KNOWLEDGE BUILDING AND GENDER–ARE THERE DIFFERENCES IN KNOWLEDGE BUILDING BEHAVIOURS ALONG GENDER LINES?

Abstract

Evidence from social network research indicates that students communicate along gender lines in schools. Research indicates that in at least one knowledge building classroom, such gender differences are present. However, anecdotal evidence from teachers in knowledge building classrooms indicates that this effect is typically not present. This study examines the stored data from interactions in the Knowledge Forum online learning environment to see if such gender differences are present in a study classroom of Gr. 5/6 students in an inner city school.

Results indicate that there are differences both in indegree centrality between males and females in the reading of notes and in rates of note contribution, with the boys having contributed only about half the number of notes as the girls. However, the class did not, as predicted, fragment along gender lines, with heterophilous groupings among the students being common.

Introduction

For many years, anecdotal evidence from teachers has held that the preferences among genders seen in friendship, acquaintanceship, and working networks (Hallinan, 1979; Hansell, 1984; Lai & Wong, 2002; Louch, 2000; Ortiz, Hoyos, & López, 2004; Palonen, Hakkarainen, Akkerman, Lehtinen, & Voeten, 2005; Watts, Dodds, & Newman, 2002) were not present in knowledge building classrooms. However, a study by Palonen & Hakkarainen (2000) using data from a knowledge building classroom indicates that this view is not correct. Instead, Palonen & Hakkarainen (2000) found that males did not, in general, interact online with females, and that female students tended to interact more strongly with other females. They also found that males tended to participate overall less than females. It is the purpose of this paper to examine a knowledge building class to see if the gender preferences found by Palonen & Hakkarainen (2000) are present, and if they are similar to the earlier findings.

Social Networks

A social network is formed when individuals interact. Social network analysis attempts to determine the constraints on behaviour that result from the nature of the social network in which the individual is embedded , and as such, the primary focus is on the relations (links) among the individuals to elucidate that structure (Degenne & Forsé, 1999). An important tool in this study is the sociogram, a kind of diagram (often called a graph) in which the individual agents in the system (students in the case of schools) are connected by lines indicating a social connection.

In addition to sociograms, there are various network measures that are used to glean further information about the nature of the network being examined. Among these are the number of nodes (agents) in the network, the number of edges (lines) connecting them, the number of isolates (non-participants in the network,) and the network density. The number of nodes, edges, and isolates are simple counts. The density is a calculated measure consisting of the number of actual interactions divided by the theoretical maximum number of interactions (Degenne & Forsé, 1999; Scott, 1991; Wasserman & Faust). This calculation results in a number ranging from zero to one, but is often expressed as a percent. For example, if there are five interactions in a network, but ten are possible, then the density would be 5/10 or 0.5. Expressed as a percent, this would be 50%, meaning that half of the possible interactions were realized. Density is an important measure of the amount of overall activity in networks, although it should be noted that density tends to decrease with network size. Looking at the previous example, it would be relatively easy for a group of ten people to realize all possible interactions, but much

more difficult for a network of one thousand. Thus in understanding network density, the size of the network has to be taken into account.

Another important network measure is centrality. Centrality measures attempt to determine which agents are the most important in the network based on their individual frequencies of interaction. Among these, one of the most important and reliable is indegree centrality (Scott, 1991). An indegree occurs when one individual contacts another. For example, considering a telephone network, if person A telephones person B, the call would be an indegree for person B. Indegrees are often considered to be measures of prestige and status in communities (Degenne & Forsé, 1999), and are therefore often used in the study of friendship networks, although it is less clear what prestige and status would mean in a knowledge building classroom.

While indegrees are simple counts, there is a problem when using the raw measure as a centrality measure because this can be misleading depending on the graph size. For example, if two actors both have raw indegree measures of 9, it might be interpreted that they are equivalent in centrality. However, if one actor is in a social network of size ten, and the other in one of size one hundred, the interpretation of their centrality would change. Because of this, a measure of *relative* indegree centrality has been proposed. Relative indegree scores are calculated by dividing the raw indegree scores by the total network size. In the above example, this would result in relative indegree centralities of 0.90 and 0.09 respectively, giving a clearer picture of the relative centrality of each actor in their networks. Relative indegree centralities are used in this study.

