Study of the Interactive Activities with FIAS and Network Analysis Technology

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Abstract—As ICTs continue to enter the classroom, the interaction between teachers and students in the classroom is changing. The purpose of the study is to find out what the important teaching&learning activities are in such classrooms, and whether there are stable interaction patterns in these activities. In order to achieve this goal, the Flanders interaction analysis system (FIAS) was transformed in the study, and based on the data generated by the FIAS, we carried out sequence and frequency analysis with PHP programming language. For visualizing the research results, we produced the adjacency graph of teaching&learning activities using network analysis technology and the Gephi software. In addition, we analyzed the two web-based classrooms using the above method. The conclusions are as follows: It is an effective teaching method to require students to evaluate according to the work submitted using the Internet. The use of educational websites or special topic software is a common feature of both classes. A more fixed sequence of activities in these kinds of classes is that the teacher first adopts the opinions of the students, then raises open questions and then responds positively.

Keywords-Flanders Interaction Analysis; Web-Based Classroom; Teaching & Learning Activities; Network Analysis

I. INTRODUCTION

In the current Chinese elementary education, the activities of teaching and learning in the classroom are still a vital part of school schooling, and classroom is the most important place for student to gain knowledge and other abilities. There are plenty of research on using ICTs in the classroom. Moreover, much research focus on web-based education, but in many of the research, ICTs was acted as a supplement to the classroom; students were required to learn utilizing the Internet before or after school. In this study, we concentrated on the class in which web technologies (including LAN and Internet) served as the foremost techniques for teaching and teaching and were used from starting to end.

In recent years, scholars had done much research on teaching and learning behavior in classes that had been changed by web technology. When Shiang-Kwei Wang [1] developed learning environment for high school students in subject of geography, he suggested that full of challenging & causing a probing & facilitating the control & stimulating the legend were the four important strategies to develop an online learning environment as the guiding principle. Yang Gang & Xu Xiaodong [2] considers teacher-student interaction through network is interpersonal contact in the process of learning and educating. This interaction is "people - people" relationships mediated by digital connection, and also is the way to shorten the emotional psychological distance. They pointed out that some teachers resist on making information technology into the teaching, and do not wish to carry out teaching activities on the web. One of the worries of them is the losing control of those resources, and become people who lack of resources. Moreover, the students know more than they do, this situation will affect his authority among students. Si Zhiguo etc. [3] given an observation on four novice teachers' classroom record using English online practice communities, drawn novice teacher teaching approach is relatively simple and the type of answer question is lack of change, but they had more attention in the classroom on encouraging students to express their views . Doris Lee [4] points out that the widespread adoption of online teaching with constructivism as the main guiding ideology in China will be complicated. The foremost obstacle to the application listed in his text is this: First, the characteristics of Chinese classroom are teacher-centered and the target of knowledge acquisition is test-driven. The second is that the constructivist learning theory is unfeasible to improve student achievement. The third is caused by the utilization of online teaching. The teacher's role will change.

Now, there are all kinds of teaching skills competitions for teachers in Chinese K-12 education area, such as open class, observe classes and other Teaching appraisals. There have been many cases in that web technology are the primary technical means. The classes that used web technology, especially used Internet as the main teaching media (called as web-based class) are the object of this study. We will analyze how the teaching and learning activities are organized in these outstanding class, and through quantitative analysis, we try to find some remarkably effective teaching model to provide a reference for future web-based class teaching practice.

II. METHOD

A. The object of study

The teaching experiments using web technology into classroom appeared generally in more economically developed regions. Tianjin as the more developed regions in north China, there are two classes gained the first class prize in the Fourteenth National Grand of multimedia educational software, they were all high school science Lessons and

taken web as the primary technical means, this research will study the two classes, its basic information was shown in Table 1.

TABLE I.   SUMMARY OF SAMPLE LESSON INFORMATION

Subject	Grade	content of courses	Time Length	Teacher	School
Math	high school	Linear programming in the actual problems	45:09	Zhou Yujun	Tianjin xinhua middle school
Chemistry	high school	the general steps and methods of organic compounds	43:39	Hao Yuanqing	Yaohua High School

The math lesson which content is "Linear programming in the actual problems" was taught by teacher Zhou Yujun. The content was included " understand and master the graphical method of linear programming problems; master basic modeling approach to solve practical problems with some simple knowledge of linear programming." In the process of the class, students were given a specific problem, then they were put forward their own ideas and operation by themselves by using some software such as Geometer Sketchpad & Excel, finally, by the web-based learning management system they exchanged their ideas each other, by this means they could enrich their knowledge and broaden their vision.

