# An Analysis of the Social NetworkStructure of Knowledge Management Students at NTU

Guo Yanru, Zhu Xiaobo, Lee Chu Keong

*Abstract*—This paper maps the structure of the social network of the 2011 class ofsixty graduate students of the Masters of Science (Knowledge Management) programme at the Nanyang Technological University, based on their friending relationships on Facebook. To ensure anonymity, actual names were not used. Instead, they were replaced with codes constructed from their gender, nationality, mode of study, year of enrollment and a unique number. The relationships between friends within the class, and among the seniors and alumni of the programme wereplotted. UCINet and Pajek were used to plot the sociogram, to compute the density, inclusivity, and degree, global, betweenness, and Bonacich centralities, to partition the students into two groups, namely, active and peripheral, and to identify the cut-points. Homophily was investigated, and it was observed for nationality and study mode. The groups students formed on Facebook were also studied, and of fifteen groups, eight were classified as dead, which we defined as those that have been inactive for over two months.

*Keywords*—Facebook, friending relationships, Social network analysis, social network sites, structural position

## I. INTRODUCTION

THE rapid adoption of digital technology in the past few decades has markedly changed the way people communicate, work and live. Nowhere has this change been greater than in the lives of students.

Born in the digital age, today's studentsthink and process information fundamentally differently from their predecessorsdid – so differently that some researchers have given them new names. Prensky, for example,called them "Digital Natives",the word "native" being used as they are considered "native speakers" of the digital language, having grown up with devices like tablets and cell phones [1]. Prensky compared themto "Digital Immigrants", people who were not born into the digital age, but had, over time, become fascinated by its tools. White, on the other hand, recently coined the term "Digital Residents", to refer to the people who developed an online identity and tended to use the Web in many aspects of the lives, compared to "Digital Visitors", who only used the Web as a tool to solve problems whenever they arose [2]. To White, "Digital Residents" have chosen to integrate their working life and their online activities to a high degree, while "Digital Visitors" tend to log off after completing their online tasks. Prensky and Whiteareboth right. The students of today are comfortable using digital vocabularies and codes, and usenouns such as blogs and wikis, and verbs such as upload and tweet. They also develop identities in one or more Web 2.0 services. A category of Web 2.0 application that is extensively used by the today's students is the social networking site (SNS). SNSsare web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system [3].

Lee Chu Keong is with Nanyang Technological University, Singapore email:ascklee@ntu.edu.sg

Examples of SNSs are Facebook, MySpace, Renren, and Orkut. With over 845 million users at the time of writing (April 2012), Facebook is the leading SNS in English-speaking countries.In Singapore,Facebook has 2.6 million users. This means that 55.05% of the population of Singapore and 70.74% of its Internet users are Facebook users. In terms of user demographics, the two largest age groupsare 25-34years (33%), followed by 18-24years (26%). This mirrors the situation found in the United States, where the two largest age groups are 18-25 (35%) and 26-34(20%). From these statistics, we can infer that in both countries, students and young adults account for a large portion of Facebook users.

Singapore does not only have a high penetration rate of Facebook users, but also users that spend a considerable amount of time on it. An international study by Experian [4] on the use of social networks in different countries revealed that Singaporeans topped the world in terms of the time spent per session on Facebook, a whopping 38 minutes and 46 seconds! This was followed by users from New Zealand, Australia, and UK. The United States, where the Facebook phenomenon began, came in 5th place with 20 minutes 46 seconds, followed by France, India, and Brazil.

## II. LITERATURE REVIEW

Although social networks were traditionally maintained through face-to-face interactions, they are todayfrequently kept alive through technology, e.g., using telephones. Thompson studied the use of house phones, public phones and especially mobile phones, by two categories of foreign workers in Singapore, namely, domestic workers (almost exclusively female, and mainly from Indonesia and the Philippines) and construction workers (almost exclusively male, and mainly from Thailand and Bangladesh), to maintain their social networks, in Singapore and in their country of origin [5]. Because the cost of owning a mobile phone is relatively expensive for this category of workers, they have, over time, developed various strategies, like owning several SIM cards, to keep the cost low. For many foreign workers, the mobile phone has become a critical link to the networks in their home country. They telephone their family members (parents, children, and spouse), other relatives working in Singapore, former employers, and even boyfriends that they have never ever met!

Thompson found that mobile phones were especially important for facilitating the organisation of small networks in foreign worker communities. The activities organised range from tiny ones like arranging for face-to-face meetings with friends during 'off days' to large ones. Thai construction workers, for example, organised a largeannual football tournament (the "Thai Labour Cup"),involving up to twenty teams and lasting several months primarily using the mobile phone. The strength of the ties within the Thais and Filipina foreign workers communities in Singapore were found to be stronger simply becausemobile phone use is more prevalent in these communities.

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:6, No:10, 2012

On the other hand, the strength of the tieswithin the Indonesian and Bangladeshicommunities are less strong because of theirrelatively more limitedaccess to mobile phones. Thompsonconcluded that this is evidence that a mobile phone facilitates social networking, and fosters connection, community, and the "reproduction of community" (p. 375) between Singapore and their home countries.

Besides the use of the telephone, social networks are today maintained through social network sites (SNSs). SNSs offer the advantage such as lower cost compared with telephones, and they are more flexible with a more complete suite offeatures, such as emails, wall postings, instant messaging, video calls, photo and video uploads, etc. Users can also create groups to enablethe participation of more than two parties. Adamic, Buyukkokten, and Adar studied Club Nexus [6], an online community at Stanford University with 2,469 users and 10,119 links between them.

Club Nexus allowed users to send e-mails and invitations to their "buddies", chat, post events, buy and sell used goods, search for people with similar interests, be notified of their buddy's birthdays, place personal advertisements, and display their artwork or post editorial columns. As such, Club Nexus is arguably the very first SNS.