In the case of students working with Knowledge Forum or other online learning environment, there are five kinds of indegrees that can be tracked: note reading, building-on (responding), co-authoring, referencing, and annotating. In the current study, only reading and build-on indegrees are considered, as the other measures were too sparse to yield meaningful results. Therefore, if student A reads a note by student B, it is an indegree for student A; if student A builds onto a note by student B, it is an indegree for student B, and all centrality measures are relative indegree centrality.

Gender Preferences

As noted in the introduction, a number of researchers have noted gender preferences in friendship networks. Usually, these are homophilous–men tend to associate more with men, and women more with women. This is important in knowledge building because, "A fundamental principle of human communication is that the exchange of ideas occurs most frequently between individuals who are alike, or homophilous" (Rogers, 1995, p. 286). Since knowledge building is about the sharing, shaping and changing of ideas, it is important to know what factors are affecting the exchange of ideas.

In particular, it has been found in schools that friendship cliques tend to be markedly homophilous (Hansell, 1984), and that this changes with age until about Gr. 5 & 6, when cross-gender relationships range between 12% for Gr. 5 to 6% for Gr. 6 (Hallinan, 1979). However, it is unclear from these data whether or not friendship patterns produce similar preferences as patterns in schoolwork. As noted earlier, Palonen & Hakkarainen (2000) found such differences, but it is unclear how stable they are among different classes.

Strength of Ties

Another factor relating to both the flow of ideas and to gender preferences in schoolwork is the strength of the social tie. Weak ties are characterized by infrequent, non-reciprocal interactions, while strong ties are characterized by frequent, reciprocal interactions (Hakkarainen, Palonen, Paavola, & Lehtinen, 2004). Granovetter (1973) noted that weak ties often act as bridges between otherwise unconnected communities, and were therefore important in the overall cohesion of society and the transfer of simple information (Hansen, 1999). Strong ties are characteristic of cliques or clusters within larger social groups. They are important in the transfer of complex knowledge (Hansen, 1999) in which context-bound (tacit) knowledge is transferred through repeated interactions (Hakkarainen et al., 2004; Hansen, 1999).

In the context of the present study, we would expect that complex idea spread would tend to occur among homophilous gender groups rather than through the class as a whole, probably leading to two gender-based factions holding different views.

Note Contributions

An important factor in online communication is the number of notes contributed. Like the interactions among students, Knowledge Forum also tracks the number of notes contributed by each student. These results were analyzed graphically in order to see if they shed any light on the interaction patterns shown by the social network analyses.

Methodology

The class consisted of 22 Gr. 5/6 students in a mixed class from an inner city school in a large urban centre. Of the 22 students, 20 chose to participate in the study, giving a participation rate of 91%. Of the participating students, 10 were male and 10 were female, making comparisons between the groups quite easy.

The students each had access to a laptop computer and were given time for two ninety-minute periods each week over an extended period to work with the Knowledge Forum software knowledge building around the topic of ancient civilizations. Server log data recorded by the Knowledge Forum software was used to determine who read whose notes (building-on and referencing being too sparse to produce usable data for this analysis.)

Once obtained, the social network data were imported into the *Ucinet* social network analysis software (Borgatti, Everett, & Freeman, 2002). From these data, it was possible to create a sociogram and perform the necessary sociometric calculations. The data used were the *who's read whose notes* data, number of participants (20), number of edges (reading events,) number of isolates (non-participants,) and the network density.

Note contribution data were analyzed using the *Excel* spreadsheet program.

Results

Note Reading Results

Basic Sociometric Measures for note reading

Table 1 shows the basic sociometric measures for note reading.

Table 1

The basic sociometric measures for note reading in the class: number of nodes (participating students,) the number of edges (communication events,) number of isolates (non-participants,) and the overall network density.