The chemistry lesson delivered by teacher Hao Yuanqing which content is "the general steps and methods of organic compounds". Mr. Hao had given screen broadcasting to the students by using the LanStar classroom network system, and introduced learning content and located the suspect, students were required to design experimental device and detect the composition of organic compounds by using virtual chemical laboratory simulation software. If they had finished the apparatus design, they could upload them o the teaching website. In the end, teachers and students evaluated these devices figure and made a summary together.

B. Research Methods

In this paper, Flanders Interaction Analysis System (FIAS) [5] is used to quantitatively analysis for the class. In spite of FIAS has some advantages , it emphasis too much on teacher behavior (7 categories) in the class , ignoring student behavior (2 categories) , and can not reflect the role of information technology in the class teaching & learning [6]. Multimedia technology, computer and network technology and wireless communication technology are more and more into the classroom, traditional FIAS do not have the ability to encode such interactions between teacher and student using information technology. In addition, FIAS can only code the student's behavior overall but cannot code individual behavior when the students did something differently.

In this study, two chosen cases were web-based class; teachers and students had more than half the time in the use of computers and other technology teaching & learning. Depending on class situation, we modified the IASNC (Interaction Analysis System on Network Courses) system which was improved based on FIAS by Professor Gu Xiaoqing and her team [7] specifically on information technology system. As shown in Table 2, the coding system we adopted can better reflect the interaction of the web-based class. Among the system, the students using technologies (such as curriculum teaching & learning platform, educational software, virtual labs, Internet, etc.) can be broken down into different aims(such as 'events help clarify technical point of view ', 'the use of technology for independent' , 'inquiry-based learning' , 'use of technology evaluation feedback' , 'the use of technology to synchronize / asynchronous interaction'). The several aspects of the activities are often carried out simultaneously, in order to ensure the uniqueness of the code, these activities are no longer treated differently, but they are expressed in a unified way by "students use technology to autonomy, collaboration, and inquiry learning".

TABLE II.   IASNC CODING SYSTEM

Category		Code	Coding Description
Teacher Language	Indirect Influence	1	Teacher accept emotion
		2	Teacher encourage & praise
		3	Adopt an idea
		4	Ask open questions
		5	Ask Closed questions
	Direct Influence	6	Teaching
		7	Instruct
		8	Criticise
Student Language		9	Passive response
		10	Active response
		11	Active ask question
		12	Discuss with companion
Quietness		13	Chaos
		14	Thinking
ICTs		15	Teacher control technology
		16	Students individual or collaborative or inquiry learning using technology

We coded manually the two classroom records using the IASNC coding system. In accordance with the provisions of FIAS interaction analysis system, we made a sample once every three seconds, and given a code value to each three seconds of class activities prescribed by the significance of the coding system. In order to ensure the accuracy of coding, class memoir was viewed repeatedly and confirmed by 2 separate experts. It also stipulates that if multiple actions occur in the same 3 seconds, only the main actions will be recorded to ensure the uniqueness of the code.

For more scientific and accurate statistical analysis of the data obtained, we imported the code value into a MySQL database and used PHP language to analysis and process. Finally to generate IASNC interaction matrix.

III. RESULTS

We used IASNC system to make quantitative analysis of the two classes with reference to the process, procedures and techniques of traditional FIAS [8] [9] [10], Results of the analysis are as follows:

A. Analysis of classroom activities

We described the classroom activities taking the math class taught by teacher Zhou Yujun as an example; the chemistry class's analysis is similar to this. Using the method mentioned above, we coded the math classroom record and obtained the IASNC matrix, as shown in Table 3.

