A case study of social network analysis of the discussion area of a virtual learning platform

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ABSTRACT: The social network analysis method, which was used to explore the collaborative capabilities of college students in a virtual learning environment, is described in this article. In this method, diagnostic evaluation and assessment was applied to analysis of the changing trend in collaboration. The students' network relationships were analysed through social network analysis. Measures included density and centrality. Using the reform of the Database Principles course as a vehicle, the characteristics of students' collaboration in an advisory type social network were determined. This illustrated the usefulness of social network analysis. A positive trend emerged from the students' collaboration in the virtual learning environment, as determined by the social network analysis.

INTRODUCTION

A virtual learning environment (VLE) is a standardised learning and management system based on the Internet and is used mainly to support content delivery of educational material over the Internet. It promotes the interaction between teachers and students and supports study assessments [1]. The discussion area as a tool of collaborative learning on the VLE is an important asynchronous communication medium for students, which can be used outside the classroom.

As reported in this article, a consulting social network was formed by the discussion area of the WebCT (course tools) virtual learning platform. The network included teachers and students. The discussion centred on the curriculum reform of the Database Principles course. The course deals with the steps needed and methods to design databases, with the structured query language (SQL), database security, and so on.

Co-operation of the individual student was measured quantitatively by social network analysis. Then, the core participants, the edge participants and the specific performance of each participant in co-operative learning using the network were established. Finally, it was illustrated that social network analysis plays an effective role in process evaluation using comparison and dynamic measurement analysis.

RESEARCH METHODS

Social networks refer to a set of social actors and their relationships [2]. In this study, a collaborative learning network in WebCT was studied to explain the effects on student groups by describing the structure of the consultant study relationships. Social network analysis was used to describe and measure the relationships among actors or between actors, and other tangibles or intangibles, such as information and resources [3].

The researchers analysed individual ability, as revealed in discussions, in studying the core problem in the Database Principles course. The analysis of ego-centred networks was used to define the social network from an individual point of view. The analysis centres on a particular actor, considers the relations to that actor, and determines how the individual behaviour is affected by these interpersonal relationships. Analysis indexes related to ego-centred networks include degree, in degree, out degree, density and centrality.

Density analysis of the social network, analysis of centrality, and betweenness centrality, which characterises the actors of the network, were used. Researchers obtained a preliminary diagnostic evaluation of students' co-operative ability, by questionnaire survey. Trends of the students' co-operative ability were determined by comparison analysis, through evaluating the discussions from the discussion area.

QUANTITATIVE ANALYSIS OF SOCIAL NETWORK DATA

The Research Subjects and Data Collection

The 30 research subjects study or work at the information and computing science specialty in the Communication University of China and they all participate in the course, Database Principles. The relational data (data about relationships) were collected twice. First, the collaboration among students was measured by questionnaire before the course.

Second, a discussion area was established that related to the core issues of the course using the WebCT virtual learning platform and UCINET 6.2 was used by which to count and analyse the relational data. UCINET (University of California at IrvineNETwork) is integrated software for social network analysis and includes NetDraw for data visualisation. This software was initially developed by Linton Freeman - an authoritative scholar in the research of social networks, and who worked at the University of California at Irvine. The software was then maintained and updated by Steve Borgatti, who works at Boston University, and Martin Everett, who works at the University of Westminster [4]. The research for this article was carried out using a statistical analysis of the relational data in consulting social networks.

Statistics and Analysis of Relational Data

Binary Matrix

An N*N matrix was formed from the relational data from the learning network. The N is the number in the group, rows are the selectors (initiators) and columns are the selected (objects of the initiators). A figure one at the intersection of a selector's row and the selected's column indicates an interaction. The final result is the overall network matrix for this group. In these data statistics, the teacher's row is 00, and the students are 01 to 29.

If student i posts and student j replies, the two students have an interaction, and this interaction is expressed by Zij = 1, the value of the ij^{th} element of the matrix. Note that an interaction requires both a post and a reply. If there is no interaction between the two individuals, Zij = 0. Matrices were constructed in UCINET 6.2 using the interaction data from the WebCT virtual learning platform. The binary matrix is shown in Figure 1.

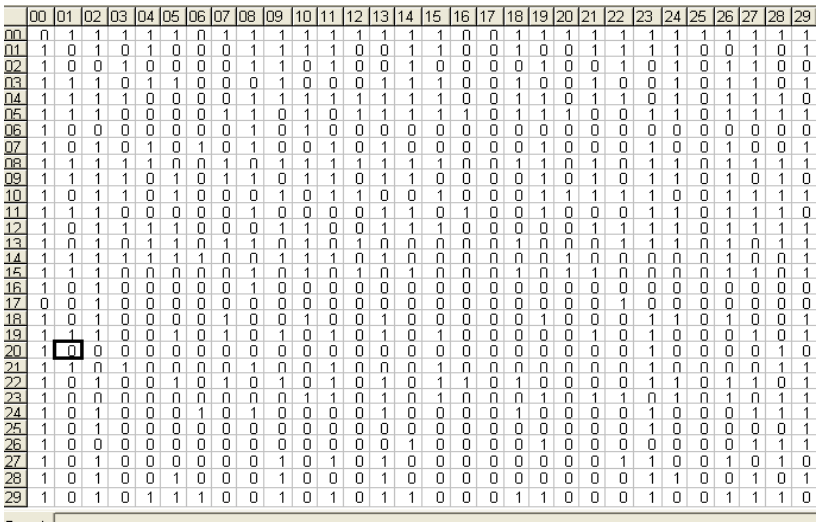


Figure 1: Relational matrix of binary data from the discussion area.

