How Many Are Good Enough for the Adolescent Social Network Nomination

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Abstract: - For social network analysis, the most common method used to generate social network data is the method of Name Generator. Nonetheless, the number of nomination has been an unsolved mystery for social networkers. Namely, for each respondents, to name how many people are good enough to generate a stable network, which is able to represent the truly association structure among these respondents, still, is an empirical research question for researchers. This study devoted to explore this question and to provide a preliminary answer. A set of social network data was collected from a sample of Taipei metropolitan junior high schools, including 44 classes. In each class the students were asked to nominate ten best friends in the intimate order. It was supposed that in each class has ten sociometric data for different nomination, and the total amount of sociometric data was 440. The software UCINET6.0 was applied to analyze the social network variables, and NEGOPY4.30 to define the network position. Comparing the betweenness, constraint, and efficiency, this study found that two names will generate more diverse network position with unstable structure, three names are the minimum to get more stable network structure, four or five names are needed to observe the links between boys and girls, but more than five names seem to be redundancy.

Key-Words: - Social network, Nomination number, Adolescents, Junior high school, Evaluation

1 Introduction

Nomination is the most common method to generate social network data. In social network analysis, there have had two approaches. One is the sociometric approach measuring the interpersonal relations in a small, closed set of actors, the other approach deals with the social world of an individual [1]. Many researchers have discussed the second approach, while little attention was focused on the bounded social network, especially for adolescents' peer network. The current study systematically examines the appropriate number of nomination.

Adolescents are embedded in a rich network of peer relations [2], including best friendships, cliques or friendship groups. Studies of adolescent peer relations have focused on the characteristics of peer social network, and its correlations with deviant

behavior. The most common method used to gather network data is name generator. Subjects are asked to name their best friends. The number of friends named either has a limitation of three to ten or no limitation at all.

Many researchers asked the subjects to name three friends in studying friendship structures. Fisher and Bauman [3], Ennett and Bauman [4] focused on the influence and selection in the adolescent peer group. Ennett and Bauman [5] studied the variability of friendship structures. Yang and Yang [6] stuided the Markov process of a longitudinal friendship network. The subjects were asked to nominatee up to 10 best friends, and only the first three best friends were analyzed. While Urberg, Degirmencioglu, Tolson, and Halliday-Scher [7] provided 10 spaces for listing friends to study the structure of adolescent peer networks, but only the mutual choices were included in analysis. In another study [8], the mutual choices defined as the actual friendships, the subjects were asked to generate a list of best friends up to 10. Yang [9] asked the subjects to nominate not more than 10 good friends, and compare the difference of value similarity between symmetric and asymmetric pairs for the homo- and hetero- gender of dyads. Cairns, Leung, Buchanan, and Cairns [10] studied the fluidity, reliability, and interrelations of children's and adolescents' social networks. Subjects were free to nominate any number of friends.

Others analyzed the adolescent social network to establish an association between peer group structure and deviant behavior. Bauman and Fisher [11], Ennett and Bauman [12], Aloise-Young, Graham, and Hansen [13] studied the peer influence on smoking behavior; they asked the adolescents to name three best friends. Yang, Chen, Yen, and Ke [14, 15] asked high school students to name four friends in the same class to explore the effects of peer group on the smoking behavior. Engels, et al. [16] asked the adolescents to write down the names of their best friends with a maximum of five and found the high similarities in smoking between reciprocal friends. In a longitudinal investigation of Ennett and colleagues [17], the social network was used to measure peer context, and the nomination number was fixed at five closest friends. Hall and Valente [18] asked students to nominate five best friends over two time periods. They measured the network centrality and found the direct effect of selection and the indirect effect of influence on smoking behavior. Michell and Amos [19] asked pupils to name up to six friends to study the girls' smoking behavior. Ennett, Bailey & Federman [20] studied the social network characteristics associated with risky behaviors among runaway and homeless youth. The youths provided information on up to seven members of their networks. Urberg, Degirmencioglu, and Pilgrim [21] studied the close friend and group influence on adolescent cigarette smoking and alcohol use. Adolescents were asked to nominate up to 10 best friends. Haynie's [22] studied the impact of peer influence on adolescent delinquency. Adolescents were asked to identify their best male and best female friends from a school roster (up to 5 friends of each sex).

Most of these studies didn't discuss how to decide the number of nomination. Pearson and Michell [23] explained why they asked the subjects to give information on up to six friends. Their motivation to use six friends was the need to strike a balance between naming too few links which generates peer structures of inadequately cohesive and having too many choices which tends to provoke subjects to name peers who are not close friends leading to an overestimation of the number of links.

Our focus on the number of nomination is appropriate because no prior study has empirically examined this issue. Social network theories can be applied to different levels of analytic interest, from individuals to groups [1]. In this study an empirical data was systematically analyzed to examine individual network variables and network structure for finding the best number of nomination.