The rich profile data that was collected, which included information on the self-described personality of the members, enabled the researchers to correlate other attributes with personality type. They found that the number of buddies a user had was distributed highly unevenly, with most users listing just one buddy, and over 200 listing no buddies.

Adamic, Buyukkokten and Adar felt that the unevenness of the distribution of the number of buddies reflected the different levels of sociability in people, and the different levels of willingness to enter into social contacts in an online service. Homophily was observed between members of the same personality type. The researchers concluded that the structure of the social network in Club Nexus closely mirrored that of the community structure in Stanford University.

With its rapid rise in popularity, Facebook has recently attracted both academic and business attention. Ferguson studied the effectiveness of using Facebook to recruit prospective students in some colleges in the US [7]. Likening Facebook to a super-charged version of the word-of-mouth mechanism, Stutzman claimed that the way people use it to build networks is not different from the way they joina club or fraternity in search of others with common interests [8].

Adapting to college life is a major transition for many students. As with other life transitions, such as completing education, or relocating to a new city, it is a time of personal growth because of the many challenges it throws up. In addition, it is also a stressful time as it involves meeting new people, getting used to new settings, acquiring new information, and mastering new roles and identities.

Cognitively, a transition represents a change or an interruption in one's schema. Because of this, the individuals experiencing transition seek resources to help them construct a new schema to understand the world– they seek others with common interests.

Stutzman investigated how social network sites facilitate the transition by providing a location for two things: (1) the giving and receiving of social support during transition; and (2) the information required to integrate successfully into the transition environment. He concluded that social network site profile contributes significantly to the growth of the socio-technical network over the course of the semester, and online content creation and sharing behaviors are associated with individual network expansion.

Facebook users can be classified into mobile, semi-mobile and non-mobile [9]. Mobile users are those who access Facebook using "smart" mobile phones, and can therefore access Facebook anytime, anywhere. Semi-mobile users are those who carry their laptop with them to different places, e.g., classrooms, coffee shops and libraries for Facebook access. Lack of access to electricity supply or Wifi affects their Facebook usage. Non-mobile users of Facebook are those who access Facebook using desktop computers. Barkhuus and Tashiro found that how one access Facebook affected how many times one accesses it per day [9]. Unsurprisingly, mobile users access Facebook most frequently (6.9 occasions per day), followed by semi-mobile users (4.7 times per day), and lastly non-mobile users (2.6 times per day). They found that students used Facebook to communicate, and used the Wall and instant messaging for most frequently this purpose. Facebook was for the coordination of social gatherings, which ranged from meetings, lunch dates, and birthday parties. The management of peripheral friendships (i.e., those characterised by "weak ties") was supported by Facebook, and it was particularly useful in cultivating relationships with whom the students specifically did not want to develop a close relationship.

Kapucu, Yuldashev, Demiroz, and Arslan used social network analysis to study the interactions between students in a Master of Public Administration programme at the Department of Public Administration of the University of Central Florida [10]. Twenty-eight (out of twenty-nine) students attending an elective course filled out survey forms designed to uncover the friendship and work-advice relationships. The surveys were conducted twice: once at the beginning and another at the end of the semester. This enabled the researchers to understand how the two networks evolved over the semester. The two networks (friendship and work-advice) were studied because they reflected fundamentally different types of interactions. While the work-advice network includes student interactions based mainly on class work, the friendship network includes those based on extracurricular relationships.

The researchers found that the friendship network among class members developed considerably during the term, as indicated by the increased number of ties reported at the end of the term. A parallel increase was also observed in the work-advice network. Due to the implementation of various collaborative teaching activities, namely, response and term papers, class discussions, a simulation, and a site visit, which required the students work in teams, the connectivity in the work-advice network increased. The number and size of cliques also increased in tandem with the increase in connectivity.

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:6, No:10, 2012

Cliques which can represent either formal or informal groups, emerged over the course of the academic term, evidence that the collaborating learning techniquesthat were implemented during the semester succeeded in increasing student interactions.

Granovetter proposed that the strength of a tie is related to a combination of four factors, namely, the amount of time, the emotional intensity, the intimacy (mutual confiding), and reciprocal services which characterise the tie [11]. Although the four factors are independent, they are highly correlated.

A high amount of the combination of four factors is characteristic of a strong tie, and vice versa. Granovetter found that those people to whom one is weakly tied are more likely to move around in different circles than the person himself. In other words, the degree of overlap of the friendship networks of two individuals is related to the strength of the tie between them. The stronger the tie, the greater the degree of overlap of their friendship networks is.

The result of this is that paradoxically, although those with whom one has strong ties are more motivated to offer job-related information, they are less likely to be able to offer opportunities that are not already known to the job seeker.

Weak ties are therefore an important source of information when one is searching for new career opportunities. In such situations, individuals with few weak ties will be at a disadvantage as they will be deprived of information from the more remote parts of their social network. They will be limited to only the information available to their cliques, and close friends.

## III. THE MSC (KM) PROGRAMME

The Master of Science (Knowledge Management) programme had its beginnings as a special topic within the Master of Science (Information Studies). After two years of piloting, the programme was officially launched in2002, with only the part time study option.

In 2006, the programme was offered for the very first time, on a full time basis, and international students were admitted. Today, more than half of the students are from China and India. Up to 2011, 325 students havesince graduated from the programme. For AY 2011/2012, sixty new students were admitted from both Singapore and overseas, especially from China and India. All students are expected to finish nine courses and a critical inquiry project, or eight courses and a dissertation before graduation.