Number of Nodes	Number of Edges	Number of Isolates	Density
20	348	0	92%

From *Table 1* it can be seen that the class was active in note reading, with 348 distinct note-reading events among 20 students. There were no isolates–no students whose notes were not read or who did no reading. The density of 92% indicates that of most of the notes that could be read by students were read by them, although there were individual differences as will be seen. Basically, this shows a healthy reading level for the group.

Indegree Centrality Analysis

Figure 1 and *Figure* ***2*** show the results of the indegree analysis using relative indegree centrality scores.

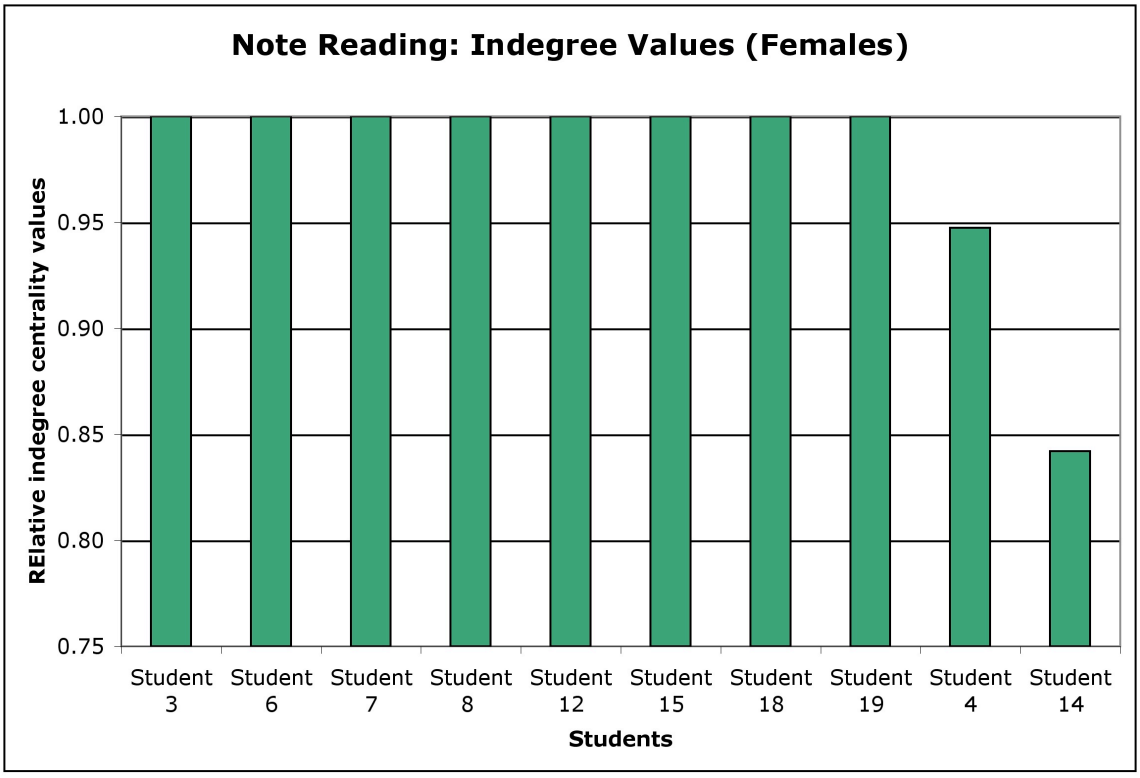

Figure 1. Graph showing the indegree centrality scores for the girls in the class. The scores were sorted from highest to lowest of this analysis. Eight of the girls had indegree values of one–the maximum possible.

As can be seen from *Figure 1*, the indegree centrality scores for the girls ranged from a low of 0.84 to a high of 1.0 (the maximum possible). Eighty percent of the girls received an indegree centrality score of 1.0, with the rest being quite high as well. Student 14 was the lowest-read female student, but even her score was fairly high.

