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Development and Evaluation of a Technical Information Sharing System for International Remote Medical Education

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Abstract. Technical issues with videoconferencing can often disturb the learning process of international remote medical education. In this study, a system to share technical information among technical support staffs and accelerate their collaboration was developed and evaluated for the purpose of preventing technical issues. The system design incorporates two types of websites. The first site enables each institution to share their technical information. The second site enables the chief engineer to browse the shared information and provide tailored technical direction. The system was evaluated via online questionnaires and online interviews. The first site enables each institution to document their technical environments by visually choosing elements. Pictograms are displayed on the second site for the chief engineer to offer suitable technical direction. The result of questionnaires and interviews were positive. The system contributes to sharing technical information more easily and helps technical staff use the collective information to improve connectivity testing.

Keywords: Remote medical education · Videoconferencing · Prototyping

1 Introduction

Videoconferencing (VC) can be an effective support to international medical education programs and reduce medical disparities around the world [1-3]. However, technical issues, such as network disconnections, often disturb the learning process during remote medical educational programs [1, 4, 5]. These situations challenge the use of VC in the field of medical education, which requires the ability to transmit high-quality medical content [6]. Thus, resolution of technical issues should improve the educational process and contribute to the expansion of remote medical education.

Previous research offers a framework for addressing technical issues in remote medical education [7]. Technical issues can be avoided by user behavior to check connectivity prior to a program. However, additional factors can cause technical issues directly and/or via unintended user behaviors. These factors include differences among institutions such as the technical environment, skills, knowledge, languages, and commitments. However, no solution has been found regarding this matter.

Kudo et al. conceptualized the technical support team [8]. They classified technical support staffs into two roles: the chief engineer who coordinates all technical matters among multiple participating institutions, and on-site engineers who manage their own institutions and must cooperate with the chief engineer and other on-site engineers. Because the technical environment of each institution is independent, the chief engineer needs sufficient technical information from each site to effectively plan and direct the connectivity tests.

From these backgrounds, we developed and evaluated a system to improve and accelerate cross-institutional connectivity tests by effectively sharing technical information among technical support staffs in this study. The system should include the following design concepts.

Concept A: Documenting and sharing information about each technical environment easily. The purpose of concept A is to decrease miscommunication due to differences among technical support staffs and minimize support needs. Concept A supports easier and better communication in two ways. First, it offers on-site engineers a set of uniform choices to help them describe their technical environment in a structure way. Uniform choices clarify, especially for inexperienced on-site engineers, what the chief engineer needs to know. Second, it offers a visualization of each technical environment to overcome possible language barriers.

Concept B: Using collective technical information to improve connectivity tests. The collective technical information from all remote sites can be used in two ways. First, the collective technical information should be the reference for chief engineers in designing and directing the connectivity tests. Thus, the display of all site-specific information must be easy to understand. Second, the collective site-specific technical information should be matched to critical communication devices.

This study followed the process of human-centered design, which includes consideration of the characteristics of technical support staff themselves and their behavior as stakeholders of technical quality control. As part of this human-centered approach, we referred three steps of participatory design [9]. Previous study included stages 1: initial exploration of work, and 2: discovery process. And this study addresses stage 3: prototyping.

2 Method

2.1 System design

To implement the two essential concepts, the system is designed to comprise two types of website: the transmission site for use by on-site engineers and the reference site for the chief engineer (Fig. 1). In the first step of system design, the scope of technical information to be shared among on-site and chief engineers is classified into categories. Then, the transmission site and the reference sites were designed to capture and share classified technical information. In designing an appropriate user interface for each site, we referenced Nielsen's heuristics [10].