2 Methods

A random sample of 1,434 junior high school students was collected from 44 classes of 33 schools at Taipei. The 33 schools were selected randomly to provide a socially and economically diverse sample of the whole Taipei metropolitan city. And in these schools, 44 classes were randomly selected from the 7th grade during 1996.

The students were asked to nominate 10 best friends in terms of intimacy. The boundary of network was limited in the same class. A nominated friend not in the same class was not included in the analysis. The software UCINET 6.0 [24] was applied to analyze individual network variables, NetDraw 2.081 [25] was applied to draw the network graph, and NEGOPY4.30 [26] to define the position in the network. There are a series of social network graphs from one to ten nominations in each class. And for each social network, there are individual network variables including betweenness, constraint, and efficiency, and network structure variables including a variety of network position.

Betweenness is a measure of the number of times a vertex occurs on a geodesic. It is expressed as

CB(ni)= Σbjk(ni)/bjk. Let bjk be the proportion of all geodesics linking vertex j and vertex k which pass through vertex i. The betweenness of vertex i is the sum of all bjk where i, j and k are distinct and j < k. The normalised betweenness centrality is the betweenness divided by the maximum possible betweenness expressed as a percentage. Constraint is calculated as $(p_{ij} + \sum p_{iq}p_{qj})^2$. p_{ij} is the proportion of i's relations allocated to j. p_{iq} is the proportion of i's energy invested in relationship with q. p_{qj} is i's interaction with q divided by j's strongest relationship with anyone. Efficiency is computed as ***Effective size/observed size, Effective size*** = $\sum [1-\sum p_{iq}m_{jq}]$ (m_{jq}=i's interaction with q divided by j's strongest relationship with anyone, p_{iq}=proportion of i's energy invested in relationship with q). ***Effective size*** is network size (N) minus redundancy in network.

Many writers have offered definition of degree, closeness, betweenness, and density as individual network variables. Degree which is defined as the total number of direct connections and closeness as a point's geodesic distances to all points on the graph [1, 27, 28] are relative to nomination number. Density is a size-dependent measure which is difficult to use in comparisons of graphs of radically different sizes [27]. While betweenness measures the extent to which a particular point lies 'between' the various other points in the graph and a point of relatively low degree may play an important 'intermediary' role [27]. It is not relative to nomination number and may be used as a good measure. And for comparing between different classes, we normalized the betweenness as our measure. Constraint and efficiency were offered by Burt [29]. Constraint is essentially a measure of the extent to which ego is invested in people who are invested in other of ego's alters. Efficiency is the effective size divided by the number of alters in ego's network. They are not relative to nomination number directly and were computed as a measure.

UCINET 6.0 is software of social network analysis created by Borgatti, Everett, and Freeman. It was applied to analysis individual network variables, including betweenness, constraint, and efficiency. NEGOPY is another social network analysis program. It detects groups and assigns individuals in the network to a discrete set of categories. This set of categories is based on a systems-theoretic approach to organizations. There are two major categories into which individuals are assigned—isolates and participants. Isolates include all the individuals who are minimally connected to others in the network and have four types. Isolate type 1 are the individuals who have no links to any other individuals in the network. Isolate type 2 are all the individuals who are linked to only one other individual in the network. If two isolates type 2 are linked to one another, they are called a dyad. And if a set of individuals are connected in a structure that is acyclic (contains no cycles), they are tree nodes.

Participants are individuals who have at least two links with other participants. They include both members of groups and individuals who connect groups to one another. Group members have most of their interaction with other members of the same groups, rather than with members of other groups. Direct liaisons are individuals who have most of their interaction with members of groups, but not with members of any one group. They provide direct connections between the groups they are connected to. And indirect liaisons are individuals who do not have most of their interaction with members of groups. They provide indirect of 'multi-step' connections between groups by connecting liaisons, which have direct connections with members of groups.

The difference between isolates and participants is the number and the form of linkage with others in a network. When the number of nomination increased, an isolate type 1 become type 2 or dyad, an isolate type2 become a liaison or a group member, dyad become tree nodes, tree nodes become group member, et cetera. It implies that the number of nomination will change the network structure. And we supposed that the increased nomination would not be necessary if it had not made the network structure any change.

For the purpose of observing the change of network positions, a series of social networks were analyzed. Now, in each class there were 10 networks from 1 to 10 nominations. We observed the categories of social network positions, compared the difference between two adjacent social networks, and calculated the change rate of each category of network positions. If there were no difference between two adjacent social networks, we supposed the latter social network (more number of nominations) was structural stable, and the number of former social network is the good number of nomination.