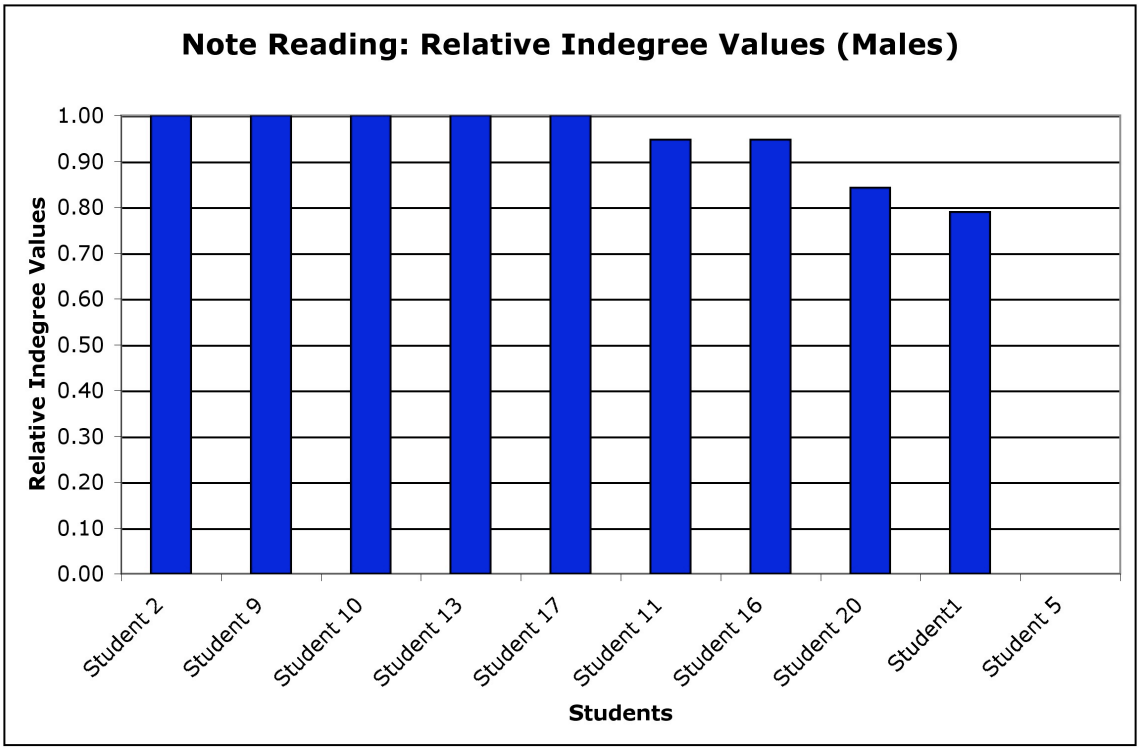

Figure 2. Indegree centrality scores for the boys, again with scores sorted from highest to lowest. Note the presence of a zero score, and that fewer boys scored 1.0 than the girls.

Figure 2 shows a considerable difference from the girls' scores. Here we can see that only half the boys scored 1.0 in relative indegree centrality, and there was one score of zero meaning that student 5 had no notes read. However, the difference between the boys and the girls is not as great as it first appears. While fewer boys received indegree scores of 1.0, two received scores above 0.9, which is still quite high.

