

Application of Remote Communication System For Nursing Education and Research

Takuri Takahashi, Hidetoshi Wakamatsu, Mitsue Maru, and Rumi Maeda

Abstract— Authors have ever developed multilateral communication system not only for remote lecture but also for the conferences. The developed system was supposed to apply in the actual nursing conference and the lectures, which mean the systems should work under the situation which is often limited by equipment, qualities of communication line and human resources. Therefore, developed system was designed as web-based platform to perform which had wider application range and was able to reduce construction and introduction costs. The survey to more than 150 attendances of the remote lecture and conference by developed system showed that the most participants satisfied with its performances. From the result, authors discuss conditions of application of remote communication system for not only the lectures but also the nursing services. The developed system may available for nursing research, so application field of nursing was discussed. For further research, next generation system which enables to use by current mobile devices was discussed.

Keywords— E-learning, Multilateral communication, Nursing education, Nursing research, International remote conferences, International remote lecture, Flash media server.

I. INTRODUCTION

JAPAN is facing to an aging society with low birthrate. In such situation, the role of healthcare and welfare are getting more important. Therefore, medical and welfare staff is requested to maintain their skills to keep their levels of services and knowledge up. For efficient learning, there are several opportunities and ways such as attending the conferences and seminars, having discussion with colleagues at workplace, using self-learning courses, or back to graduate school for further researches. On the other hand, raising workload and portal-to-portal hours of workers by depopulation in rural areas makes difficult to get their learning time.

Authors have been developed web-based life support and communication systems for elderly which designed as open and easy to access to use under the Internet environment [1]-[10]. To support learning of healthcare workers, the system was

arranged as remote education system and applied in nursing education. In this paper, the efficiency of the system is described by the application result of the international / domestic conferences and remote lectures.

II. SYSTEM DESIGN AND CONSTRUCTION

A. *The Aim of the study*

The purpose of this study is realization and estimation of remote education system on nursing, with introduction to the restricted communication environment such as limitation of the band-width and the number of available personal computer. The system should enable practicable, international multi-place remote conference and lectures without large loss of communication efficiency, comparing with normal lecture or meeting.

There are several studies realizing the remote lectures in education of nursing [11]-[15]. But as far as authors know, there were no report of operation about the remote education system which works in wide range of scales from small lectures to conferences. The former studies showed the efficiency of computer based learning, but authors have concerned with the system which has capacity to help discussion and communication in the lecture and meeting. Therefore, Authors not concern with so-called computer based learning system in this article. Some of the system shows the trial of broadcasting of the class. That is much close to our orientation, but in the reported case, architecture was too large and not easy to introduce in our supposed situations.

For the participants and the lecturers, the main purposes of attending the lecture or conferences are learn and study of nursing topics, or giving new ideas to the audiences. Their purposes are not using the remote lecture system so that the system should not request the handling or manipulation skills to each participant.

In special programs or environment for the e-learning, which planned for proofing the effectiveness of new technology or system, it is allowed to invest amount of equipments or arrange exclusive communication lines. But, in authors' cases, it comes from compelling on-site voices and there are strict limitations. Available equipments are basically the things that originally set at the meeting room or the conference hall, and there were not enough training or system introduction time and money. Hardware such as personal computers for terminals are not available for all the participants if they use online virtual conference environments[16][17].

Therefore, purpose of the study is set to construction of the

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flexible and highly available remote study environment in real world that is able to work in minimum effort, equipment and cost from small lecture to large conferences.

B. System Design and Construction

The system is constructed as web-based open framework for the aim of realization of easy access and reducing cost of introduction and operation. Also, authors consider the flexibility of the system.

Not only is the costs of its economical side but also the human resources such as learning and practicing considered.

To establish better remote studying environment, multilateral communication with high accessibility is requested.

Moreover, to avoid rising costs of system, the following conditions are considered as designing the structure;

- 1) Working under the Internet environment as controlling network cost
- 2) Using personal computers (PC) as terminal for component cost
- 3) Introduce Operation System (OS) independent framework for flexibility of system
- 4) No installation of software for easy introductions

To construct suitable configuration of the communication system, it is also important to make clear the differences caused by the scale of the meeting or lectures.