TABLE III.　MATRIX OF MATH CLASSROOM IASNC

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	total
1	0	1	2	0	1	3	0	0	3	0	0	0	0	0	0	0	10
2	0	2	1	1	1	2	0	0	3	0	0	0	0	0	1	1	12
3	3	3	38	0	9	7	0	0	18	0	0	0	0	0	0	3	81
4	0	1	0	9	0	2	2	0	0	0	0	0	0	0	0	0	14
5	3	0	3	1	15	5	4	0	11	0	0	0	0	1	0	2	45
6	1	1	2	2	11	93	5	0	0	0	0	0	0	1	4	1	121
7	0	0	0	0	0	5	34	0	3	1	0	0	0	0	4	4	51
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	3	4	27	0	2	2	2	0	27	0	0	0	0	0	1	0	68
10	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2
15	0	0	0	1	2	0	4	0	2	0	0	0	0	0	89	2	100
16	0	0	7	0	3	1	1	0	0	0	0	0	0	0	1	383	396
total	10	12	81	14	45	121	52	0	67	2	0	0	0	2	100	396	902
	162			173			69			2		496					902
%	17.96%			19.18%			7.65%			0.22%		54.99%					100%

As can be seen from Table 3, the ratio of teachers and students to use computers in teaching and learning activities is up to 54.99 percent. The teachers and students to use computers for teaching and learning activities, combined analysis with language part, can more authenticity display the interaction of the classroom. Further analysis using the variables can be drawn:

1) Analysis of teaching & learning structure. The teacher verbal behavior ratio (the count of 1-8 and 15 times / total) was 48.22 (the norm is about 68) in the class , the ratio of student verbal behavior (the count of 9-12 and 16 times / total) was 51.55 (the norm is about 20), based on the two data above, student activities is the mainstream in the class. The ratio of Quiet and chaos (the count of 13-14 / totals) was 0.22 (the norm is about 11). This data indicated that classroom time was fully used.

2) Analysis of teacher's style and tendency. The ratio of teachers of indirectly influence and directly affect (the count of 1-5 / the count of 6-8) was 93.64 (the norm is about 100). This data indicated that teacher was tend to control the students directly, and the closed questions was majority in all questions teachers asked. And students' Passive response were majority also, the ratio of teacher's positive reinforcement and negative (the count of 1-3 / the count of 7-

8) was 201.96% , the data reflected the teacher's teaching style and tendency to students is encouragement and agreement, instead of instruction and criticism..

3) Analysis of application of technology. The ratio of teacher and students activities using technology was as high as 54.99%, it indicated the application of technology was fully and effectively.

B. Sequence analysis of two teaching activities.

Through the above analysis, we can understand what teaching & learning activities are often used in web-based classroom. Based on above data, sequence analysis of teaching & learning activities can be carried out. We will find what combination of activities are often used. The raw data that were utilized for FIAS analysis above was processed. The same continuous teaching & learning activities were recorded as one, in this way, a series of teaching activities that are interleaved will be obtained. As shown in Table 4.

TABLE IV.　TEACHING ACTIVITIES SEQUENCE ANALYSIS

Number of teaching activities	Math	Chemistry
	212	208
Frequency of 3 Continuous activities (>2)	[3-5-9]: 4 [3-9-3]: 14 [3-16-3]: 3 [5-6-5]: 4 [5-9-3]: 6 [6-5-6]: 3 [6-5-7]: 3 [6-5-9]: 3 [6-7-6]: 3 [7-6-7]: 3 [7-9-3]: 3 [9-3-1]: 3 [9-3-5]: 6 [9-3-6]: 4 [9-3-9]: 13 [16-3-16]: 3	[3-5-9]: 8 [3-9-3]: 6 [4-9-3]: 3 [5-7-15]: 3 [5-9-3]: 13 [7-5-9]: 4 [7-15-7]: 4 [7-16-7]: 11 [9-3-5]: 9 [9-3-6]: 4 [9-3-9]: 4 [9-5-9]: 3 [16-6-16]: 3 [16-7-15]: 3 [16-7-16]: 11
Frequency of 4 Continuous activities (>2)	[3-9-3-9]: 8 [6-7-6-7]: 3 [9-3-5-9]: 3 [9-3-9-3]: 11 [16-3-16-3]: 3	[3-5-9-3]: 6 [3-9-3-5]: 3 [5-9-3-5]: 4 [5-9-3-6]: 3 [5-9-3-9]: 3 [7-5-9-3]: 3 [7-16-7-16]: 8 [9-3-5-9]: 7 [9-3-9-3]: 3 [9-5-9-3]: 3 [16-7-16-7]: 9
Frequency of 5 Continuous activities (>1)	[3-9-3-5-9]: 2 [3-9-3-9-3]: 7 [5-9-3-9-3]: 2 [6-7-6-7-15]: 2 [9-3-5-9-3]: 2 [9-3-9-3-6]: 2 [9-3-9-3-9]: 7	[3-5-9-3-5]: 2 [3-5-9-3-6]: 2 [3-9-3-5-9]: 2 [4-9-5-9-3]: 2 [5-3-9-3-5]: 2 [5-9-3-5-9]: 3 [5-9-3-6-9]: 2 [5-9-3-9-3]: 2 [7-16-7-16-7]: 6 [9-3-5-9-2]: 2 [9-3-5-9-3]: 5 [9-5-9-3-9]: 2 [15-7-16-7-16]: 2 [15-16-7-16-7]: 2 [16-7-16-7-16]: 6