Sociogram of the Social Network

The social network structure is a real or potential relational schema among social actors [5]. It is most important to understand the overall model of society for social network analysis [6].

The sociogram shown in Figure 2 is mapped by the NetDraw program in UCINET. As can be seen from Figure 2, the dots 00, 02, 13, 29, 24 are located in the condensed centre of the discussion area. This shows that the members represented by these dots interacted frequently with other members in the discussion area.

On the other hand, members represented by dots 20, 25, 06, 16, 17 had little interaction. Sociograms can show the trend of interactive collaboration since there are likely to be many condensed centres built in the process of learning. The researchers, then, measured other characteristics of the data.

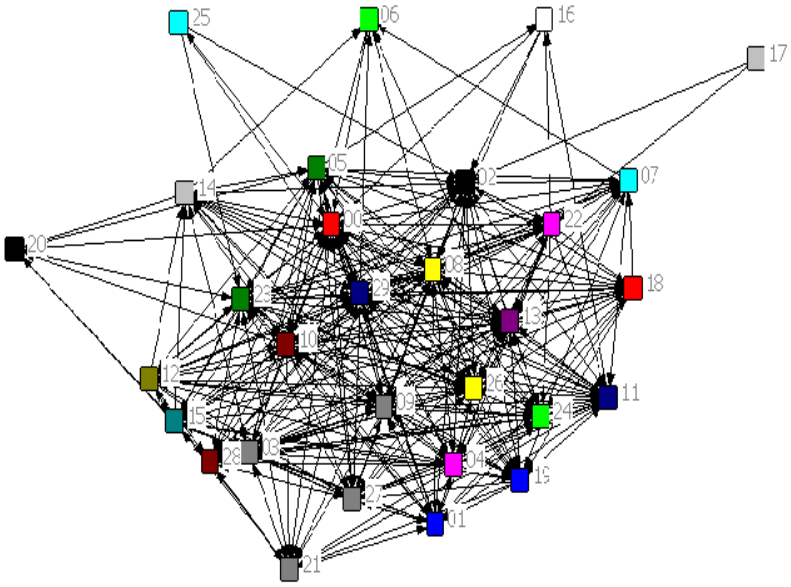


Figure 2: Sociogram of the discussion area.

Network Density

To measure the tightness among the nodes in sociogram, the researchers chose to measure the network density, which is important in social network analysis. The greater the interaction between the members of the network, the greater the network density [7].

High network density indicates more co-operation in the group and easier communication. This might imply a better task performance [8]. Conversely, if the interaction between the members of the network is small, there will be less mutual support and perhaps a lack of satisfaction with the tasks being undertaken.

Referring to the network density Formula (1), L is the number of connections in the network and N is the number of network nodes. The density can range from 0 to 1 in a binary network diagram; the higher the values, the more tightly the nodes are connected.

$$\Delta = \frac{2L}{N(\mathrm{N}-1)} \tag{1}$$

The researchers worked out the global density of the consulting network in the discussion area, using UCINET 6.2. The result is shown in Figure 3.

The result shows that the overall density for the consulting group of collaborative information is 0.4264. In reviewing the class, the researchers concluded communication among the students was good, and that they could effectively study co-operatively using the discussion area of the WebCT teaching platform.

	Density	No. of Ties
test30	0.4264	371.0000

Figure 3: Network density statistics of discussion area.

Degree Centrality

Degree centrality, or centrality for short, represents the extent to which dots are connected into the network. Degree centrality can be divided into two categories: absolute centrality and relative centrality; the former is the count of direct connections to a dot, while the latter is a standardised form of the former, i.e. it is the ratio of absolute centrality to the greatest possible centrality of the dot.

Degree centrality also includes introverted centrality and extroverted centrality, or in degree and out degree for short. The researchers analysed the centrality for the discussion advisory network and determined the degree centrality using UCINET 6.2. A sample of the results is shown in Table 1.

Table 1: Degree of centrality in learning network of the virtual learning discussion area (partial).

