Integrated medical informatics with small group teaching in medical education

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Abstract

National Taiwan University College of Medicine (NTUCM) introduced small groups of teaching and basic-clinical integrated courses for medical students in 1992. By using computer network and multimedia techniques, this study tried to overcome barriers to learning in small group teaching. The Department of Medical Informatics of NTUCM established campus networking and computer classrooms and provided Internet and intranet network services including mail, netnews, bulletin board systems (BBS), world wide web (WWW), gopher, ftp and local file servers. To implement an interactive learning environment, the authors first tried mail lists, newsgroups and BBS. Next an integrated learning system prototype on the WWW was developed to provide functions including online syllabus, discussion boards simulated to BBS, online talk, interactive case studies, virtual classroom with video on demand (VOD) and Internet medical resources. The results showed that after the medical students completed the required course of medical informatics and had good network access using a network to communicate with each other became a daily practice. In the future, the system will extend to the tutoring of clinical practice and continuing medical education. The authors expect a national medical education network and more international cooperation and exchange. © 1998 Elsevier Science Ireland Ltd. All rights reserved.

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1. The new pathway: small group teaching

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In September 1992, National Taiwan University College of Medicine (NTUCM) began

the new pathway to reform the medical education curriculum. The major change was to integrate courses in basic and clinical sciences. These integrated courses combined faculty from basic and clinical science using both didactic lectures and small group interactive discussion [1]. The purpose of newly introduced small group teaching was to inspire active learning. With a cooperative and social learning environment, small group discussion can greatly enhance student–teacher and student–student interaction [2].

For the new pathway, the authors recruited clinical faculty as tutors to join and guide small discussion groups. In a small group, medical students learn to use critical thinking and problem solving skills for active learning. The discussion is just the beginning. The students need more medical information and teaching materials to fulfill their curiosity. In these circumstances, a computer network and multimedia technology can play an important role in supporting small group teaching. Computer assisted learning is also a new trend for medical education [3–5].

2. Medical informatics in NTUCM

In recent years, the Taiwan information industry ranked the third in the world in

Table 1

Curriculum of medical informatics for 2nd year medical students

Curriculum of medical informatics (4 h/week, including practice)

Basic computer concept
 Basic network concept
 Computer language BASIC (2)
 Operating system
 Chinese system and word processor
 Database and data processing
 Computer medical resources
 Multimedia and CAI
 Computer statistics(2)
 Intelligent health information system
 Medical diagnostic decision support systems
 Computer medical record and computer reminder

manufacturing computer products and the National Information Infrastructure (NII) program started in 1995. But for the medical field there was a time lag to catch up with the new technology mostly due to early dissociation with other sciences. Because of educational competition in the form of entrance examinations and the 7-year undergraduate to graduate system of medical education, most medical students have little opportunity to use computers. Therefore the authors had to teach both the teacher and the students and help them to use the existing resources

Table 2

Usage of mail server for medical students

Grade	Rank	Number	Log-ins/day	People/day
Med1 student	7	133	0	0 (0%)
Med2 student	6	133	21	8 (6.0%)
Med3 student	2	133	287	61 (45.9%)
Med4 student	3	136	166	52 (38.2%)
Med5 student	4	133	162	42 (31.2%)
Med6 student	1	134	319	68 (50.7%)
Med7 student	5	137	115	32 (23.4%)
Total		939	1070	263 (28.0%)

Table 3
Mailing lists of small group teaching courses

Number of e-mails	Clinical diagnosis	Medical problem solving
Tutors (4)	Nine e-mails	14 e-mails
0	Tutor B,C,D	Tutor D
2		Tutor C
5		Tutor B
7		Tutor A ^a
9	Tutor A	
Students (33)	13 e-mails	13 e-mails
1	Three students	Five students
2	Three students	One student
3		Two students
4	One student	
Total participants	One tutor, seven students	Three tutors, eight students
Total e-mails	22 e-mails	27 e-mails

^a Tutor A went abroad for 1 month and kept active in the mailing list.

[6]. In 1994, medical informatics became a required course for second year medical students in the School of Medicine, NTUCM [7]. After establishing campus networking and computer classrooms and developing the education and research program for medical informatics, the authors started the first Department of Medical Informatics in Taiwan in August 1996.

In 1995 NTUCM carried out NII distance education and tele-consultation pilot projects awarded by the Ministry of Education and the Department of Health. Through these programs NTUCM set up external communication networks from dial-up terminal telephone line services, integrated service digital networks (ISDN), T1 and T3 lease lines, to an asynchronous transfer mode (ATM) network. By integrating multimedia computer assisted learning applications to the network infrastructure, the authors tried to establish a

virtual medical campus and overcome barriers to learning in small group teaching. The goal was to develop an intelligent interactive computer network system on the Internet to provide a socialized, cooperative learning environment for second to fourth year medical students [8]. In this study, the authors collaborated with clinician, computer scientist, medical engineers, psychologists and educators to develop a web-based learning environment [9].