3 Results

There were 727 boys (50.7%) and 707 girls (49.3%) in 44 classes, including 6 boys' classes, 6 girls' classes, and 32 boys and girls' classes. The results of analyze are summarized in three sections. In the first part, the individual network variables are described. The second part focuses on network structure. And

the third part, the individual network variable and network structure are linked.

3.1 Individual network variables

The frequency of nomination number was shown as table 1. The mean of nominations was 4.30 (SD=2.94). Among 1434 subjects, 109 (7.6%) students named up to 10 friends, and 138 (9.6%) didn't name any friend. Most of the subjects named one to five friends, 145 (10.1%) students named 1 friends, 162 (11.3%) students named 2 friends, 206 (14.4%) students named 3 friends, 163 (11.4%) named 4 friends, 158 (11.0%) named 5 friends.

Table 1. Frequency of outdegree

Outdegree	N	%
0	138	9.6
1	145	10.1
2	162	11.3
3	206	14.4
4	163	11.4
5	158	11.0
6	116	8.1
7	112	7.8
8	61	4.3
9	64	4.5
10	109	7.6
Total	1434	100.0

The variances of betweenness were counted for each different nomination. For each class there was a variance curve from 1 to 10 nominations. As shown in figure 1, in 44 classes there were two classes which curves were higher than others. The individual betweenness in these two classes were shown as figure 1-1 and 1-2. From these figures we could find whose betweenness changed sharply. They were id "687" and "695" in class A, id "989" and "978" in class B.

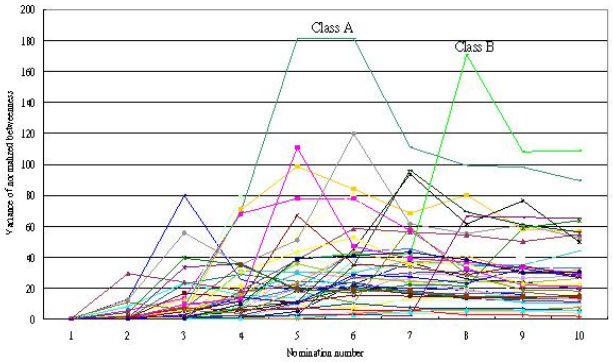
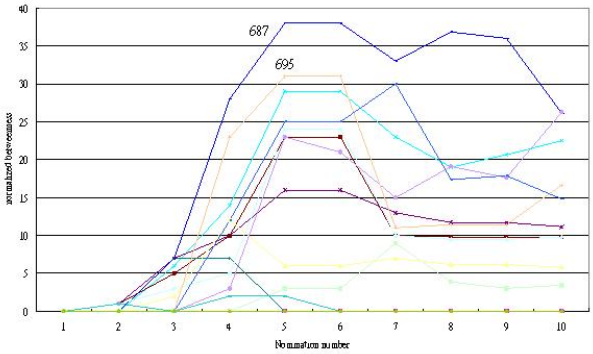
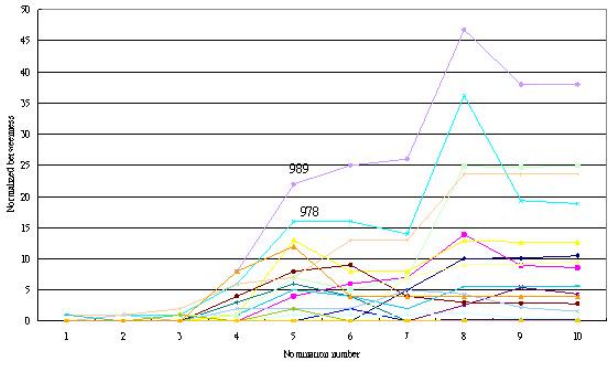


Figure 1. Variance of betweenness of 44 classes



Note: 687 is a boy, and 695 is a girl in class A.

Figure 1-1. Normalized betweenness in class A (12 boys and 7 girls)



Note: 989 is a boy, and 978 is a girl in class B.

Figure 1-2. Normalized betweenness in class B (8 boys and 13 girls)

The variances of constraint and efficiency of 44 classes were consistently decreased as the nomination was increased from 1 to 3. The curves became flat as the nomination number was increased to 4 or 5. (Figure 2 and 3)