Full time students generally complete the programme in two semesters (approximately 10 months), while part timers complete it in four to five semesters (2 to 2½ years). Students are required to group together with other classmates for the team assignments, and because of this, some of the students start Facebook groups to coordinate their work.

## IV. METHODOLOGY

This research used the techniques of social network analysis (SNA), a set of methodological tools that focuses on the relationships among social entities, typically, people, and on the patterns and implications of these relationships [12].

As SNA focuses on uncovering the patterns of people's interaction, it allows researchers and practitioners to see how actors are located or 'embedded' in the overall network [13]. SNA assumes that interpersonal ties matter, as do ties among organisations or countries, because they are the means by which behavior, attitudes, information, or goods are transmitted. With increasing research interest, SNA has been applied to study organisational behavior, inter-organisational relations, social support, information flow, knowledge creation and the spread and control of contagious diseases. Through its focus on relationships, SNA captures the interactions and connections between different social entities (e.g., individuals, groups), and enables the researchers to study individual actions and behaviors within the context of larger structural configurations [14].

The participants of the paperare the 60 students of the 2011 class of the Master of Science (Knowledge Management) programme at the Nanyang Technological University. After consent was obtained, data was collected from each participant over a four-day period using a questionnaire which required participants to list all their Facebook friends from the class, and from the seniors and alumni. This information formed the basis for the relational data. Other information collected from each participant was gender, nationality, mode of study, and total number of Facebook friends. Lastly, they were asked whether or not they had other Facebook accounts, or an account in other social networking sites like Renren. This question was asked as we suspected that many of the students from China maintained an account on Renren.

Revealing who one befriends on an SNS is sensitive as at the same time, it also reveals who one has not befriended. Because of this, research participants could feel threatened. Therefore, the first step we took was to mask the identities of the participants by anonymising each name using a coding system. The code included information about the gender ("M" for male and "F" for female), mode of study ("FULL" for full time and "PART" for part time), country of origin ("SG" for Singapore, "CN" for China, "IN" for India, "MY" for Malaysia, "MM" for Myanmar, "ID" for Indonesia, "RU" for Russia, "IS" for Israel, "PH" for Philippine), year of enrolment, and a unique number at the end. For example, "F_FULL_CN_2011_58" refers to a female student from China who enrolled into the MSc (KM) programme in 2011, and who is pursuing her studies full time. The seniors and alumni were coded in a slightly simpler way. "M_CN_12" indicates a male senior or alumnus from China. There are 46 seniors and alumni who have befriended students from AY2011 cohort.

The information collectedon gender, nationality, mode of study, and total number of Facebook friends was then compiled and statistically analysed using Microsoft Excel. The relational data was then analysed using UCINet Version 6 and Pajek Version 2.05.

The DL files were then read into UCINet for analysis. UCINet was used to compute the density, centralities, to partition the class intoactive and peripheral members, and to identify the cut points in the network.

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:6, No:10, 2012

Pajek was used to plot the class-members-only sociogram (Fig. 1), and the class-members-with-seniors-and-alumni sociogram (Fig. 2). The Facebook groups that were started by the participants were studied, with the date of the latest activity noted. If it was inactive for two months, it was classified as "dead". Otherwise, it is "alive".

## V.    RESULTS AND DISCUSSION

The 2011-12 cohort of MSc (Knowledge Management) students comprise 60 students from seven countries. table I shows the breakdown of the students according to gender and mode of study, and table II shows the breakdown of the students according to nationality and mode of study.

TABLE I
STUDENTS BREAK DOWN ACCORDING TO GENDER AND STUDY MODE

| Gender | Part Time | Full Time | Total |
|---|---|---|---|
| Male | 14(53.8%) | 9 (26.5%) | 23 (38.3%) |
| Female | 12(46.2%) | 25 (73.5%) | 37 (61.7%) |
| Total | 26 (100.0%) | 34 (100.0%) | 60 (100.0%) |

TABLE II
STUDENTS BREAK DOWN ACCORDING TO NATIONALITY AND STUDY MODE

| Nationality | Part Time | Full Time | Total |
|---|---|---|---|
| Chinese | 7 (26.9%) | 23(88.5%) | 30 (50.0%) |
| Filipino | 0 (0.0%) | 1 (3.8%) | 1 (1.7%) |
| Indian | 2 (7.7%) | 6 (23.1%) | 8 (13.3%) |
| Israeli | 1 (3.8%) | 0(0.0%) | 1 (1.7%) |
| Myanmar | 5 (19.2%) | 0 (0.0%) | 5 (8.3%) |
| Russian | 0 (0.0%) | 1 (3.8%) | 1 (1.7%) |
| Singaporean | 11 (42.3%) | 3 (11.5%) | 14 (23.3%) |
| Total | 26 (100.0%) | 34 (100.0%) | 60 (100.0%) |

### A.    The Sociograms

Fig. 1 shows the sociogram for the Facebook friending relations within the class. The four isolates in the class show up clearly, and visually, the network seems to be made up of a dense core, and a less dense periphery. Fig. 2 shows the sociogram for the network including seniors and alumni. Again, the network seems to have a dense core of active members, and a periphery that is less dense.