3. Subjects and methods

3.1. Subjects

In the School of Medicine at NTUCM, there were 939 students divided to seven grades. The second to fourth year medical students were chosen for small group teaching. In each grade there were about 135 students divided into 16 small groups. Each group had a tutor who was usually a young attending physician.

3.2. Method

Without the support of a computer center on the medical campus, the Department of Medical Informatics set up all the hardware and software for the computer network assisted learning environment. A curriculum of medical informatics for medical students was also organized. The first stage focused on setting up the network environment on the medical campus and gathering baseline data for medical informatics and small group teaching. The second stage was to remove barriers between faculty and students by setting up network services. In the third stage, the authors tried to develop an integrated learning environment system on the world wide web (WWW) to enhance self-learning and small group discussion on the network.

Fig. 1. BBS statistics during a day, total log-ins: 4314, average usage: 14 min.

4. Result

4.1. Curriculum for medical informatics and campus network

In 1994 medical informatics became a required course of two credits for second year medical students. The course was 4 h a week and consisted of 1 h of lecture and 3 h of practice. The content included basic computer concepts, computer language, operating systems, basic network concepts, Office programs and applications for medical informatics (Table 1). For the campus network the backbone was fiber distributed data interface (FDDI) which underwent an upgrade to ATM. Twenty Ethernet subnets consisting of over 2000 nodes were connected to three major router nodes in a star shape. All buildings were wired including the student dormitories and dial-up terminal service was provided to students living at home. Two computer classrooms were established. One was a mobile classroom consisting of 140 486PC notebooks brought in by the students to use in class, the other was 40 multimedia Pentium PCs. All workstations of both classrooms were able to access the Internet directly.

4.2. Internet and intranet services

Servers were installed included (1) mail servers automatically providing all students e-mail accounts, (2) a netnews server providing about 10000 newsgroups and moderating 50 tw.med.* news groups in the medical field, (3) a bulletin board system providing 165 discussion boards including all the medical specialties through a news server feeding to all the other medical colleges in Taiwan, (4) WWW servers allowing all faculty and students to establish homepages and (5) other public services including gopher, ftp and a 250 user Novell server on the local area network [3]. The authors recruited several medical students each year to become system operators after they had completed the medical informatics course. Fifteen students were trained and assigned to handle these servers.

4.3. Computer network learning environment

About 1000 log-ins per day was noted for the mail server of the school of medicine, which has about 1000 accounts and nearly 30% students logged in each day (Table 2). Two mailing lists of small group teaching

Table 4
BBS statistics of people, departments and case discussion group

Discussion board	Rank	Visits/day	Posts/mo	Time (s/visit)
People				
Med1 student	6	356	1435	130
Med2 student	2	480	1202	130
Med3 student	5	369	510	85
Med4 student	7	336	714	62
Med5 student	3	419	511	113
Med6 student	1	510	364	105
Med7 student	8	275	140	91
Internship	11	224	111	84
Residentsip	12	204	164	107
School of medicine	19	164	32	37
Med alumni	23	135	41	94
Case discussion	114	16	15	90
Departments				
Psychiatry	36	80	109	156
Internal med	84	29	20	52
Pediatrics	90	26	11	93
ObsGyn	91	26	15	92
Ophthalmology	100	22	14	74
Surgery	106	20	6	62
Dental med	108	19	22	99
Rehabilitation	112	17	9	67
Dermatology	116	16	11	59
Family medicine	122	15	13	35
Neurology	133	12	12	38
Urology	138	11	8	71
ENT	139	11	8	41
Forensic med	146	10	3	52
Anesthesiology	154	6	1	70
Average (165 boards)		64	62	107

courses ‘Clinical Diagnosis’ and ‘Medical Problem Solving’ were set up to encourage tutors and students to use e-mail for discussion among four small groups including four tutors and 33 fourth year medical students. For 4-month periods for each course, there were both 13 e-mail response from about one fourth of the students, which is seven and eight students, respectively. Among four tutors only tutor A was active and sent nine e-mails in the first course and always kept active even during when he went abroad in

the second course. Tutor B and C became active in the second course, however tutor D was always inactive (Table 3).