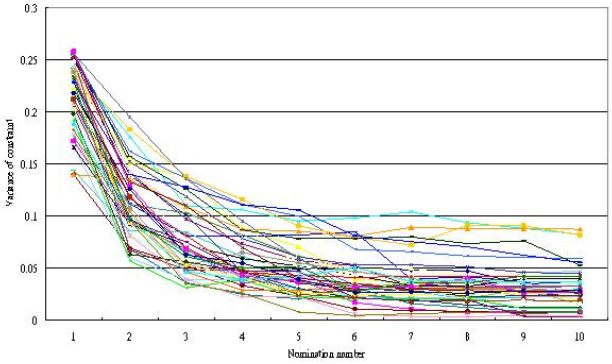


Figure 2. Variance of constraint of 44 classes

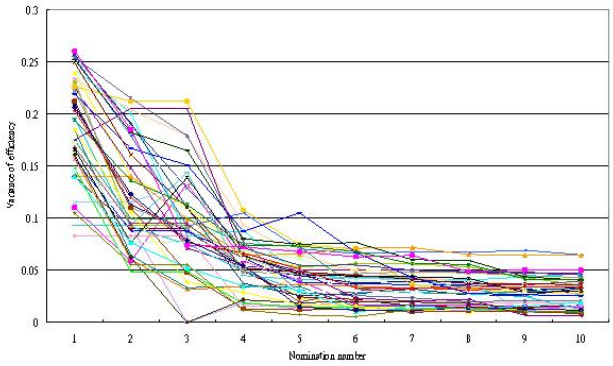


Figure 3. Variance of efficiency of 44 classes

3.2 Network Structure

NEGOPY was used to define network position for each student within their classes. We calculated the difference of network position for two adjacent networks. For example, in class A, there were 3 isolate type1, 4 isolate type2, 10 dyad members, and 2 tree nodes as the nomination number was 1. When the nomination number was 2, there were 3 isolate type1, 6 isolate type2, 2 dyad members, 5 tree nodes, and 3 group members. The differences between these two networks were 2 for isolate type2, -8 for dyad members, 3 for tree nodes, and 3 for group members. The cumulative differences between two adjacent networks for 44 classes were transferred to percentage and shown as table 2-1 and table 2-2.

As table 2-1, the change rate of group members from 2 to 3 nomination was 25.77%, it meant that there are about a quarter of subjects became group members as the nomination increased from 2 to 3. While the group members increased, the isolates decreased. The decreased rates were 5.11%, 5.84%, and 2.63% for isolate type 1, isolate type 2, and dyad respectively as table 2-1. At the same time, the tree nodes and direct liaisons were decreased by , 9.58% and 2.64% respectively as table 2-2.

From 3 to 4 nomination, the change rate of group members was 9.01%, meanwhile the change rates of isolates were -3.80%, -1.36%, -0.68%, and -2.73% for each isolates category (Table 2-1 and table 2-2). And as figure 4, the change rate from 4 to 5, or more nominations, were less than ±5% for each category of network positions.

The increase of nomination would change the categories of network position. As the nomination number was only one, there were not any participants. Most of the students were isolates. While the nomination number was more than 5, most of the students became group members. Between these two extremes, we found 2 nominations would generate more diverse network position than any other nominations for most of these classes, as shown in table 3.

Table 2-1. Change rate of network position between different nominations

Nomination number	Group member	Isolates type1	Isolates type2	Dyad
2→3	25.77	-5.11	-5.84	-2.63
3→4	9.01	-3.80	-1.36	-.68
4→5	4.49	-2.07	-2.11	-.04
5→6	4.05	-.38	-2.58	-.13
6→7	1.66	-.45	-.29	-.28
7→8	1.27	-.15	-.78	.00
8→9	.98	-.37	-.06	-.02
9→10	-.18	-.11	-.61	.00

Note: 2→3 means the nomination number increased from 2 to 3.

Table 2-2. Change rate of network position between different nominations

Nomination number	Tree node	Liaisons direct	Liaisons indirect
2→3	-9.58	-2.64	.02
3→4	-2.73	-1.13	.71
4→5	-1.31	.99	-.17
5→6	-.16	-.94	.37
6→7	.02	.23	-.89
7→8	-.15	-.19	-.13
8→9	.07	-.85	.25
9→10	-.13	-.09	1.11

Note: 2→3 means the nomination number increased from 2 to 3.