On Facebook, a person clicks on the "Add Friend" button to add a person to his or her social network. This suggests that a directed network should be used, as there is an "adder" and an "addee". In practice though, many people forget who added whom, and Facebook represents friendships without differentiating the "adder" and the "addee". Therefore, a decision was made to model the network as an undirected one.
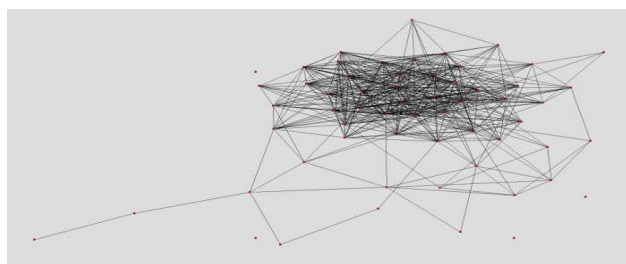


Fig. 1 Sociogram of the Facebook friends within the KM class
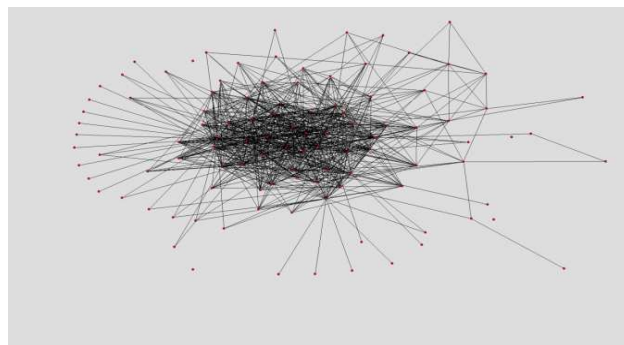($n = 60$)



Fig. 2 Sociogram of the Facebook friends of the KM class with seniors and alumni($n = 106$)

### B.    Density

One of the most widely used concepts in graph theory is that of "density" [15]. Although 1,042 links exist among current students, the value of $l$ used for computing density and centrality is 521.

The network density within the 60 KM classmates is 29.4%, which means that on average, one student has approximately 17 other classmates as Facebook friends.

### C.    Inclusivity

Since density can be influenced by other factors such as the network size and the network type (e.g., love networks tend to be much less dense than friendship networks),we explored the inclusivity in the network as well.

For friending relations with classmates, four isolates were discovered. The isolates are of two types. One of the fourisolates is an isolate because he does not maintaina Facebook account.

The other three isolates are different in nature as theyare isolates not because they do not maintain Facebook accounts, but becausetheyhave no connections with any other students in the class, seniors or alumni. This suggests that we should compute two different inclusivity measures.

The "normal" inclusivity is $\frac{56}{60} = 0.93$ for the KM class network, withfour studentsexcluded from the network. The rest of the 56 students are reachable in some way. We propose an alternative inclusivity measure that includes only the members of the network that maintain Facebook accounts.

This makes more sense in the social network analysis of SNSs as a person without an account cannot possibly be connected to the network, and hence it is more reasonable to exclude them from the denominator.

We propose calling this the "effective inclusivity" of a network. Therefore,the effective inclusivity of the class network is$\frac{56}{59} = 0.95$, since unlike the other three isolates, this student "M_FULL_CN_2011_47" is an isolate because he does not have a Facebook account.

### D.    Centrality

The concept of centrality was applied to human communication studies as early as 1948 [16]. Since this pioneering work, a number of competing concepts of centrality have been proposed.

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:6, No:10, 2012

As a result of these different measures of centrality, there is considerable confusion in this area. We computed four centrality measures, namely, degree centrality, global centrality, betweenness centrality and Bonacich centrality. The four centrality measures will be discussed in turn below.

### 1. Degree Centrality

For the group that only consists of current KM students, the average degree centrality is 17.37, meaning that on average, a student has approximately 17 other classmates as his Facebook friends. The student "F_FULL_CN_2011_12"has thehighest degree centrality and is adjacent to 37 other classmates. Being completely disconnected from the rest in the network, four students have a degree centrality of zero, and are therefore isolates. The standard deviation of degree centrality is 11.67, therefore 95% of the degree centrality values falls within two standard deviations of the mean, or from 0 to 41. What this means is that 95% of the class have between 0 to 41 Facebook friends within the class.

When the seniors and alumni are added to the network, the degree centrality of 49 of the students is increased, but over 60% of their friends are still with their classmates, i.e., over 60% of the ties are within-cohort. Our results are consistent with those of Stutzman [8],who found that within-cohort ties account for 60%-85% of total ties reported by freshmen. Although the student "F_FULL_CN_2011_12"has the highest degree centrality in the classmates-only network, her ranking falls in the network that includes seniors and alumni as there are students (e.g., "F_FULL_CN_2011_21") who are better connected to the seniors and alumni than she is. In addition, besides the four isolates, seven others who have Facebook friends among their classmates have no friends among the seniors and alumni. We deduce that just because a student is well-connected to hisclassmates, it does not automatically follow that he will be as well-connected to a larger group that includes his seniors and alumni.

### 2. Global Centrality

Global centrality is only applicable for networks with no isolates. Therefore, the four isolates were removed (resulting in a network of size 56) before computing the global centrality values. Among the students, "F_FULL_CN_2011_12" and "F_FULL_CN_2011_21" toppedthe degree centrality ranking.

It was found that they also ranked the top two in global centrality, which means that they are geodesically closer toall other students than their friends. For the two networks, students' local centrality and global centrality are relatively consistent,with only a maximum of four ranks difference between the two centrality rankings.

The only exception to this is the ranking of two students, "F_FULL_CN_2011_48", who moved up by 8 rankings, and "F_PART_SG_2011_16" down by 9 respectively. This is quite remarkable in a network of just 56 connected nodes. For the case of"F_PART_SG_2011_16", she ranks 22nd in degree centrality with 22 KM friends. But her friendsare well-connected, and this results in herglobal centrality ranking being moved upto 14th place.

### 3. Betweenness Centrality

The student with highest betweenness centrality is "M_PART_SG_2011_51". With a very low degree centrality of 4, he ranks the top in betweenness centrality, because he is one of the only two students that can get to "M_PART_SG_2011_32"and "M_PART_SG_2011_01". Heconnects the two students with other students in the class and acts as a bridge that bonds the network together, hence his high betweenness centrality value.