Sociogram Results

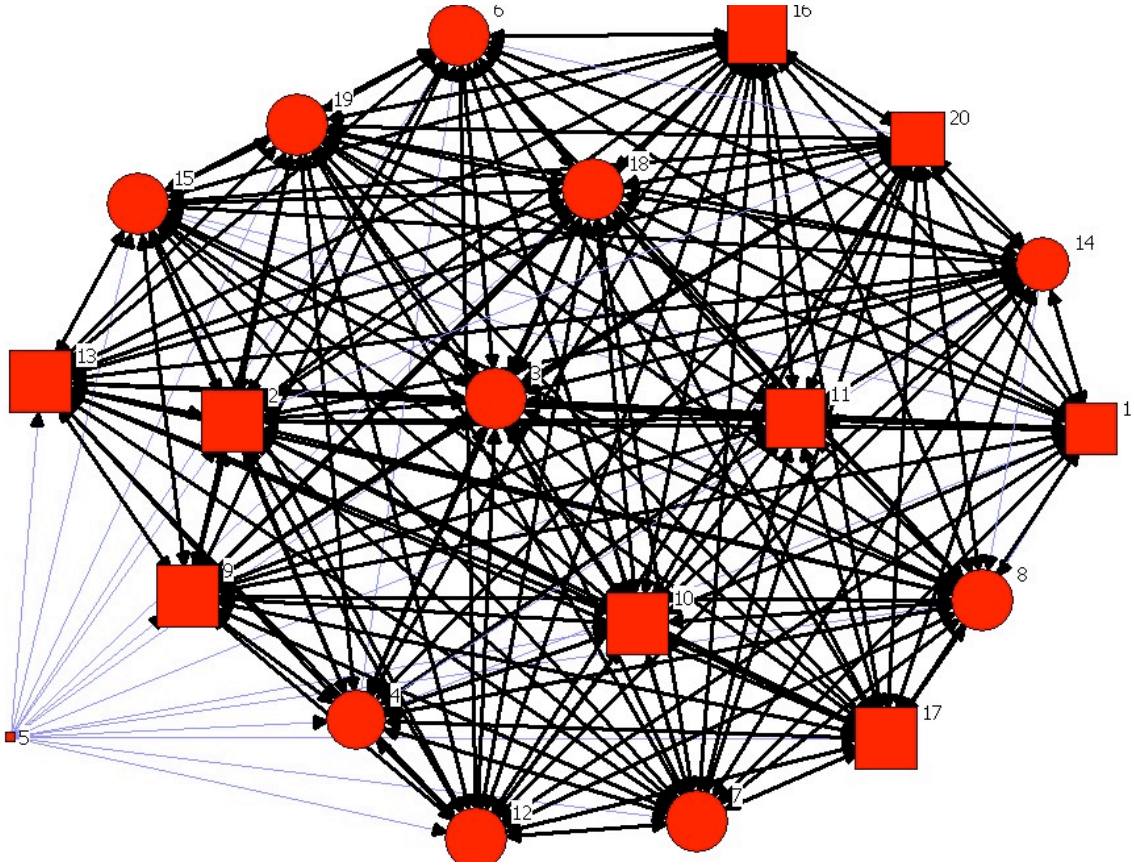

Figure 3. A sociogram showing three things: strong (reciprocal) ties being indicated as having two arrowheads and darker lines, and weak ties as having only one arrowhead and fainter lines; the gender of the actor, as indicated by circles for the girls and squares for the boys; and the relative indegree frequency indicated by the size of the node.

Figure 3 is more complex to read than the graphs, and needs a fuller explanation, as it shows quite a lot of information. In *Figure 3* there are two sorts of line. Double arrowheads and darker lines indicate strong (reciprocal) ties among students. Having one-way arrowheads and fainter connecting lines indicate weak ties. The shape of the node indicates gender, with circles representing girls and squares representing boys. Finally, size of the node indicates indegree frequency, with larger nodes indicating that notes by

that student have been read frequently and smaller nodes indicating that the student has been more seldom read.

As can be seen from *Figure 3*, the node sizes for most of both boys and girls are close to equal in size. Although the indegree centrality scores show variance, it is not as dramatic as the raw numbers make it seem. In this class, as regards note reading, one student stands out: student 5. Student 5 has read a number of notes, but no one appears to have read his notes (the square indicating a male.) As well, it can be clearly seen that the gender preferences shown in Palonen & Hakkarainen (2000) in which males tended to interact with males and females tended to interact with females are not present. In groups in which homophilous ties are strong, the boys would tend to cluster together and the girls would tend to cluster together, with weak-tie bridges between them. We do not see that here. Instead we see a closely clustered group with one outlier–again, student 5, who has only weak tie links with the other students as regards note reading. Weak tie links can be seen among the students, but strong tie links between males and females are frequent, as between students 11, 10 and 3, 7, and 14 which contain male-female interactions. Male-male interactions and female-female interactions are also present.