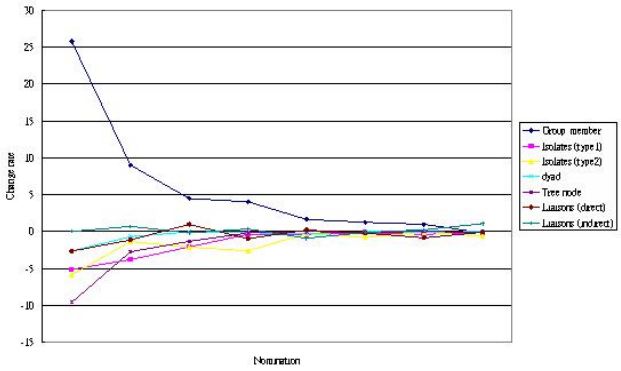


Figure 4. Change rate of network position

Table 3. Nomination number for diversity of network position categories

Nomination number	No. of classes	%
2	33	75.00
3	6	13.64
4	3	6.82
6	2	4.55

Table 4. Nomination number of structural stable

Nomination number	Criteria I No. of class(%)	Criteria II No. of class (%)	Criteria III No. of class (%)
3	0 (0)	1 (2.27)	3 (6.82)
4	1 (2.27)	7 (15.91)	7 (15.91)
5	9 (20.45)	12 (27.27)	17 (38.64)
6	8 (18.18)	10 (22.73)	10 (22.73)
7	6 (13.64)	8 (18.18)	5 (11.36)
8	5 (11.36)	2 (4.55)	2 (4.55)
9	5 (11.36)	3 (6.82)	0 (0)
10	4 (9.09)	1 (2.27)	0 (0)
＞10	6 (13.64)	0 (0)	0 (0)

Note: Criteria I: Network position was classified as group member, dyad, tree node, isolate type 1, isolate type 2, liaison type 1, and liaison type 2.
Criteria II: Network position was classified as participants and isolates.
Criteria III: Network position was classified as group members and others.

Comparing the adjacent network structure, we identified the nomination number of structural stability as presented in table 4. There were three criteria for this comparison. For criteria I, network position was classified as group member, dyad, tree node, isolate type 1, isolate type 2, liaison type 1, and liaison type 2. As shown in the first column of table 4, there were 9 (20.45%) classes became stable as the nomination increased to 5. Eight (18.18%) classes became stable as the nomination increased to 6. And 6 (13.64%) classes didn't get stable as the nomination increased to 10. For criteria II, shown in the second column of table 4, network position was classified as participants and isolates. There were 7 (15.91%) classes became stable as the nomination number was 4, 12 (27.27%) classes became stable as the nomination increased to 5, and 10 (22.73%) classes became stable as increased to 6. For criteria III, shown in the third column of table 4, network position was classified as group members and not group members. Most of the classes' networks became stable as the nomination number increased to 6. There are 7 (15.91%) classes became stable as the nomination number was 4, and 17 (38.64%) classes became stable as the nomination number increased to 5, and 10 (22.73%) classes became stable as increased to 6.

3.3 Individual network variable and network structure

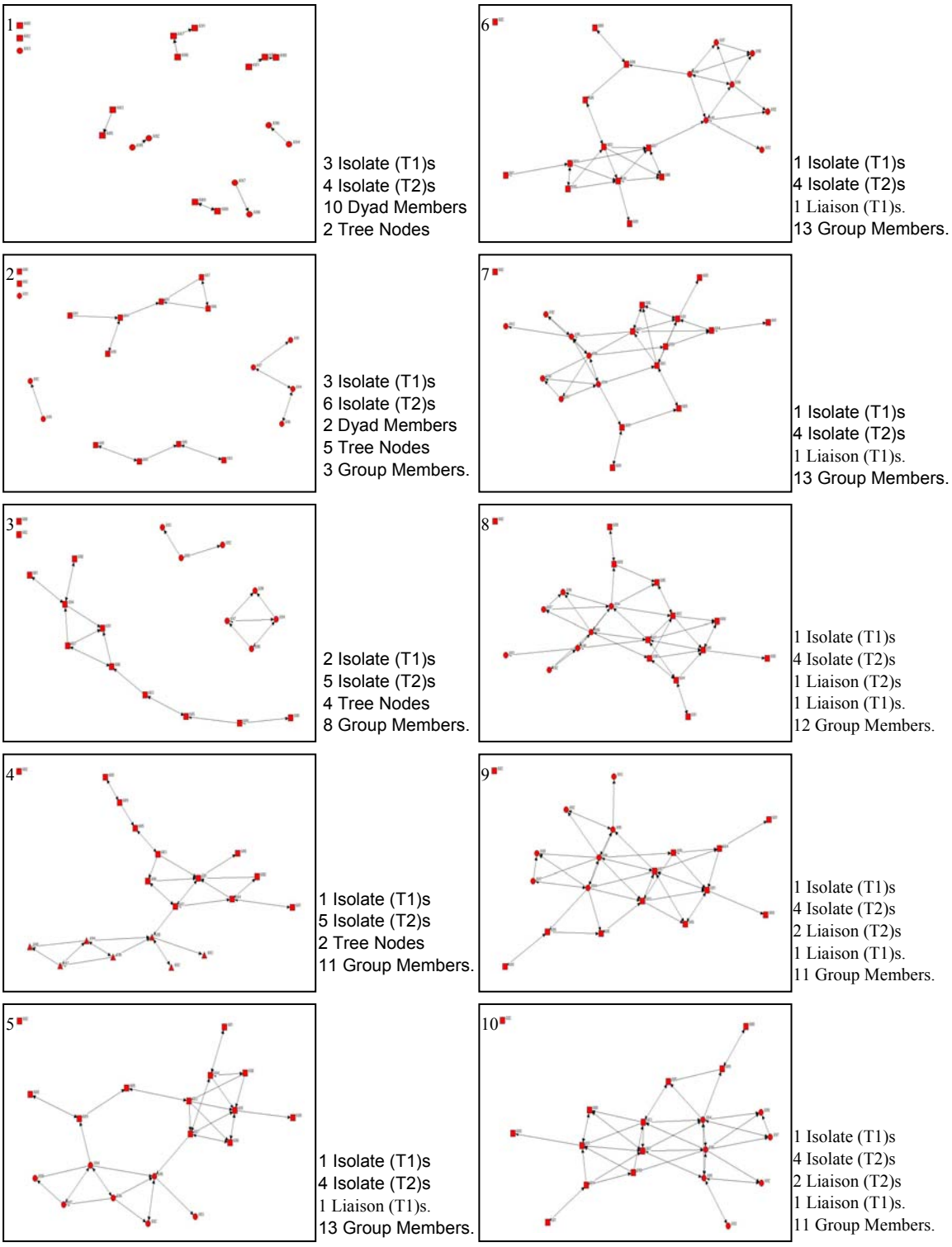
There were two classes with extraordinary high variances of betweenness. We further examined these two classes' network map, as figure 5 and 6. These two higher curves are boys and girls' classes. In these two classes, boys and girls were separated into different components until the nomination number increased to 4 or 5. A boy nominated a girl or a girl nominated a boy would construct a bridge between boys and girls and increase the betweenness. In class A, when the nomination number increased to 4, 695 (a girl) and 687 (a boy) linked, and their betweenness increased (Figure 1-1). In class B, as the nomination was below 4, a boy (989) only had a link with a girl (978). When the nomination number increased to 5, the boy's and the girl's outdegree and indegree increased. Their betweenness increased as shown in figure 1-1.