We consider the common point to archive in the system as follows;

- 1) Discrimination of each participant
- 2) Multilateral communication by face expression (video) and voice (audio)
- 3) Sharing reference presentations or documents
- 4) Less additional efforts for making presentations
- 5) Add information on the shared presentation during the lectures or meetings

The following condition of facility at lecture or meeting place is also considered;

- 1) Number of available terminals
- 2) Projector or Display and its size and numbers
- 3) Public address system (PA) and/or headphones
- 4) Type and numbers of microphone
- 5) Communication line and bandwidth

The number and assignment of lecturer or audience and their skills for information equipment would become a condition of the meeting. Time-zone difference of each remote participant would be also considerable on the operation.

The difference of the visual and auditory environment between individual and classroom participants will give influence on communication environment. For example, Fig. 1

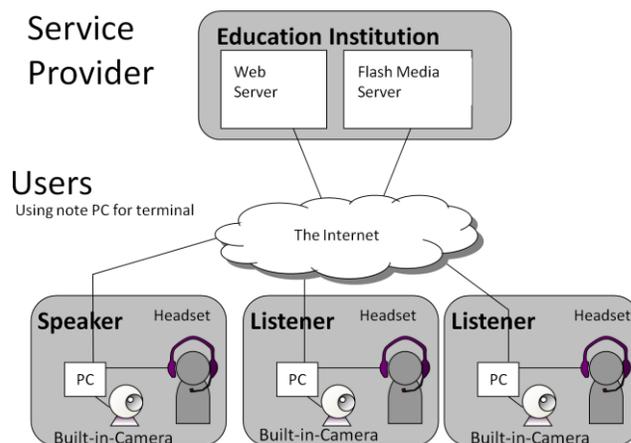


Fig.1 System operation scheme for remote lecture (separated attendances)

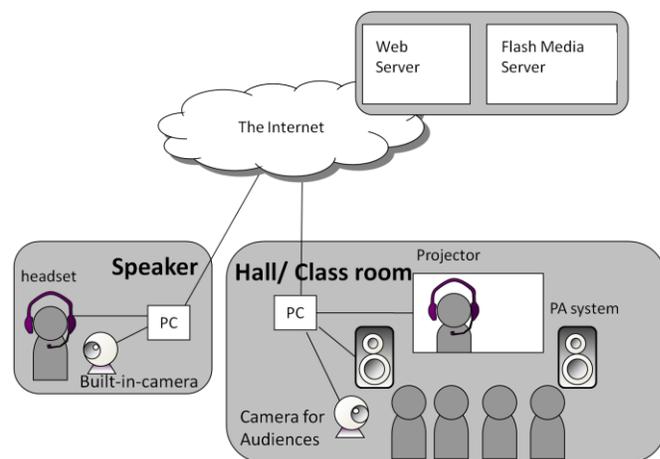


Fig.2 System operation scheme for conference or meeting

shows remote lecture that all participants including lecturer attend from different point. Figure 2 shows the scheme of conference or meeting, which audiences stay at the same places and only a speaker attends from outside of the meeting place. To use the same communication system in such two different situation, the setup of monitor / projected screen or microphone and headphones / public address system (PA) is regard as the key of the operation, as we mentioned.

In the case of fig.1, individual participants use their own personal monitor of their computer, sending video of their face by built-in camera, using headphone to avoid howling. On the other hand, in the classroom or conference hall, all participants look at the same projected screen and listen to the lecture of the speaker by single PA. That means higher occurrence of howling. Cameras are not provided for every individual participant in such situations so it is impossible to send all participants figures at the same time.

To considering the conditions as mentioned above, we designed the architecture of the system as open accessible web platform. Flash Media Server (FMS) by Adobe Systems incorporated was adopted as a real-time communication

framework. FMS holds information of participants' video, voice, pointers, chat and presentation information. Broadcasting such data will realize smooth real-time and multilateral communication. Also, the system is not requiring installation of any special software or registration for using the services, because FMS works on Flash Player plug-in with internet browsers and these are pre-installed in most modern PC.