Note Contribution Results

Figures 4 & 5 how the differences in note contribution patterns among male and female students in the class.

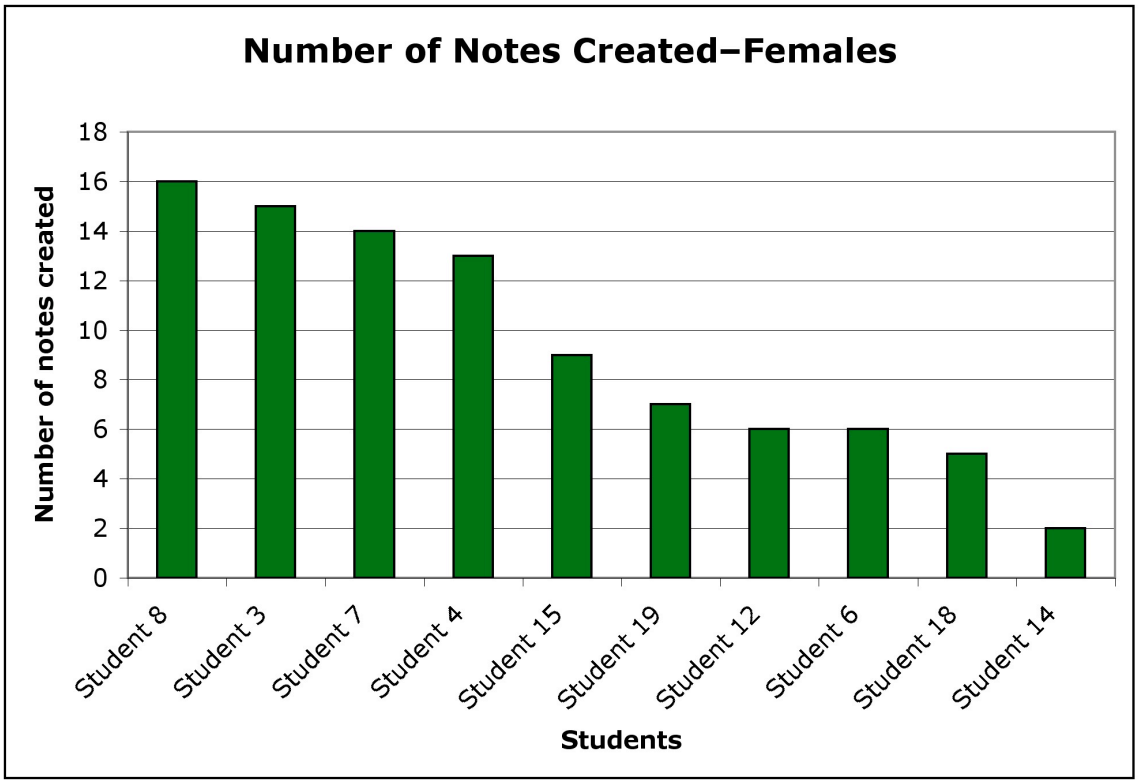

Figure 4. Note creation results for the girls, sorted highest to lowest. These range from a low of 2 to a high of 16.

As can be seen in *Figure 4*, there is considerable disparity in the numbers of notes contributed among the girls, with a low of only two notes contributed to a high of sixteen with the rest being distributed in an almost linear fashion.

