adj R-Sqr: 0.029 ; significance: 0.15

Regression Coefficients – Disc 2 B

	Coefficient	Significance
Intercept	0.45	0.98
In-group	0.26	0.05

Model fit: Adj R-Sqr: 0.059 ; significance: 0.06

Regression Coefficients – Disc 3 A

	Coefficient	Significance
Intercept	0.4	0.35
In-group	-0.08	0.35

Model fit: Adj R-Sqr: 0.006 ; significance: 0.6

Regression Coefficients – Disc 3 B

	Coefficient	Significance
Intercept	0.47	0.98
In-group	0.28	0.037

Model fit: Adj R-Sqr: 0.069 ; significance: 0.06

Regression Coefficients – Disc 4 A

	Coefficient	Significance
Intercept	0.39	0.05
In-group	-0.24	0.05

Model fit: Adj R-Sqr: 0.06 ; significance: 0.08

Regression Coefficients – Disc 4 B

	Coefficient	Significance
Intercept	0.32	0.989
In-group	0.28	0.024

Model fit: Adj R-Sqr: 0.072 ; significance: 0.06

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Mixed Dyadic-Nodal: variable homophily model

Constant homophily: tests the model that each diagonal cell (commenting within MSN, within DNP, and within PHD groups) differ from commenting behavior between groups.

Regression Coefficients

	Coefficient	Significance
Intercept	0.47	0.98
MSN	-0.13	0.36
DNP	0.38	0.01
PHD	0.53	0.02

Model fit: Adj R-Sqr: 0.111 ; significance: 0.05

- The probability that any two student comment on each other is 47%.
- The probability that any two MSN students comment on each other's post is lower.
- The probability that DNP student is 38% and significantly higher.
- The probability that PHD students comment on each other is also significantly higher.

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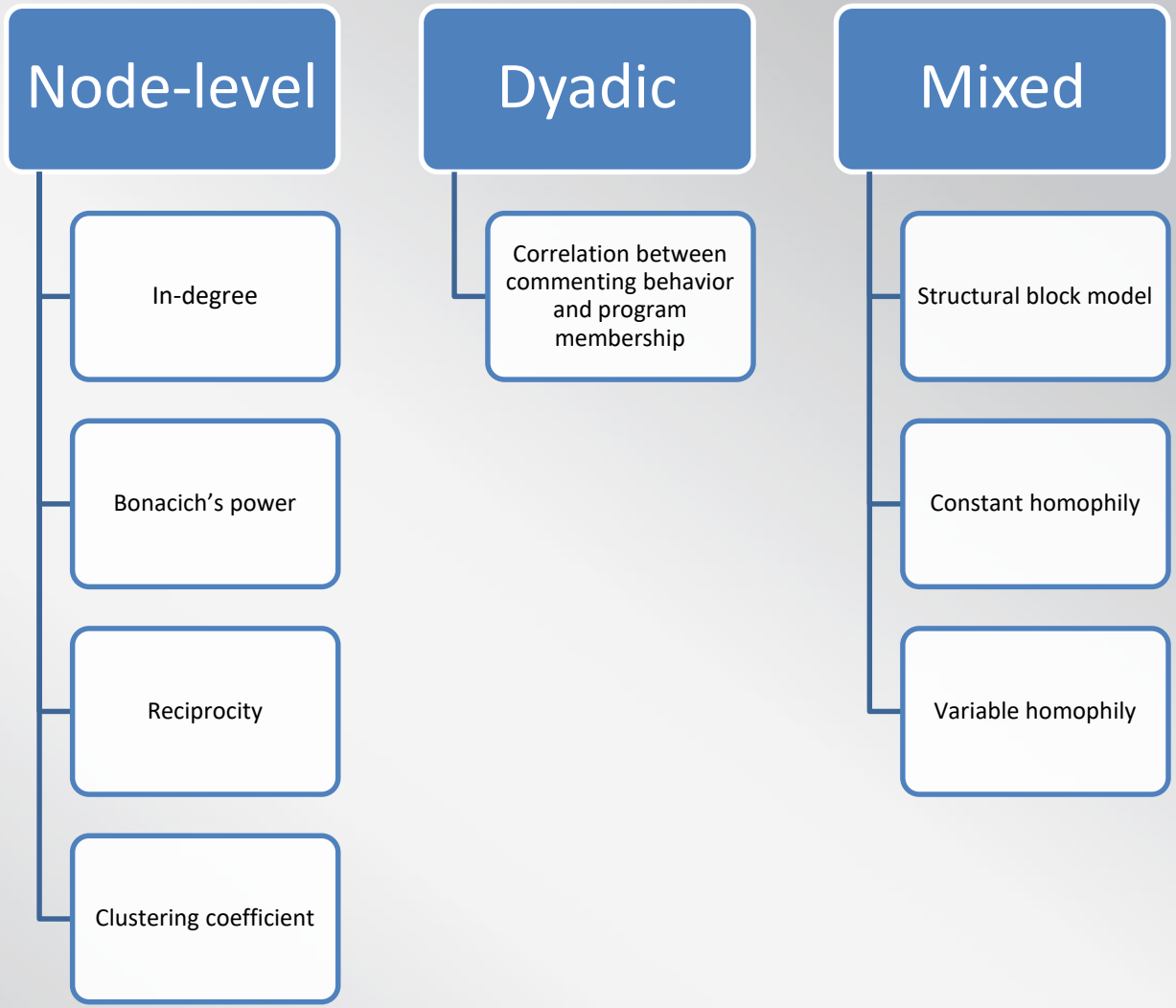


Insights (1)

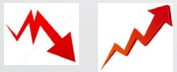
- Facilitation mechanisms
- Student teams
- Evaluation mechanisms


Density


Centrality


Reciprocity

Clustering Coefficient



Dyadic Correlations

Within-group homphily

Insights (2)

- To facilitate more accurate coding, may help to ask students to clarify intended recipient
- Inclusion of both SNA *and* content analysis would provide a fuller, holistic examination of the performance of networked learning communities.
- Instructors can capitalize on use of online discussions, a common experience in students' education, by:
  - Manipulation to maximize synthesis of knowledge
  - Use as an opportunity to educate about ways to become more effective team members

Limitations

- Included only the early course discussions
- Potential differences between discussion topics over the 3 weeks
- Challenges ensuring reliability of coding
  - Several instances where the intended recipient(s) lacked clarity
- Social network analysis quantifies amount and types of interactions, but not quality of interactions

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