We used Apache web server for deploying Flash files and static pages. To use the system, attendances access to the specified web page via internet browser. The web server will send Flash file to the terminal and the local Flash Player will cooperate with FMS to realize real-time communication. The system provides face-to-face video and voices of each participant, pointers on the display, text chats and shared presentation which is able to add free hand writing or comments by keyboards. Also, quality level of the visual and audio can be selected from the pull down menu to adjust compression methods and sampling rate.

PHP Hypertext preprocessor (PHP) was introduced for generating dynamic webpage and a part of the Presentation converting process. When the user post Microsoft PowerPoint file (PPT) via web browser. PHP will receive PPT as Presentation file and it will be automatically converted to Flash file which is sharable on the developed system. The lecturer can select necessary file from pull down menu. The speaker could manipulate pages of the presentation and all terminals synchronize to show the selected pages.

These web servers and FMS is available as hosting services which costs less than 150 US Dollars per month.

As terminals, current note PC with built-in camera and external headphone/microphone plugs are assumed. For better operation, more than 1280 x 1024 display resolutions is preferable. OS are Windows XP / Mac OS X or later. Pre installed web browser which working on the latest flash player plug-in is required. Also, Asymmetric Digital Subscriber Line (ADSL) level or better network is needed for smooth communication.

In remote lecture style as shown in Fig.1, all attendance recommended to use headset for avoiding howling caused by open speaker and microphone. In the conference style like Fig. 2, only speaker is requested to use the headset. At the meeting place, position of the microphone and PA should be carefully chosen. Sensitivity of microphone at the meeting place is adjusted by software, but input from microphone would be turned off during speaker talking to avoid wraparound.

III. APPLICATION AND RESULT

Authors reports trials of the system with domestic remote lectures which had eight students, two international conferences which had more than 82 and 28 participants, domestic and international lectures that have 27 and 28 students.

A. Domestic Remote Lecture

Authors have introduced developed system to the domestic remote lecture in Okinawa. Okinawa is located south west part of Jana, more than 1500km away from Tokyo. It has a number

of isolated islands and for that geographic conditions, ubiquitous education for raising nursing skills of such area is required.

Eight graduate students in Okinawa Prefectural College of Nursing (OPCN) attend the formal remote lecture operated by the developed system. Figure 3 shows the screen capture of the remote lecture from Tokyo Medical and Dental University (TMDU) to Okinawa.

At OPCN and TMDU, optical fiber without proxy or firewall was used as communication line. Student at outside of OPCN used personal internet access at their home, and that was ADSL or Fiber To The Home (FTTH) services. The terminal was students own PC with distributed USB Web Camera.

A couple of students took the lecture from isolated islands several times. Such islands were connected to main island of Okinawa with Integrated Services Digital Network (ISDN) level network at that time and that carries all communication traffics of isolated island and the main island. Its capacity of was not satisfied our specifications.

Questionnaire has been taken in 3rd of February 2008, for the usability of the system, communication difficulty and differences from normal classes. The questions are following;

- (a) Total communication quality (Total Communication)
- (b) Sound quality (Listening)
- (c) Making remarks to the others (Making remark)
- (d) Comparing with the conventional lectures (Less strangeness).



Fig.3 Remote lecture in Graduate school in Okinawa

Table 1. Questionnaire result in Okinawa

	Very good	Good	Bad	Very bad
Total Communication	1	5	2	0
Listening	5	3	0	0
Making remark	2	5	1	0
Less strangeness	0	3	3	2

Table 2. Students attribute

Students	Number of attendance	Transfer	Transit Time(hours)	Expences to Stay(dollar)
A	30	Airplain and Taxi	3	318
B	25	Ship	3	104
C	25	Car	2	28
D	25	Ship	1	25
E	35	Car	1	5
F	10	Car	0.5	0
G	25	Car	0.67	0
H	35			0
Average	26.25		1.60	96

Their answers were selected from four alternatives (Very good, good, bad and very bad). Free descriptions were also allowed for each answer. Table 1 shows the result of the questionnaire. Their evaluation was mostly positive.