On the other hand, although "F_FULL_CN_2011_21" ranks second on degree centrality due to large number of friends she has, her betweenness centrality only comes 13th. It is because the people she is connected with are also well connected with others, as they are located in a relatively central part of the network.

### 4. Bonacich Centrality

As shown in the results, "F_FULL_CN_2011_12", "F_FULL_CN_2011_21" are clearly still the most central students. This is because they not only have high degree (as suggested by their degree centrality), but are also connected to each other, as well as are connected to other students with high degree and global centralities. "F_FULL_SG_2011_31" moves down from 6th in degree centrality to 11th in Bonacich centrality, which shows that she is connected to some people who are less well-connected than she is, and they weaken her power and influence in the network.

### 5. Centrality Measures: A Summary

Four different centrality measures have been used to characterise the actors in the network, providing a moreholistic understanding of the important nodes in the social network. One node's centrality is affected not only by numbers of links it has, but also by numbers of links its adjacent nodes have. Other factors such as size of network, the inclusiveness of the network, the centrality of one's neighboursimpactsthe structural location of the node.

In a larger population, the centrality measures might show significant differences when the nodes are ranked, but since our network is made up of only 60 students, the variations are not significant. Still, although the ranking based on the different centralities were consistent, several students saw significant shifts of up to nine positions.

### E. Active and Peripheral Members

We can see that only three part-time students are in the active member group, the other30 members in this group are full-time students. This is not surprising, as participation in an SNS takes time, something full-time students are better able to afford. On the other hand, there are only five full-time students in the peripheral group, which is dominated by the part-time students. Density within active group and peripheral groups is shown in table III.

TABLE III
INTERGROUP AND INTRAGROUP DENSITY MATRIX

|  | Active | Periphery |
|---|---|---|
| Active | 74.3% | 11.0% |
| Periphery | 11.0% | 8.7% |

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:6, No:10, 2012

The results of this section agree with Wenger, McDermott and Snyder, who argued that different levels of participation should be expected in any community [17]. Members who are active participate regularly in community forums and assume a leadership position by identifying topics of interest, while peripheral members keep to the sidelines and carry less authority than the active members.

### F. Homophily

Tables IV, V and VI show the total number of friends that the participants have, broken down into gender (table IV), mode of study (table V) and nationality (table VI). For example, 509 in table IVmeans that the number female friends that current female KM students have on Facebook add up to a total of 509.

TABLE IV
FRIENDING BEHAVIOUR ACCORDING TO GENDER

| Gender | No. of Students | Female Friends | Male Friends | Total Friends |
|---|---|---|---|---|
| Female | 37 (61.7%) | 509 (69.9%) | 219 (30.1%) | 728 (100.0%) |
| | | 13.8 female friends | 5.9 male friends | 19.7 friends per female student |
| Male | 23 (38.3%) | 218 (69.4%) | 96 (30.6%) | 314 (100.0%) |
| | | 9.5 female friends | 4.2 male friends | 13.7 friends per male student |

Table IV shows that the female students have more female and male friends (hence, also more total number of friends) than the male students.

A weak gender homophily (female students tend to make friends with female students)is observed in female students in class as the percentage of female friends (69.9%) is greater than the percentage of females in the class (61.7%). However, the reverse has been observed for the male students.

The male students too, prefer to befriend female students (69.4%, which is greater than the expected 61.7%), rather than male students (30.6%, which is smaller than the expected 38.3%).

Table V shows that full-time students are more extensively connected to their classmates than part-time students. This is possibly because part time students work full time, and only take two courses in the first semester, compared to the five courses typically taken by full-timers. This means that they have a limited time to interact with their classmates.

TABLE V
FRIENDING BEHAVIOUR ACCORDING TO STUDY MODE

| | No. of Students | Part Time Friends | Full Time Friends | Total Friends |
|---|---|---|---|---|
| Part Time | 26 (43.33%) | 80 (39.60%) | 122 (60.40%) | 202 (100.0%) |
| | | 3.1 PT friends | 4.7 FT friends | 7.8 friends |
| Full Time | 34 (56.67%) | 124 (14.74%) | 717 (85.26%) | 841 (100.0%) |
| | | 3.6 PT friends | 21.1 FT friends | 24.7 friends |

Part time students come to school on less frequent basis; often just to attend classes (and often just in the nick of time) and they leave right after the class ends at about 10:00 p.m. As fulltime students focus their attention on studies and stay on campus for a much longer time, they get to interact with each other much more often It is therefore natural that they have more friends. Homophily is strongly observed for the full time students as 85.3% of their Facebook friends are fellow full time students, as compared with the expected 56.7%.

TABLE VI
FRIENDING BEHAVIOUR ACCORDING TO NATIONALITY

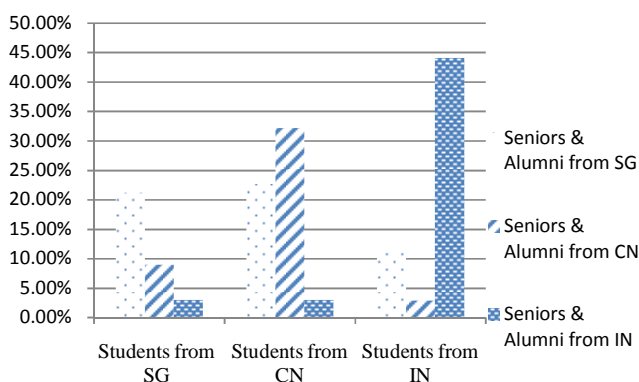| | Alumni from SG | Alumni from CN | Alumni from IN | Alumni from Other Countries | Total No. of Alumni Friends |
|---|---|---|---|---|---|
| Students from SG | 7 (21.2%) | 3 (9.0%) | 1 (3.0%) | 22 (66.6%) | 33 (100%) |
| Students from CN | 53 (22.7%) | 75 (32.2%) | 7 (3.0%) | 98 (42.1%) | 233 (100%) |
| Students from IN | 4 (11.8%) | 1 (2.9%) | 15 (44.1%) | 14 (41.2%) | 34 (100%) |