There were much more utilization for the bulletin board systems (BBS), about 4000 log-ins per day with three peak at noon, 5 and 10 p.m. (Fig. 1). Furthermore, the discussion board for each class in the medical school was read around 200–500 times per day comparing with 20 times per day for boards of clinical departments (Table 4) or case discussion boards associated with small

group teaching. A survey of participants revealed nearly 60% were medical students (Table 5). Although the discussion board was not very active, the board manager, who was a medical student, treasured a lot of excellent materials including clinical cases, frequent asked questions, articles of clinical experience and several clinical pathology conference files (Table 6).

An integrated learning system prototype on the WWW platform with Common-Gateway Interface (CGI), Javascript and Java techniques was developed (Fig. 2). It provided functions including online syllabus, discussion boards simulated to BBS (Fig. 3),

Table 5
Participant of case discussion board of BBS

Participant	Number	%
Medical students grade 1–3	20	33
Medical students grade 4–7	15	25
Non medical students	7	12
Graduate students	8	13
Resident	0	0
Faculty	1	2
Nurse	2	3
Paramedical	1	2
Other	6	10
Total	60	100

Table 6
Analysis of case discussion board of BBS

Item	Number
Rank	114
Daily visit	16 log-ins
Monthly posts	15 articles
Average reading time	90 s
Digest: board manager (medical student)	
Clinical cases	20 cases
FAQ: 10 specialty	200 articles
Clinical experience:	13 articles
Intern survival guide	13 pages
CPC	9 cases

online talk, interactive clinical case study (Fig. 4), virtual classroom with multimedia lecture note combining video on demand (VOD) (Fig. 5) and network medical resources for small group teaching course of 2nd to 4th year medical students.

5. Discussion

Traditional medical education focused on lectures and gave too much information to students. Memorizing the facts without thinking caused a reduction of creativity and problem solving capability. Small group teaching and discussion enhance self-directed learning and knowledge acquisition [10]. During the learning process, a student must spend a lot of time searching for medical information outside the textbook and must carry out data management [11]. Problems might occur at each step and the student has no one to discuss these problems with. The tutor, who is responsible for heavy clinical duty, cannot find time to discuss problems with the students after class. Since face to face interaction was not possible, synchronous or asynchronous interaction through Internet or intranet communication was the best solution.

Medical students in Taiwan generally lack computer knowledge and capabilities and about one third are computer illiterate [12]. However they participated in the Internet world through the most popular network system such as BBS without difficulty. After taking the compulsory course of medical informatics, the activities on Internet and medical literature searching increased greatly and the preference for graphic user interface (GUI) was also enhanced [12]. For different type of network system, using e-mail mailing list for group discussion is the simplest way, but the participation usually very low due to

Fig. 2. Integrated web-based distance learning system.

poor interaction and lacking integration function with other system. Users need to learn several difficult UNIX commands to use the mail server, or they need to have a dedicated PC with Windows based POP3 program installed for e-mail receiving. Most tutors of small group teaching failed to do so, so they were not active in the mailing list. Internet BBS is a very friendly network system integrated with online chat, netnews, gopher, even text mode WWW works within a BBS. That's the reason why it attracted a lot of users especially beginners, however it was considered to be recreational rather than educational. Students loved it and indulged in it, but faculty and senior doctors considered it time-wasting. The engagement of a medical

student to a BBS class board was 20 times higher than in a mailing list (Table 7) and it was the major group learning factor considered within small group teaching [13].

In recent years, WWW became more and more popular. The web server of School of Medicine, National Taiwan University, which provide disk storage for homepage of medical students and faculty, had 25000 hits per day. The advantage of a WWW system is it combines hyper-linked multimedia and graphic user interface designed with CGI, Java technique. It seems WWW has become the total solution.

In this study, the authors tried to integrate a web-based medical information system using a multimedia database to support the

Fig. 3. Web BBS for small group teaching course of 2nd to 4th year medical students.

Fig. 4. Interactive clinical case study for medical students.

Fig. 5. Virtual classroom with multimedia lecture notes and VOD.

Table 7
Participation of different type of network for a medical student class

Type of network system	Read frequency	Post frequency	Engagement
Mailing list	40/day	0.1/day	1/400
Case discussion board	1.6/day	0.05/day	1/32
Class board	400/days	20/day	1/20
WWW	high	?	?

application of computer assisted learning through a kernel of the CGI program. In the same manner, it can also be used in tele-consultation, distance education and tele-homecare.

By integrating medical informatics in the small group teaching curriculum, the authors provide not only a new pathway of commu-

nication among students and tutors, but also expand the learning environment. In the future, the authors will extend the system to the tutoring of clinical practice and continuing medical education. The authors expect a national medical education network and more international cooperation and exchange.

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