In addition, each participant was asked the time and expenses that required to participate in the course of the meeting if they come to the OPCN campus which located in the main island of Okinawa. Table 2 shows the results. Average round trip time was 1.6 hours and the longest was three hours. Transportation and accommodation fee was 96 dollars in average and maximum was 318 dollars. At that point, students had been use the system 26.25 times in average. In the free description, there were some indications about the latency which appears on the communication with isolated island.

B. International Conferences

The system was twice introduced to the international nursing conferences. First one was 11th World Association for Infant Mental Health (WAIMH) held in 3rd August, 2008. The conference hall was at Pacifico Yokohama, Japan and Speaker had lecture from Seattle, USA. The Main Hall of Pacifico Yokohama Large Hall has maximum capacity of about 4500 audiences. The second one was 2nd conference of Japanese Association on Infant Health (JAIH). Speaker had lecture from Tampere in Finland and the conference hall was in Tokyo Medical and Dental University (TMDU), in Tokyo Japan. The maximum capacity of conference hall was about 320.

In both cases, the speakers were impossible to attend the meeting in Japan so they had a lecture using our developed system. They use their own note PC with the Internet connection as terminal. The existence of proxy or firewall was not confirmed but we have asked the information sector of their facilities to open the particular port used by the system. The speaker connected to the system by announced URL by web browser. In the conference hall, we arranged two note PC as the terminal. One terminal used for projecting presentation and speakers figure on the screen. This terminal was connected conference hall PA. Also this terminal used as capturing and send the interpreter’s figure and voice to the speaker so the interpreter’s microphone was directory connected. The other terminal is provided for Question and Answerers time from the audiences. The camera which connected to this terminal was facing to the sheets of conference and microphone was set at the

front of the audiences. The extra optical internet connections without any proxy or firewalls were introduced to each conference hall and the terminals were access to the server using this line. We arranged three times of practice run as preparation. Figure 4 shows arrangement schema of conference from United States(WAIMH).

We had questionnaire to the participants about visual, sound and the levels of strangeness. The questions are following;

- (a) The visual quality (Visual)
- (b) The sound quality (Sounds)
- (c)Comparing with the conventional lectures (Less strangeness).

Their answers were selected from four alternatives (Very good, good, bad and very bad). Free descriptions were also allowed for each answer. Table 3 and 4 shows the result. Blank or multi-marked answers are calculated as “Invalid”. In both cases, a number of attendances mark positive evaluation.

Table 3. WAIMH questionnaire result

	Very good	Good	Bad	Very bad	Invalid
Visual	35	46	1	0	
Sound	43	37	2	0	
Less Strageness	16	53	8	1	4

Table 4. JAIH questionnaire result

	Very good	Good	Bad	Very bad	Invalid
Visual	24	4	0	0	
Sound	13	10	2	1	2
Less Strageness	4	17	5	2	4

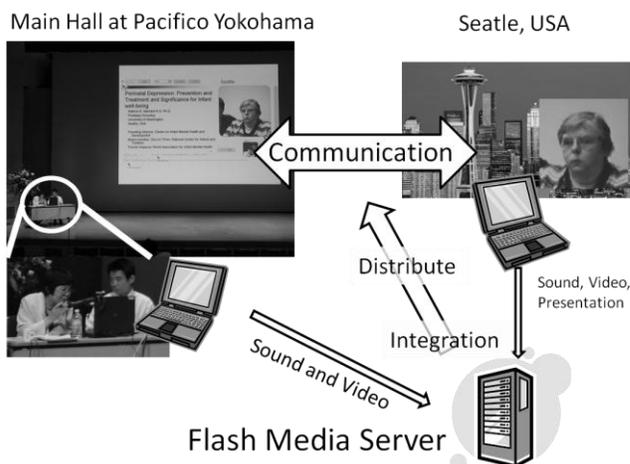


Fig. 4 International remote conference from USA.