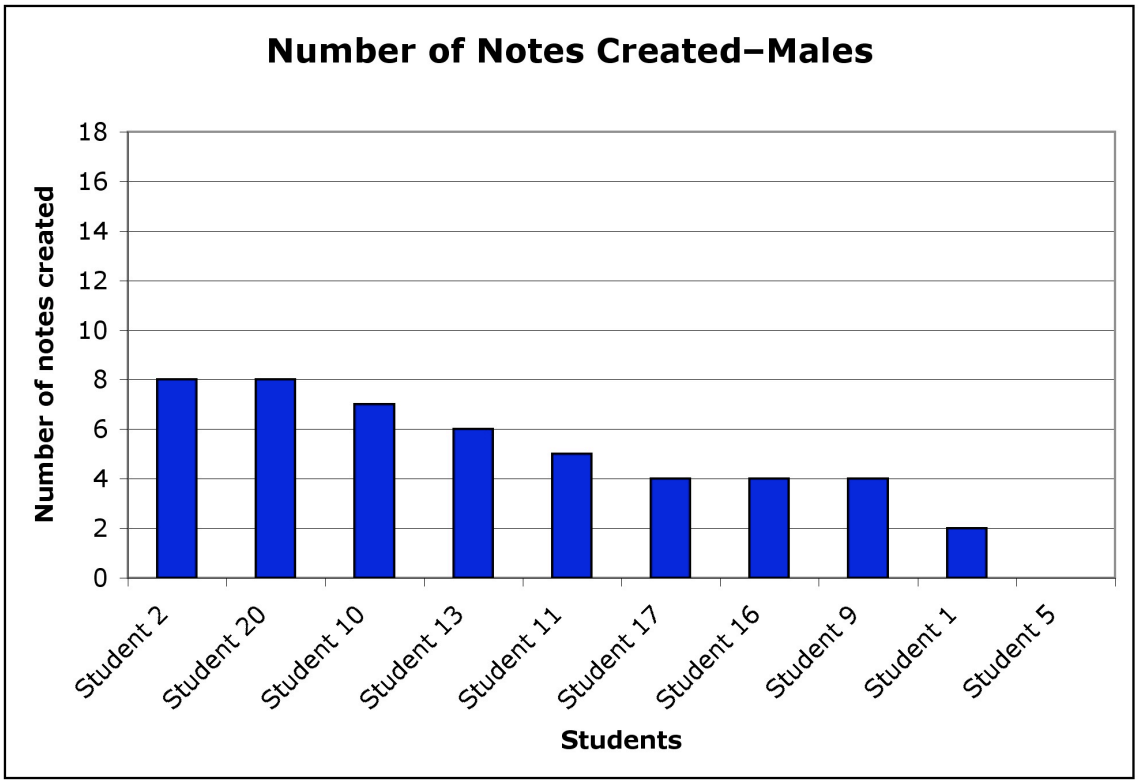

Figure 5. Note contributions by the boys. Again the data are sorted highest to lowest, and we can see a considerable difference in note contribution patterns. The boys' note contributions range from zero to eight, lower than those of the girls.