Fig. 3 Student friending behaviour according to nationality

From the friending relationships with seniors and alumni, significant homophily based on nationality is observed. Students are more inclined to befriend a senior or alumni with same nationality on Facebook. People are more likely to have contact with those who are closer to us to geographic location than those who are distant. Since people coming from the same country generally speak the same language, communication is easier and common cultural issues are understood immediately during interaction. With distinct cultural differences in these three countries, shared tastes are more likely to happen with people from same country. Smooth coordination of activity and communication is another possible reason. For example, different holidays are celebrated in different cultures, and students tend tocelebratethem with people from same country. Taking into account Ellison, Steinfield, and Lampe's finding that people tend to use Facebook to maintain offline relationships or solidify offline connections [3], it is not surprising to obtainthese results.

### G. Facebook Groups Set Up By Students

The Facebook groups that have been started by the Knowledge Management students were identified and studied. Fifteen such groups were found.

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:6, No:10, 2012

Facebook groups are essentially small groups, which Trenholm defines as a collection of three or more interacting individuals who have a collective perception of their membership, who depend on each other to the extent that any action affects all members, and whose behavior gradually becomes structured and patterned [18]. The name, number of members, and date of last relevant posting of each Facebook group started by the KM students were noted. From this information, a Facebook group is categorised as "dead" if no postings relevant to the objectives of the group were made within the last two months. For example, for the group, "WKW SCI KM 2011/12-Presentation Improvement CoP", a posting was made on January 25, but it had nothing to do with presentation skills, and was deemed unrelated to the subject matter of the group. It is therefore classified as "dead". Three types of groups were identified.

Academic groups are groups that have been started for discussing academic matters, pertaining either to a module, or to a skill required in the course. Because of the general scope of such groups, they are typically large. Two academic groups were found. The "Presentation Improvement CoP" sought to improve the presentation skills of its members, while the "KM CoP" group, which had more seniors and alumni than current students, had the objective of discussing matters pertinent to knowledge management in general.

TABLE VII
ACADEMIC GROUPS STARTED BY KM STUDENTS

| Academic Groups | No. of Members | Date of Last Relevant Posting | Status |
|---|---|---|---|
| WKW SCI KM 2011/12-Presentation Improvement CoP | 32 | January 16, 2012 | dead |
| KM CoP | 57 | March 16, 2012 | alive |

Participation in the two academic groups was low. This agrees with the results of several researchers into the uses of Facebook for academic purposes, for example Selwyn studied students' educational use of Facebook, and found that a mere 4% of a total of 68,169 wall postings were related to education-use, with no significant difference in terms of education-related Facebook activity by students' gender, year of study or assessment marks [19]. Another research done by Santos, Hammond, Durli and Chou found that students in Singapore used social networking sites for social interactions only [19]. They preferred to use SNSs to interact with their friends and to "relax", rather than for professional networking or academic discussions. Research by Roblyer, McDaniel, Webb, Herman, and Wittyinto the use of Facebook to support classroom work showed that only 5 students (out of 120) used Facebook to communicate on class projects [21]. Joinson found that of the seven uses of Facebook he identified through factor analysis, participation in groups was the least frequent activity [22]. Some possible explanations of why academic use of Facebook is low are discussed at the end of this section. Assignment groups are those that have been started with the intention of coordinating the work related to an assignment in a course.

These groups typically have a very small membership as they comprise only the members of the assignment group, and are usually abandoned after the completion of the course.

TABLE VIII
ASSIGNMENT GROUPS STARTED BY MSC (KM) STUDENTS

| Assignment Groups | No. of Members | Date of Last Relevant Posting | Status |
|---|---|---|---|
| KM-Assets-Group | 3 | March 17, 2012 | alive |
| Semester2-CI-Best practices | 3 | March 16, 2012 | alive |
| K6234 Storytelling Group Discussion | 3 | March 15, 2012 | alive |
| KM-BI-Sem2 | 7 | March 17, 2012 | alive |
| KM-Measurements-BSC exercise1 | 3 | March 14, 2012 | alive |
| Intellectual Capital Assignment | 3 | November 2, 2011 | dead |
| WKW Data Mining Exam | 12 | November 18, 2011 | dead |
| K6213 Technologies Term Paper | 3 | November 15, 2011 | dead |
| NTU Information Entrepreneurs | 7 | October 26, 2011 | dead |
| K6201TermPaper | 3 | November 14, 2011 | dead |
| MSc Information Studies/Systems/KM (NTU) | 5 | December 6, 2011 | dead |

Unbelievably, all 11 groups have been started by the same student, "M_FULL_RU_2011_20", who is passionate about using Facebook for academic discussions. De Villiers stated that there is seldom a balanced level of representation among the participants in online study groups [23], with some members participating enthusiastically and others less so. It seems that this unbalanced level of representation also applies to the starting of groups, with a few individuals more inclined to start groups, and other individuals, happy just to participate.

The last category of groups issocial groups. These groups also tend to be large, and they were stated to encourage communication and social networking among students. According to the founder, "M_MY_09", "My Open Recommendations" was to "build a community by sharing personal recommendations", while "Happy KM 2012", comprising only Chinese students, was initiated to become a place where students could seek help and useful information from each other.