C. International and Domestic remote lectures for undergraduate students

Remote lecture for undergraduate nursing students has operated by the developed system. There were two trials, one

was domestic and the other was international. Both were organized under the part of the International Nursing Development Course for fourth grade undergraduate student in TMDU.

First trial held in 22nd June 2010. Speaker had a lecture from Kyushu, southern big island of Japan. The topic was about nursing in East-Asia, including Taiwan and Hong Kong. The second trial held in 31st May 2011. There are two speakers in second trial, one from Kyushu and the other from Hong Kong. The topic from Kyushu was nursing in East-Asia and mostly same as its lecture in 2010. The topic from Hong Kong was state of the art technology of artificial patient model for nursing training.

In both cases, the speaker was not able to have lecture at TMDU so they give lectures using the developed system. They used their own PC as terminal and connected via their faculty network, which has proxy or firewalls. The internet connection in the class room at TMDU also had a proxy. At TMDU class room, we arrange two PC as we described above, one for display screen and the others for question and answers. But in this case, we do not have any interpreter at class room.

Figure 5 shows the layout of the classroom in year 2011. In year 2010, we had a liquid-crystal projector in front of classroom. In year 2011 we arrange another room which has with two large liquid-crystal monitors and four plasma sub-monitors for display. The Hong Kong speaker had a lecture in English and the speaker of Kyushu interpreted it to Japanese after. Students alternately listened English from Hong Kong and Japanese interpretation from Kyushu.

The questionnaire result shows in table 5 and 6. The questions are following;

- (a) Total communication quality (Total Communication)
- (b) The visual quality (Visual)
- (c) Comparing with the conventional lectures (Less strangeness)
- (d) Necessity of remote communication system in the nursing field.

Table 5. Questionnaire result in class of 2010

	Very good	Good	Bad	Very bad
Communication	14	12	1	0
Visibility	2	14	10	1
Less strangeness	3	10	12	2
Necessity	2	19	5	1

Table 6. Questionnaire result in class of 2011

	Very good	Good	Bad	Very bad
Communication	5	18	3	0
Visibility	12	12	2	0
Less strangeness	0	6	11	9
Necessity	6	10	9	1

Their answers were selected from four alternatives (Very good, good, bad and very bad). Free descriptions were also allowed for each answer. According to the firewall of the facility, there were some communication latency occurred during the class.



Fig. 5 International Classroom from Hong Kong

D. International remote seminar for Graduate students

Remote seminar for graduate students has operated by the developed system. In this case, the discussion was much more important than other cases which already we described.

The seminars were organized as the part of the International Nursing Development Course in Graduate School of Health Sciences, TMDU. It was hold in 24th October and 16th December 2011. The seminar is ongoing and planned to have four more sessions in January and February 2012.

The lecturer at United States could not give their seminar in Japan, so the system was introduced. Lecturer used own PC as terminal and access to the web via personal internet connection at home so there assumed no proxy or firewalls. In seminar room at TMDU, we arrange two note PCs as terminal, one for connect to the liquid-crystal projector and speakers. The other one was used for discussion. The terminals are connected to the internet by high-speed wireless fidelity (Wi-Fi) via TMDU line, which means there was proxy or firewall.

Eight students attend the seminar. At first session, students discuss their research field an interest with the lecturer at United States. The lecturer gives question and advices for each student's topic. In the second session, topic of the seminar was Evidence-based practice, which is essential topic in nursing researches. Half of the lecture was took for the lecture about the over view of the Evidence-based practice from US, and the other half was one-by-one discussion about application of Evidence-based practice to each students research. Figure 6 shows the student and lecturer discussion using the system. All discussion and the lectures with US were in English and there are some conclusion and comments from professor in Japanese after the remote seminar.

The questionnaire result shows in table 7. The questions are following;

- (a) Total communication quality (Total Communication)

- (b) The visual quality (Visual)
- (c) Comparing with the conventional lectures (Less strangeness)
- (d) Necessity of remote communication system in the nursing field.