As can be seen in

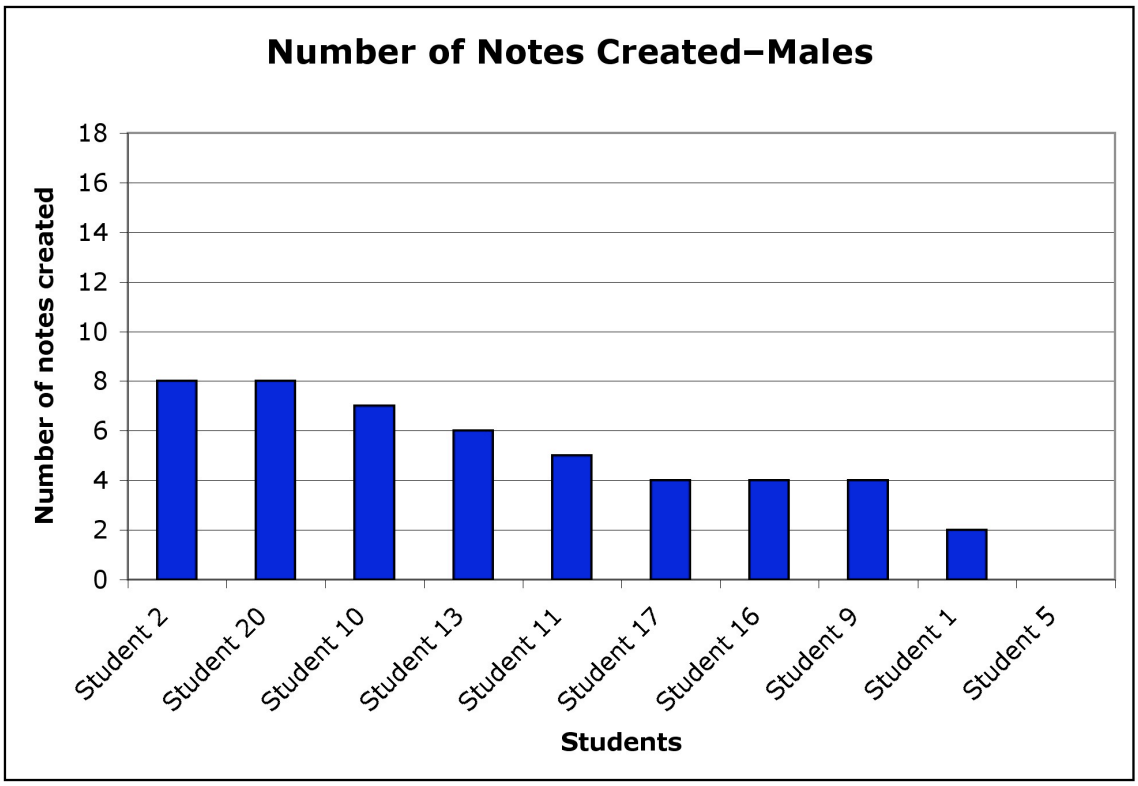

Figure 5, there is a considerable difference in the note contributions of the boys as compared to the girls. The boys' highest number of note contributions is only half the number of that of the girls. As well, the boys have one student (student 5) who has contributed no notes during the study period. Like the girls' contributions, the boys' note contributions decay in an almost linear fashion from the highest to lowest.

Discussion

This paper began noting the anecdotal evidence from teachers' knowledge building classes to the effect that gender differences were not evident in their classrooms. Evidence from social network studies was presented that homophilous groups were markedly preferred in students' friendship and acquaintance networks. Further, evidence from Palonen & Hakkarainen (2000) indicated that we would see gender differences with females reading more notes by females and males reading more notes by males– essentially two separate groups joined by weak tie bridges. However, what we have seen in this class is that females read notes by both females and males, and males read notes by both males and females. One male student's notes were not read, and examination of note contribution patterns reveals the he contributed no notes during the study period. He read notes, but did not contribute any of his own (although it is possible that he informally co-authored notes.) The sociogram evidence indicates that the disparity in male and female indegree centrality results is not as severe as the indegree centrality evidence might indicate. Node size (frequency of interaction) indicates that females and males are more equal in indegree than might be supposed from the indegree scores by themselves, and there is a large connected heterophilous component–enough so that it could be said that heterophilous groupings dominated. Tie strength analysis supports this analysis–there were female-female strong ties, male-male strong ties and male-female strong ties, indicating that the class had not fragmented into homophilous groups. However, there are important gender differences, with girls' notes overall being read more frequently than boys' notes.

Note contribution results indicate considerable disparity between the boys and girls, with the boys contributing just over half the number of notes as the girls. This makes the indegree centrality results somewhat surprising–the girls seem to be reading the boys' notes more often than notes by other girls. This last result supports Palonen and Hakkarainen (2000) who found that females tended to participate overall more than males. Girls' notes are read overall more often than boys' notes because they contribute more of them, and girls' note contribution rates are overall much higher than those of the boys.

Therefore, the teachers' anecdotal reports are both supported and not supported. Boys tended to contribute fewer notes than girls, and are therefore read less frequently, but nevertheless, the class did not fragment along gender lines as predicted by data from friendship networks. It is likely that the gender differences in note contribution rates have been masked by the lack of fragmentation along gender lines.

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