As shown in Figure in Table 4, the number of different teaching & learning activities is 212 in math class, and 208 in chemistry class. This showed that the math and the chemistry class was much similar. Teaching & learning activities were replaced frequently due to the combination of using of educational software and web-based teaching.

In the line "Frequency of 3 continuous activities" in Table 4, all the combination of three continuous activities was listed. The code list for the bracket indicated the orderly combination of several teaching and learning activities, the number after the bracket indicated that the combination frequency appeared. Math and chemistry class had many same combination appeared, such as 3-5-9,3-9-3,9-3-5,9-3-6,9-3-9 , 3 (Adopt an idea) & 5 (Ask Closed questions) & 6

(Teaching) & 9 (Passive response) were a combination of the four teaching & learning activities appeared more common.

In the line "Frequency of 4 continuous activities" and "Frequency of 5 continuous activities" in Table 4, it further confirmed the statistical conclusions draw for the previous line. It reveals the combination was repeated as 9-3-9-3-9, 16-7-16-7, 16-3-16-3 so on. and other activities sequences having a higher frequency appearing in the table are noteworthy , such as 7 (Instruct) -16 (Students individual or collaborative or inquiry learning using technology) -7 (Instruct) , appeared 11 times , 5 (Ask Closed questions) -9 (Passive response) -3 (Adopt an idea) appears 13 times, etc.

C. Teaching network analysis

The raw data that were utilized for FIAS analysis above was processed. The same continuous activities were recorded as one, after this data conduction, we can generate the adjacency matrix of all the 16 activities, and then we can count the adjacency each other in all the 16 activities. Adjacency matrix was generated as follows:

1)   The 16 activities as nodes;
2)   If the two activities adjoining, then think there is an edge between two nodes;
3)   Making all the 16 activities as rows and columns of the (4) adjacency matrix, activities occur every two intersect;
4)   The value at the intersection of two teaching activities was the number of edges between two nodes.

The adjacency matrix was imported into network analysis software --Gephi. We generated a network analysis diagram of activities. The diagram had generated by network analysis software was directed graph. Arrow pointing was on behalf of the order of teaching & learning activities. The thickness of the edge is equal to the number of connection of two activities.
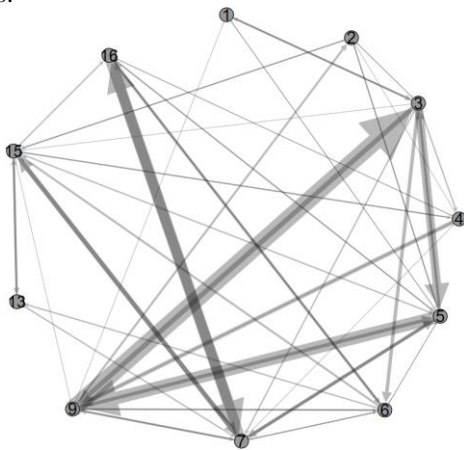