Their answers were selected from four alternatives (Very good, good, bad and very bad). Free descriptions were also allowed for each answer. According to the firewall of the facility, there were communication latency occurred during the discussion. Also, the wraparound was caused by the arrangement of speaker and the microphone.



Fig. 6 International Graduate school seminar from United States. Having discussion with lecturer.

Table 7. Questionnaire result in Graduate school seminar

	Very good	Good	Bad	Very bad
Communication	1	7	0	0
Less strangeness	0	1	7	0
Necessity	8	0	0	0
Nursing Research	8	0	0	0

n=8

From table 7, most students satisfy its communication quality but felt strangeness from normal lectures. In free description, communication delay and the wraparound was stated as a reason of such strangeness and the difficulty in discussion. On the other hand, all students had positive answer for necessity of remote lecture and application of such communication system in nursing research.

IV. DISCUSSION

A. Result of the Conference and lectures

From more than 150 questionnaire results of conferences and lectures, the performance of constructed system is mostly estimated as enough for practical use.

In trial at Okinawa, Table 2 shows that the introduction of the system reduces the cost of transportation for the students in time and fee. In our questions, there were actual transportation time

was made clear but the flight schedule of airplane was not frequent so taking class require staying at the main island, so effect of reduction of time to take class is possibly more than the values shown in the table. That was a benefit for students, but it was actually benefit for local residents of isolated islands too. The student was single personnel for public health of the island. When she had a lecture at university at the main island of Okinawa, there was happened that temporary unavailability of healthcare support for residents of the island. The introduction of the system reduces such situation as possible.

There was some latency reported on the system when the students at the isolated island attend the classroom. The reason of that was assumed the narrow bandwidth of the communication line to the isolated island. As we mentioned, such island only had ISDN level capacity and not enough for smooth communication. For that situation, using both developed system and Skype was tried. Skype was not widely accepted than today at that time but the implementation of peer-to-peer protocol for transmitting the audio was much effective to reduce latency in narrow bandwidth. On the other hand, the function of multi-lateral face-to-face communication and sharing the presentation was not available. So, isolated island student used Skype for listening the lecturer's voice and watch the displayed presentation or use printed handout which send before the lecture by e-mail. Recently, high-speed broadband networks were introduced to such island so the communication difficulty is much eased.

The application to the nursing international conference showed that the system have enough capacity for operation under the large conference hall which had more than 4000 sheets at WAIMH. From table 3, the visual and sound quality was enough for presenting in front of the audience using liquid-crystal projector and PA at such a large hall as shown in fig. 4. Authors could not assume the number of the total participator at our session but upper floor of the hall was closed and there were not crowded at seats so we believe that the collection rate was not really low at all even the numbers of collected was less than one hundred. It was same as in Japan-Finland international conference on JAIH. In both cases, the style of lecture was mainly one-way talk from lecturer and that was similar to on-demand broadcasting of recorded lecture program.

On the other hand, in remote lectures for undergraduate students, the speaker often gave a question to the students and they required answering the question. In such situation, interactivity was much play more important role in the communication. Table 5 and 6 shows the result of "less strangeness" is much higher than other result that showed before. We have set default bandwidth higher for ensuring the quality of video and audio, but it was not suite for interactive communication. The latency was also caused by the firewall and proxy that set at both Kyushu and TMDU network. Authors change quality of the data to reduce transfer latency during the class and that changing realize much smoother interaction between separated lecturer and the students. From such

experience, the frequency of the interaction may be an issue that should be clear before start the lecture.

The seminar for the graduate students had more discussion time than conferences or undergraduate student classes and it makes clear the defect. From table 7, "Comparing with the conventional lectures (Less strangeness)" was negative; seven in eight was marked "bad". They felt difference from normal lectures and the reason was delay and the wraparound. For avoid wraparound, microphone of the speaker was turned on and off at appropriate timing, but the communication delay that caused by the proxy/firewall was inevitable. We use Wi-Fi to connect to the TMDU network. Thus the bandwidth of the link was more than 64 megabyte per second (MB/s) and that was much wider than ADSL which has less than 12 MB/s but was tested as adequate communication line[5]. We assume the Wi-Fi was not the bottle-neck which cause the latency. To avoid the effects of the proxy/firewall at TMDU network, another internet connection line, Worldwide Interoperability for Microwave Access (WiMAX), which will provide high-speed wireless access is going to introduce in next session. On the other hand, they felt quality of communication was "good".