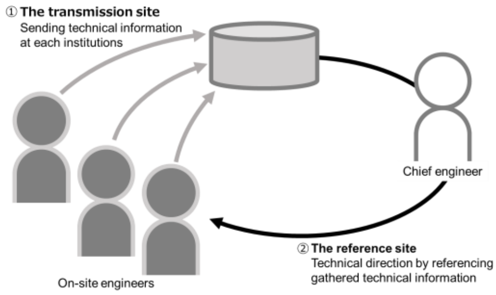

Fig. 1. Outline of the system

2.2 Criteria for evaluation

This system was evaluated during 7 international remote medical educational programs, which were organized between February and April 2020. Different evaluation methods were implemented for transmission sites and the reference site.

For the evaluation of the transmission site, on-site engineers were asked to use the transmission site to share information about their VC technical environment with the chief engineer. After the program, an online questionnaire was distributed to the on-site engineers (Table 1).

Semi-structured interviews were conducted with three chief engineers to evaluate the reference site. First, the chief engineers evaluated the reference site in an on-the-job or demonstration mode. After these experiences, an online interview was conducted with each chief engineer. They were asked to describe their usual approaches for gathering technical information from other participating institutions, as input for concept A, and about their connectivity testing, as input for concept B. Then, they explained how this system contributes to their work, in areas for concepts A and B. The transcriptions of interviews were coded and a framework was developed.

Table 1. Questionnaires and choices

Concept	Questions
Concept A	1-1. Were the choices in each category sufficient to describe your technical environment? *Definitely yes, Yes, No, Definitely no* 1-2. How do you think the number of whole input items? *Too many, A little too many, Moderate, A little too few, Too few* 1-3. Were the choices in each category easy to understand? *Definitely yes, Yes, No, Definitely no*
Concept B	2-1. Was the purpose of the web site easy to understand? *Definitely yes, Yes, No, Definitely no* 2-2. Did the chief engineer have directions according to your submitting technical environment during the connectivity test? *Definitely yes, Yes, No, Definitely no* 2-3. Could the list of test-items good reference for you? *Definitely yes, Yes, No, Definitely no*

3 Result

3.1 System design

The minimum requirement for effectively sharing VC technical information involves five categories of parts: table and display, number of participants, image-in, audio-in, and audio-out. Each category offers four choices plus “unknown/not decided”. Additionally, there are multiple choices for specifying audio-options, and memo columns to enter free descriptions or optional information in each category. Each choice offered is represented pictographically (Table 2).

Table 2. Categories and item choices to describe VC technical environment

Category	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5
Table and display	Desk with laptop	U-shaped	Single row	Classroom /Theater	Unknown /Not decided
No. of partic-ipants	Only one	Around five	Less than 20	20 or more	Unknown /Not decided
Image-in	System integrated	Webcam	PTZ camera	Handy camera	Unknown /Not decided
Audio-in	System /webcam integrated	Omnidirec-tional (speak-erphone)	Hand /Stand mic	Headset	Unknown /Not decided
Audio-option (Multiple)	Mic amplifier	Multiple mic	Audio mixer	-	-
Audio-out	System /webcam integrated	Mic integrat-ed	External	Headset	Unknown /Not decided

While referencing the classified technical information structure, both the transmission site and the reference site were designed as web-interfaces to access a single database. Google Spreadsheet (Google LLC, Mountain View, CA) was used for the database engine.

The transmission site is considered the input site, in which on-site engineers share details of their VC technical environment with the chief engineer (Fig. 2). The input process at the transmission site is divided into three steps. First, the transmission site introduces the system and describes how to use the site. Second, on-site engineers indicate their technical environment by choosing appropriate items from a visual display, and then enter their name and institution name. After submission, the test item list, which varies according to their choice of items, is shown. This list emphasizes the importance of testing connectivity prior to the program.

The reference site is designed for the chief engineer, and visually displays the technical environments of all participating institutions (Fig. 3). There are choices of items and memos shared by on-site engineers with pictograms of each technical environment. The list is ordered by submission date, and each institution can be seen by scrolling through the reference site. The chief engineer can edit the on-site engineers' choices and memos and update the database by clicking "Save Changes" button on the right side of each institution's column.