4 Discussion and Conclusion

The mean of nomination was 4.30. Most of them named one to five friends. Only 7.6% named 10 friends. The result was very close to others who asked the subjects to name 10 friends. The mean number of nomination in Haynie's research [22] was 4.15 (SD=3.02). And the average number of friends listed in Urberg, Degirmencioglu, and Pilgrim's studies [21] was 4 to 5. In other studies which asked subjects to name three friends, the mean size was 2.6 [20] and 41% of adolescent named three friends in Ennett's study [5]. It looks like that the more asked the more named. But when the number increased to more than the ultimate number of subjects' friends, the number of nomination will not be increased any more. In Cairns, Leung, Buchanan, and Cairns's study [10], subjects were free to nominate any number of friends. The result showed that a mean of 4.09 friends were named in the seventh grade. Comparing with these findings, we suggest that 4 or 5 friends may be an acceptable number for junior subjects to nominate.

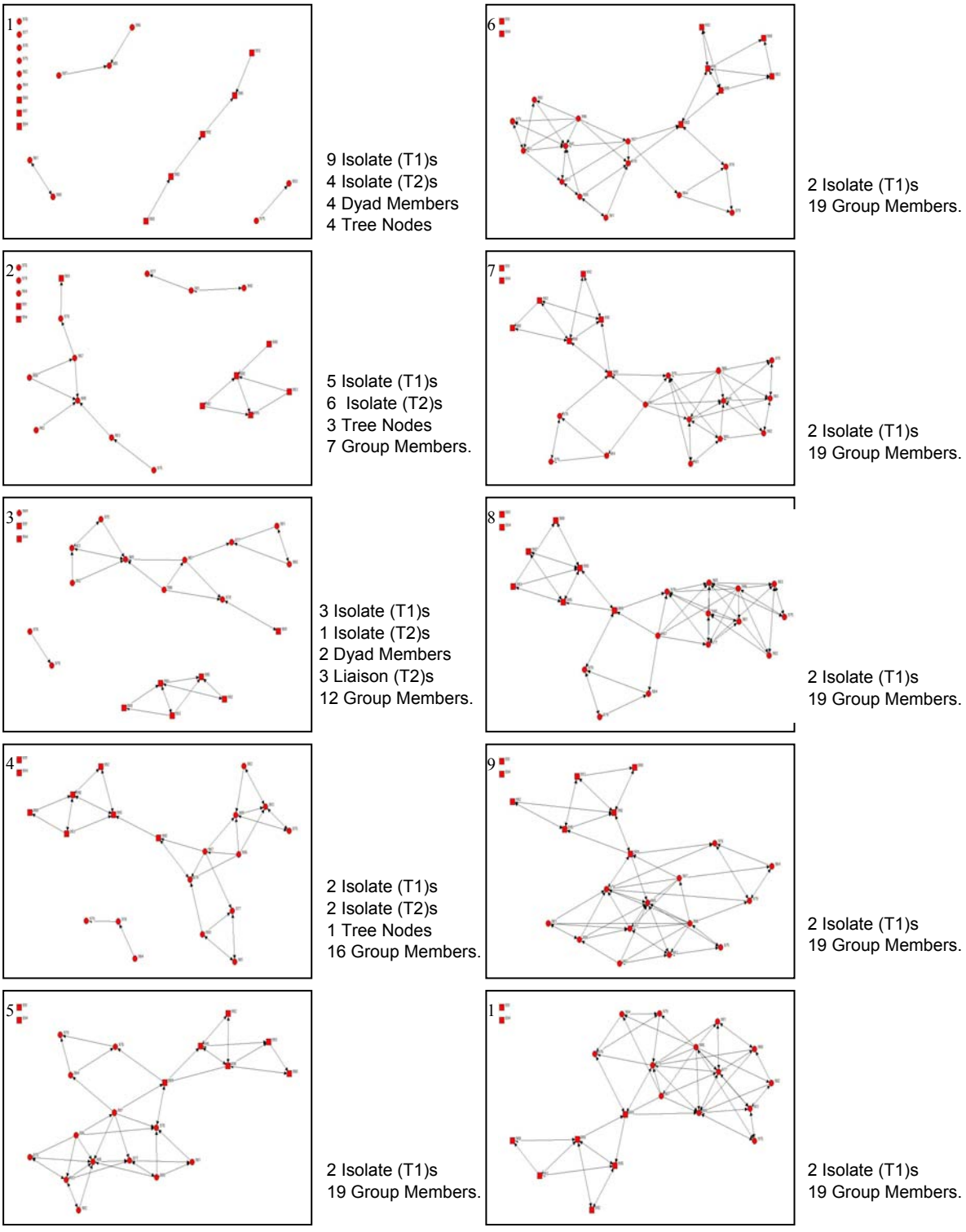
Betweenness measures the extent to which a particular point lies 'between' the various other points in the graph [27]. We scrutinized the network map with higher variances of betweenness, and found that the junior students did keep friends with the same gender. The linkage between boys and girls began at the nomination number increased to 4 or 5. It tells us that if we want to observe the interaction between boys and girls within a class, the nomination number should be up to 4 or 5.

The network position diversified as the nomination number was 2, the network structure changed dramatically as the nomination number increased from 2 to 3, and kept steady when the nomination number increased to 4 or 5. This finding suggested that if we want to get more diversity, 2



Note: The number on the upper left of each network map is nomination number.
Square represents boy and circle represents girl.

Figure 5. Network map of class A (12 boys and 7 girls)



Note: The number on the upper left of each network map is nomination number.
Square represents boy and circle represents girl.

Figure 6. Network map of class B (8 boys and 13 girls)