The results are influenced by the higher activity levels of certain participants. "My Open Recommendation"'s founder, "M_MY_09"'s postings account for more than half of the total number of postings there. "Happy KM 2012" was used to organise events and activities outside school, before it was abandoned. Further investigation revealed that the same group of Chinese students founded another group in QQ (which is the most popular instant messaging (IM) platform among Chinese students), and that group has been the major channel of communication for Chinese student since.

In general, the postings on the Facebook wall indicate that the postings tend to drift away from the original intention of the group. Information related to academic matters is also exchanged on Facebook walls, although on a less frequent basis.

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:6, No:10, 2012

TABLE IX
SOCIAL GROUPS STARTED BY KM STUDENTS

| Social Groups | No. of Members | Date of Last Relevant Posting | Status |
|---|---|---|---|
| Happy KM 2012 | 17 | November 20, 2012 | dead |
| My Open Recommendations | 53 | March 17, 2012 | alive |

A possible explanation for the lack of use of Facebook for academic discussions is that students may use other means to discuss their studies, such as other technologies (e.g., Skype, phone calls), or face-to-face discussions. The Chinese students in the KM Program prefer QQ (the most popular IM platform in China), while the Indian students preferred Gtalk (an IM tool offered by Google). Although a survey [21]has found that students communicate as much on Facebook as they do with technologies traditionally used (e.g., email), the communicative requirements of postgraduate students are more complex and most students would simply congregate on campus for direct face-to-face meetings.

Second, students in Singapore have more access to learning resources such as libraries and reading rooms. The Asian Communication Resource Center Library is equipped with most of the reference books for KM programme, and is conveniently located on the first floor in school. In addition, the NTU library has also built learning commons for the use of students. This facilities and resources support the face-to-face discussions required for student to complete their assignments. Third, Roblyer [21] showed that university faculties generally do not regard Facebook as a tool for education. They neither use Facebook for educational purpose, nor do they encourage students to use it. The lack of Facebook use by faculty members possibly contributes to the low educational usage of Facebook among students. Lastly, Santos et al. [20] suggests that students in Singapore may not realise the value in using SNS for study purpose. While Brazilian students use Facebook for both social and academic reasons, students in Singapore only use it for social ones.

*H. Number of Friends on Facebook*

The number of friends on Facebook (for students who had an account) ranged from 14 to 1,084. The average number of friends per student was 238, and the standard deviation,199.1. When ranked according to the number of Facebook friends, most Chinese students appear at the bottom of the list. On the surface, it appears that they have very few Facebook friends. Upon closer examination, though, the real reason for the low numbers becomes clear. Most of the Chinese students have enrolled in the full-time programme, and they have been in Singapore only since the start of the programme. As Facebook is banned in China, the Chinese students only started their account when they came to Singapore, while the others had a "head start" in their Facebook usage. So for the Chinese students, it will be more accurate to take both the number of their Facebook and Renren friends into account. We have decided to list the number of friends in Facebook and Renren in separate columns, and not to add them together,since this inevitably leads to double counting as some students are friends of the same person in both Facebook and Renren.

*I. Cut-Points in the Sociogram*

Two students have been identified as cut-points ("M_PART_SG_2011_51" and "M_PART_SG_2011_51"). If they are removed from the network, then the network will fragment into three separate ones. Two cut-points are merely 3.6% (<10%) of the network. This indicates that the network is robust and will not easily fragment due to the elimination of members [14].

## VI. LIMITATIONS

This paper used social network analysis (SNA) to study the structure of the relationships between KM students at NTU. While SNA provides a powerful lens into the social structure of the student network, it is not the only lens available to understand the relationships among students. Other lenses, e.g., ethnography, should be used to gain further insight into the social structure. This paperwas carried out based on the friending relations on Facebook. The undirected network sociogram is plotted out to provide an overview of how students are linked and their position in the network. However, Facebook is definitely not the only way that students interact with each other– they meet during and after classes, go out together for karaoke sessions, and discuss assignments face-to-face. SNA studies should therefore be done in conjunction with information from other sources, such as more detailed questionnaires, other social networking tools that they use, places they frequent, etc.

## VII. FUTURE WORK

Writing before Facebook started, Dertouzos [24] rightly pointed out that just because information technology allows us to reach thousands of people, it does not mean that we will. Calling the enhanced connectivity with others "electronic proximity", he reminds us that because we are still human beings, we are still limited in the number of human contacts we can cognitively handle at any given time. This limit is likely to apply to one's Facebook friends as well. Just because a student has 600 Facebook friends does not mean he has cemented a strong relationship with each and every one of them. In other words, "600" is merely his "electronic proximity". Many among the 600 are likely to be people that will never ever be contacted again. These are the people one meets at conferences, on holidays, etc. One is likely to have far fewer "real" friends. An interesting extension to this research therefore, will be to develop a typology of Facebook friends. Typologies of Facebook users have already been suggested, but we have not been able to locate a typology of Facebook friends.

Due to time limitation, the friend relationship data was collected over a four-day period, as a snapshot, while students continue to form new friendships after this period. A longitudinal study of the time evolution of Facebook friendship could be performed. Asthe number of one's Facebook friends changes during the one-year Master programme, one's individual structural position might change correspondingly, with new central stars emerging, old ones disappearing, perhaps resulting in a more closely-knitted network.

## VIII. CONCLUSIONS

This study examined the structure and configuration of the social network among the knowledge management students admitted into the programme in July 2011. The friending relationship on Facebook was used as a basis for constructing the social network. The KM class has an inclusivity of 0.93, which means that 93% of the students (all except 4 students) are connected on Facebook. The "effective" inclusivity of the network is 0.95. The difference in the values of the inclusivity and that of the "effective" inclusivity is due to the fact that one student is unconnected because he does not have a Facebook account.