ID	OutDegree	InDegree	NrmOutDeg	NrmInDeg
00	26.000	28.000	89.655	96.552
08	22.000	14.000	75.862	48.276
05	20.000	11.000	68.966	37.931
04	20.000	9.000	68.966	31.034
12	18.000	7.000	62.069	24.138
09	17.000	14.000	58.621	44.828
10	17.000	13.000	58.621	44.828
…	……	……	……	……
…	……	……	……	……
26	6.000	19.000	20.690	65.517
25	4.000	1.000	1.000	3.448
20	3.000	5.000	10.345	17.241
06	3.000	4.000	10.345	13.793
16	3.000	3.000	10.345	10.345
17	2.000	0.000	6.897	0.000

In Table 1, the out degree is extroverted centrality, the in degree is introverted centrality, NrmOutDeg is standardised extroverted centrality and NrmInDeg is standardised introverted centrality. The centricity statistics enable the state of collaborative learning in this consulting network to be quantitatively evaluated. In Table 1, 00 is the teacher with the highest in degree and out degree. That indicates the teacher is in a position of authority and has the greatest influence in the discussion area.

The students with IDs 08, 09, 10, 13, 29 have higher in degrees and out degrees, so they belong to the active members of the class. In addition, the values of standardised centrality for all of the students in class, except 17 and 25, are greater than 10. This shows that this class has a strong atmosphere for learning and good communication.

In order to analyse the collaborative ability of the network further, the researchers use degree centralisation to measure the central tendency of the network. Centralisation is divided into extroverted centralisation and introverted centralisation. The calculation process is to first find the value of maximum centrality and, then, calculate the difference between the maximum centrality and the centrality of others in the network yielding many *differences*. Then, calculate the sum of the differences and, finally, divide the sum by the maximum possible sum of differences, as shown in Formula (2).

The researchers analysed the centralisation of the discussion learning network and concluded that the extroverted centralisation was 48.633% and the introverted centralisation 55.767%, as shown in Figure 4. This further informs that this class has a strong atmosphere for learning and good communication.

$$C = \frac{\sum_{i=1}^{n}(C_{max} - C_i)}{\max[\sum_{i=1}^{n}(C_{max} - C_i)]} \tag{2}$$

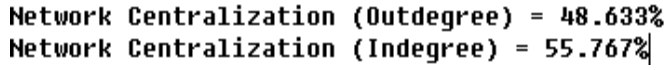


Figure 4: Centralisation in the discussion learning network.

Betweenness Centrality

Betweenness centrality refers to the degree a dot lies in the middle of the other dots in the network. The more in the middle, the higher the betweenness, and the more that people communicate with others via this dot [9].

Intermediary people who control the information stream can be found through measuring the betweenness. Betweenness centrality was determined in the virtual learning discussion area, using UCINET.

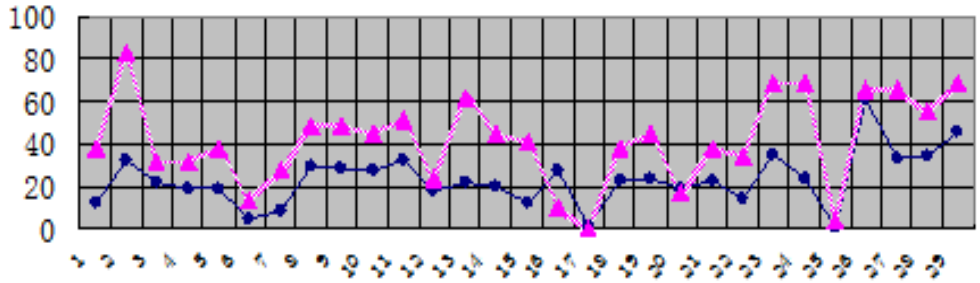
Partial data for betweenness centrality are shown in Table 2. The result for overall betweenness centrality in the network diagram is shown in Figure 4. The highest betweenness is the teacher represented by 00. Students with relatively high values are 08, 02 and 29. Some students in the class have low values, such as 17, 25, 16, 06, 20 (not shown in Table 2); they do not act very much as intermediaries in the flow of information.

Table 2: Statistical data of betweenness centrality (partial).

ID	Betweenness	nBetweenness
00	140.557	17.310
08	35.635	4.388
02	31.848	3.922
29	29.545	3.639
22	28.023	3.451
23	21.923	2.700
05	21.596	2.660
...	...	...
21	3.205	0.395
06	0.681	0.084
20	0.422	0.052
16	0.100	0.012
17	0.000	0.000
25	0.000	0.000

Emotional Goal of the Course: Analysis on the Development of Collaboration Ability

The social network analysis method was used for this study, so as to analyse the changing trend of students on the Database Principles course. This method mainly applied standardised centrality indexes to show the trends of the students' co-operative ability. As shown in Figure 5, the evaluation of the students' interaction after the course is obviously better than that before.



Note: Blue: before the course; pink: after the course

Figure 5: Controlled analysis of diagnostic evaluation and process assessment.

CONCLUSIONS

The research carried out for this study shows that the use of social network analysis methods can reveal how students' collaboration improves when a course includes a virtual learning environment that supports discussions and interaction. This research has explored the role of social network analysis in teaching.

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