names are enough. But the network structure is unstable, and may not represent the truly association structure. If we want to have a more stable structure, 3 names are the lower limit. Additionally, the variances of constraint and efficiency displayed the same characteristics. The variances were changed during nomination number increased from 1 to 3, and kept steady as the nomination number increased to 4 or 5. It also supported that more than 4 or 5 nomination would generate more redundant links, and let the variation of constraint and efficiency for each subject vanished.

Network graph will tell us the same thing more clearly especially in class B. When the students named more than 5 friends, there were 2 isolates type1 and 19 group members. As the network structure keeps steady, the increased nominations will not be necessary to detect the network positions. The phenomenon suggested that three names seem to be a minimum because it needed to reveal variation in network structure, and more than five nominations seem to be redundancy.

References:

[1] S. Wasserman, and K. Faust, *Social Network Analysis: Methods and Applications*, Cambridge University Press, 1994.

[2] W. Furman, The development of children's social networks. In Belle D. (Eds.) *Children's social networks and social supports,* New York: Wiley, 1989, pp.151-172.

[3] L. A. Fisher, and K. E. Bauman, Influence and selection in the friend-adolescent relationship: findings from studies of adolescent smoking and drinking. *Journal of Applied Social Psychology*, Vol.18, No.4, 1988, pp.289-314.

[4] S. T. Ennett, and K. E. Bauman,. The Contribution of influence and selection to adolescent peer group homogeneity: The case of adolescent cigarette smoking, *Journal of Personality and Social Psychology*, Vol.67, No.4, 1994, pp.653-663.

[5] S. T. Ennett, and K. E. Bauman, Adolescent social networks: school, demographic, and longitudinal considerations, *Journal of Adolescent Research,* Vol.11, No.2, 1996, pp.194-215.

[6] H. H. Yang, and H. J. Yang, Markov processes in a longitudinal friendship network analysis and breakfast-eating behavior, *WSEAS Transactions on Mathematics,* Vol. 6, No. 1, 2007, pp.138-144.