In all cases, basically the system was able to operate under the addition of one or two note computers with the Internet connected network. That means, there are almost no extra costs nor large system for realization of remote conferences. There result shows that our developed system and operation is sufficient to implement remote lectures in prevent the digital divide.

B. Application for nursing research

From table 7, for graduate students, the application of remote communication system in nursing research field is highly required. On the other hand, from table 5 and 6, undergraduate students are less eagerness. The reason was speculated that the development of conscious and their own interest for the nursing field. Each graduate student have research subject and that is stands for their clinical experiences as nurse.

For authors, developed remote communication system could be effective technology not only for remote education but also for nursing research.

The telemedicine would be one of the fields of application. In Japan, there are problem of uneven location of medical staff between areas. Such area, patient often have longer intervals to go hospitals and sometimes difficult to find change of condition. For patient of dermatosis, the visual communication function would become help for presenting their condition of skin and may have advice from doctor or nurse.

Another filed of application would be home-care services. The elderly nursing system change to suggest home-care rather staying hospital. Rapid increase of patient requires home-care making urgent task of formulation of regional alliances between hospital and home-care that smooth transition from hospital to home-care. In this case, there are coordination of care methods before discharge but also the follow-up is required. The system may be help of such follow-up and education of care-staff. Furthermore, introduction of the system would also enhance the

partnerships.

In pediatrics, such system may useful for support patient and family. Numbers of pediatrics professional nurse is still not enough and patients' family, especially their mother, often could not have counseling from professional nurse when they have anxiety for their child. Using the system to the special nurse of pediatrics may give proper knowledge and ease their anxiety. The special nurse may have a conference with the nurse at the hospital where the patient took medical care. If the patient was at puberty, nurse may have counseling directly with patient.

In such situations, the system requires patients only a network accessible PC and highly available so it may be use as supporting tool for nursing and its research. Validation of efficacy is our further subject.

C. Further system development

The developed system by FMS was match for our purpose and design principle, and its performance was enough for running various learning situation. But recently, mobile devices such as smart phones such as Android or iOS devices are getting popular and request of using the system from such device raised.

Android have dedicated Flash player but it was not allowed to access camera or microphone devices so it was impossible to have multilateral communication. iOS devices such as iPhone and iPad was not allowed to have Flash player.

Authors had expectation of progress of Flash player on mobile devices but recently Adobe decides discontinuing of development of Flash player for Android, so it is impossible to use by the Android smart phone. Also, Flash player for iOS was never released.

We can use FMS when build native application for each device, but that may require installation of the software and that was not suit for our system design principal.

The trend of the web technology on multimedia is shift from flash to HTML5. It may take some time but if the web browsers support functions of HTML5, we could make another new system that work as same user experiences that FMS had. Our next challenge is to make new system that work both PC and mobile devices using HTML5 technology. HTML5 Media Capture and JavaScript may be one of the key technology for our next generation system[18]. HTML5 Media Capture API is currently under working draft and supported browser is limited right now, but it may be getting popular in next couple of year. The browser will access to the build-in camera and sound device. Data from such devices may as exchange between each terminal as synchronized signal. The status of the devices or shared objects may reported by JSON format. Most of these works may be done by browser using JavaScript or its wrapper libraries.

V. CONCLUSION

Authors have developed web-based, open architecture, low-cost e-learning system for support actual remote nursing education, which often had restriction of various resources. The system design principles are discussed and the application of the system to the International and Domestic conferences and lecture shows the system has enough capacity to support variety

kinds of learning situations. The application of the system to the nursing field research has discussed and the supposition of implementation of the next generation communication system that works on the current mobile devices also discussed.

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