Figure 1.   Chemistry Classroom Teaching Activities Network Analysis

The chemistry class that taught by teacher Hao Yuanqing was processed by steps above. Network analysis graph could be generated. As shown in Figure 1, there was high frequency loop among activities 3 (Adopt an idea) & 5 (Ask Closed questions) & 9 (Passive response).And there was high frequency loop between activities 7 (Instruct) & 16 (Students individual or collaborative or inquiry learning

using technology). It was worth noting that activities 5 (Ask Closed questions) & 7 (Instruct) could link the two most used interactive teaching & learning cycle.
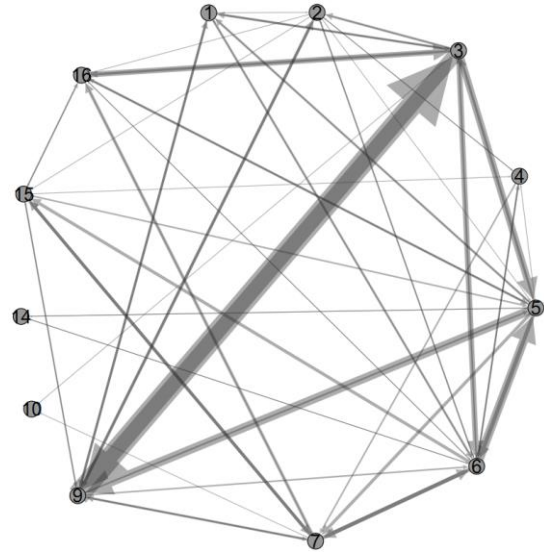

Figure 2.   Math Classroom Teaching activity network analysis

IV.   DISCUSSION

A. Integrated using of subject teaching software and course website

In the two classes, the proportion of teachers and students to use technology in teaching and learning activities was as high as 54.99% and 56.26%, ICTs had been integrated into all aspects of teaching and learning. Moreover, it had played a tangible support role, which is a prominent characteristic of the two web-based classes. In the two classes, web classroom management system had been used, students not only could explore freely in the Internet and but also could get much learning resources designed in advance, in this method the role of teachers could be maintained. Each class used a specialized subject teaching software, which greatly improves the ability of students to use information technology.

B. Multivariate evaluation based on network technology

The two teachers not only designed the students' self-evaluation of the learning content. Students or groups can also evaluate each other and teachers can comment on students. The form of evaluation is not limited to verbal evaluations. There are also asynchronous discussions with the course forum. Therefore, the forms of evaluation are varied. The two classes all had the important part, in which the students could design product or experimental plan, and upload the plan to the course website. Then they could evaluate using the function provided by learning management system. They could click the button of excellent & good & fair & poor, and the platform allowed students to enter the evaluation score, they also could enter a simple comment. Through this program, students could fully participate in the interaction, and it did not occupy too long

time. Therefore, evaluation is the ideal form to integrate web technology into classroom.

C. Existing stable teaching & learning avtivities sequence in web-based classroom for imparting knowledge

As shown in Figure 1 and Figure 2, the math class and the chemistry class had a common feature. There was solid activities sequence. It consisted of 3 (Adopt an idea) & 5 (Ask Closed questions) & 9 (Passive response). Because of in the two classes of teachers were all taught by using the subject software (eg Excel, virtual lab), at first they let the students to learn some knowledge, and then to explore for solving actual question based on the knowledge.

D. students' Individual activities cannot be quantified analysis is the defects of FIAS

In the current FIAS system, the teachers is as a whole, and students are as a whole, then interaction between teaching and learning are recorded and studied. As Fang Haiguang et al, [11] noted. FIAS can only encode and analyze the students' overall. In web-based classroom, students can operate computers access to the Internet, there is a greater degree of freedom than the customary classroom. More significant is that there is a big difference in each student's behavior, and every student should be analyzed as an individual instead of as a whole. However, in FIAS, this analysis cannot be achieved. For achieving a personalized analysis of each student's need more advanced technology, such as expression analysis, gesture-based computing, text mining and other intelligent analysis techniques.

V. SUMMARY

In this study, for the quantitative analysis of two web-based classrooms, FIAS has been improved. We find some common features of some excellent web-based class. There are many effective measures using web technology into the classroom. For example, the development of special subject teaching websites allow students to use the Internet to participate in teaching, fully using the functions of various subject teaching software, integrating web technology with the other Internet technologies, and allow students to use the Internet for inquiry and mutual evaluation of learning results.. After the network technology into the classroom, how to teach knowledge and skills to students systematically, not to make classroom fragmentation, is an important issue that

should be concerned. After using web technology, classroom that is teacher-centered and for imparting knowledge has its own law. Teaching & learning activities 3 (Adopt an idea) & 5 (Ask Closed questions) & 9 (Passive response) is stable sequence that is more commonly used.

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