[7] K. A. Urberg, S. M. Degirmencioglu, J. M.Tolson, and K. Halliday-Scher, The structure of adolescent peer networks, *Developmental Psychology*, Vol.31, No.4, 1995, pp.540-547.

[8] H. H. Yang, and H. J. Yang, University students' friendship discrepancy and time spent on the internet, *WSEAS Transactions on Mathematics,* Vol. 6, No. 1, 2007, pp.191-194.

[9] H. H. Yang, Value similarity in the later stage of friendship network formation, *WSEAS Transactions on Mathematics,* Vol. 5, No. 1, 2006, pp.167-173.

[10] R. B. Cairns, M-C. Leung, L. Buchanan, and B. D. Cairns, Friendships and social networks in childhood and adolescence: fluidity, reliability, and interrelations, *Child Development,* Vol.66, 1995, pp.1330-1345.

[11] K. E. Bauman, and L. A. Fisher, On the measurement of friend behavior in research on friend influence and selection: findings from longitudinal studies of adolescent smoking and drinking, *Journal of Youth and Adolescence*, Vol. 15, No.4, 1986, pp.345-353.

[12] S. T. Ennett, and K. E. Bauman, Peer group structure and adolescent cigarette smoking: A social network analysis, *Journal of Health and Social Behavior*, Vol.34, 1993, pp.226-236.

[13] P. A. Aloise-Young, J. W. Graham, and W. B. Hansen, Peer influence on smoking initiation during early adolescence: a comparison of group members and group outsiders, *Journal of Applied Psychology*, Vol.79, 1994, pp.281-287.

[14] H. H. Yang, D. R. Chen, L. L. Yen, and S. R. Ke, The relationship between classmates' interpersonal network and smoking behavior: a preliminary investigation among the 10th graders, *Taiwan Journal of Public Health,* Vol.21, No.3, 2002, pp.164-172.

[15] H. H. Yang, D. R. Chen, L. L. Yen, and S. R. Ke, Parent and peer group influence on the smoking behavior of high school students, *The Journal of Medical Education,* Vol.7, No.2, 2003, pp.128-139.

[16] R. C. M. E. Engels, F. Vitaro, E. D. E. Blokland, R. d. Kemp, and R. H. J. Scholte, Influence and selection processes in friendships and adolescent smoking behaviour: the role of parental smoking, *Journal of Adolescence,* Vol.27, 2004, pp.531-544.

[17] S. T. Ennett, K. E. Bauman, A. Hussong, R. Faris, V. A. Foshee, L. Cai, and R. H. DuRant, The peer context of adolescent substance use: findings from social network analysis, *Journal of Research on Adolescence,* Vol.16, No.2, 2006, pp.159-186.

[18] J. A. Hall, and T. W. Valente, Adolescent smoking networks: The effects of influence and

selection on future smoking, *Addictive Behaviors,* Vol.32, 2007, pp.3054-3059.
[19] L. Michell, and A. Amos, Girls, pecking order and smoking, *Social Science and Medicine,* Vol.44, No.12, 1997, pp.1861-1869.
[20] S. T. Ennett, S. L. Bailey, and E. B. Federman, Social network characteristics associated with risky behaviors among runaway and homeless youth, *Journal of Health and Social Behavior,* Vol.40, March, 1999, pp.63-78.
[21] K. A. Urberg, S. M. Degirmencioglu, and C. Pilgrim, Close friend and group influence on adolescent cigarette smoking and alcohol use, *Developmental Psychology*, Vol. 33, No.5, 1997, pp.834-844.
[22] D. L. Haynie, Delinquent peers revisited: does network structure matter? *The American Journal of Sociology*, Vol.106, No.4, 2001, pp.1013-1057.
[23] M. Pearson, and L. Michell, Smoke rings: Social network analysis of friendship groups, smoking and drug-taking, *Drugs: Education, Prevention and Policy*, Vol.7, No.1, 2000, pp.21-37.
[24] S. P. Borgatti, M. G.Everett, and L. C. Freeman, *Ucinet for windows: Software for social network analysis (version 6)*, Harvard, MA, Analytic Technologies, 2002.
[25] S. P. Borgatti, NetDraw: *Graph Visualization Software*. Harvard: Analytic Technologies.
[26] W. D. Richards, *NEGOPY 4.30,* Canada: School of Communication, Simon Fraser University, 1995.
[27] J. Scott, *Social Network Analysis,* 2nd ed, London: Sage Publications, 2000.
[28] A. Degenne, and M. Forse, *Introducing Social Networks*, London: Sage Publication, 1999.
[29] R. S. Burt, *Structural Holes: The social structure of competition*, Cambridge: Harvard University Press, 1992.