The student network has a density of 29.4%, which means that on the average, a student is connected to 29.4% (or 17) of his classmates. From the different centrality measurements (degree, global, betweenness and Bonacich centralities), different individuals occupy different structural roles due to theirspecific locations within the network. The students have been divided into active and peripheral members within the social network,using UCINet's Blocked Adjacency feature. The two groupsreflectthe different levels of Facebook usage, and to some extent, the time available to full-time and part-time students, to engage in online relationships. Full time students have more time, and they form the majority in the active member group. Part time students have much less time, and in turn, form the majority in the peripheral group. Through the number and type of postings in Facebook groups, we conclude that it is difficult to maintain an active Facebook group, especially when it is related to academic matters. Assignment groups are abandoned right after the course is over, academic groups languish due to a lack of participation from members, and social groups sometimes drift from their original purpose. Facebook groups require joint efforts and contributions from members to stay alive.

Homophily was observed in the relations between KM students. Through a comparison ofgender, mode of study, and nationality, homophily based on the latter two factors were found to be strong. Full time students tend to befriend other full time students, and students tend to befriend seniors and alumni from their home country. Two students were found to be cut-points in the network. As they form only 3.6% of the network, it indicates that the network is robust, and will not fragment easily. Lastly, suggestions on how this work can be extended were proposed.

## REFERENCES

[1] Prensky, M. (2001). *Digital Natives, Digital Immigrants*. Retrieved on March 5, 2012 from: http://www.marcprensky.com/writing/prensky%20-%20digital%20natives,%20digital%20immigrants%20-%20part1.pdf

[2] White, D. S., & Le Cornu, A. (2011).Visitors and Residents: A new typology for online engagement. Retrieved on March 5, 2012 from: http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/3171/3049

[3] Ellison, N. B., Steinfield, C., & Lampe, C. (2007). The benefits of Facebook "friends:" Social capital and college students' use of online social network sites. *Journal of Computer-Mediated Communication*, *12*(4), 1143−1168.

[4] Experian. (2011). *The local network: Experian analysis highlights which countries spend longest on Facebook*. Retrieved on April 12, 2012, from: http://www.experianplc.com/news/company-news/2011/27-09-2011.aspx

[5] Thompson, E.C. (2009). Mobile phones, communities and social networks among foreign workers in Singapore. Global Networks, 9(3), 359380.

[6] Adamic, L.A., Buyukkokten, O., & Adar, E. (2003). A social network caught in the Web. *First Monday, 8*(6). Retrieved April 5, 2012 from: http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1057/977

[7] Ferguson, C. (2010). *Online social networking goes to college: Two case studies of higher education institutions that implemented college-created social networking sites for recruiting undergraduate students*. Ed.D. dissertation, University of Pennsylvania, United States − Pennsylvania. Retrieved February 22, 2012, from Dissertations & Theses: Full Text (Publication No. AAT 3410480).

[8] Stutzman, F. D. (2010). *Networked Information Behavior in Life Transition*. Ph.D. dissertation. School of Information and Library Science, University of North Carolina at Chapel Hill, NC.

[9] Barkhuus, L., & Tashiro, J. (2010) Student Socialization in the Age of Facebook. *Proceedings of the 28th international conference on Human factors in computing systems (CHI, 2010)*

[10] Kapucu, N., Yuldashev, F., Demiroz, F., & Arslan, T. (2010). Social network analysis (SNA) applications in evaluating MPA classes. *Journal of Public Affairs Education, 16*(4), 541–563.

[11] Granovetter, M. (1973). The Strength of Weak Ties. *American Journal of Sociology, 78*(6), 1360−1380.

[12] Wasserman, S. & Faust, K. 1994. *Social Network Analysis.* Cambridge: Cambridge University Press.

[13] Hanneman, R.A. (2001). *Introduction to social network methods*. Riverside: University of California Riverside.

[14] Galaskiewicz, J., & Wasserman, S. (1994). *Introduction advances in the social and behavioral sciences from social network analysis*. Thousand Oaks, CA: Sage.

[15] Scott, J. (2000). *Social network analysis: A handbook*. Thousand Oaks, CA: Sage Publications.

[16] Freeman, L.C. (1979). Centrality in social networks conceptual clarification. *Social Networks*, *1*(3), 215–239.

[17] Wenger, E., McDermott, R., and Snyder, W.M. (2002). *Cultivating communities of practice*. Boston: Harvard Business School Press.

[18] Trenholm, S. (1986). *Human Communication Theory*. Englewood Cliffs, NJ: Prentice-Hall.

[19] Selwyn, N. (2009). Faceworking: Exploring students' Education-related use of "Facebook". *Learning, Media and Technology*, *34*(2), 157–174.

[20] Santos, I.M., Hammond, M., Durli, Z., & Chou S.-Y. (2009). Is there a role for social networking sites in education? *Proceedings of the 9th IFIP TC3 World Conference on Computers in Education (WCCE 2009)*, 321–330.

[21] Roblyer, M.D., McDaniel, M., Webb, M., Herman, J., & Witty, J.V. (2010). Findings on Facebook in higher education: A comparison of college faculty and student uses and perceptions of social networking sites. *The Internet and Higher Education, 13*(3), 134–140.

[22] Joinson, A.N. (2008). 'Looking at', 'Looking up' or "keeping up with' people? Motives and uses of Facebook. *Proceedings of the 26th annual SIGCHI conference on Human factors in computing systems, April 05-10, 2008*

[23] De Villiers, R. (2010). Academic use of a group on Facebook: Initial findings and perceptions. *Proceedings of Informing Science & IT Education Conference (InSITE 2010)*, 173–190.

[24] Dertouzos, M.L. (1997). *What will be: How the new world of information will change our lives*. New York: Harper Edge.