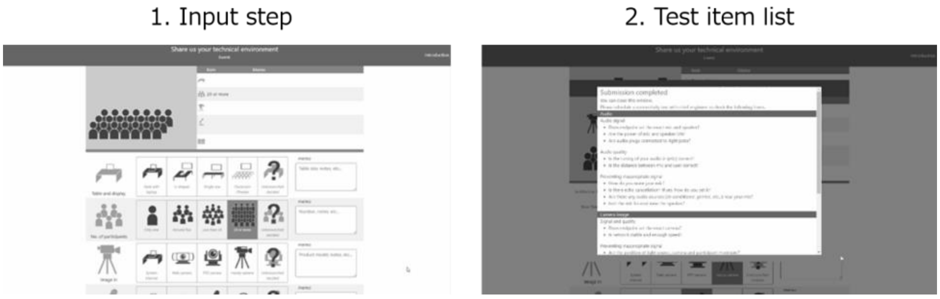

Fig. 2. Images of the transmission site

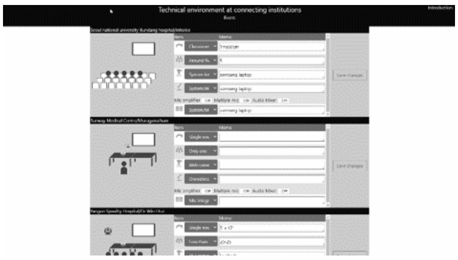

Fig. 3. Image of the reference site

3.2 Evaluation

Of 46 institutions from 20 countries, 40 (87%) used the transmission site, and 30 on-site engineers from 16 countries answered the questionnaire. Fig. 4 shows the result of questionnaire regarding concept A and B. Answers for all 6 questions were positive.

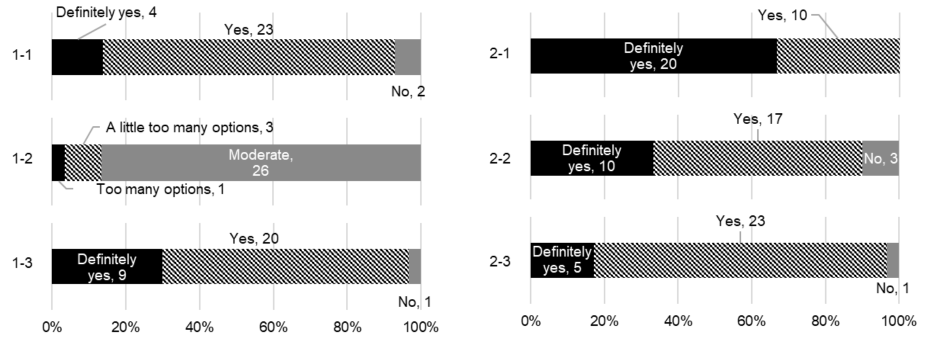

Fig. 4. Answers of questionnaires

Interviews with chief engineers focused on how this system helps them prevent technical issues during VC events. Interview transcription codes about the prevention of technical issues captured two main ideas: ways to use the shared technical information, and assessments of the system (Fig. 5).

Assessments of the system. This system acts as a reference for technical direction in three ways: offering information visually, listing all technical information in one place, and standardizing responses around uniform choices. Similarly to the transmission site evaluation, chief engineers found the visual representation of technical information intuitive and easy to understand. Listing multi-site information helped chief engineers cross-reference the information of participating institutions. However, the chief engineers also suggested ways to improve the listing such as responsive layout or hierarchization of displayed information. Uniform choices are helpful for on-site engineers to share technical information that chief engineers need. However, all chief engineers requested additional categories to this system, and additional choices for existing categories.

Way to use the shared technical information. During or before the connectivity tests intended to prevent technical issues, all chief engineers assemble the technical information from each participating institution. They use this information not only as reference for technical direction of the current event but also envisage archiving the information for future programs. Additionally, two chief engineers suggested sharing the information with others, such as on-site engineers or the session chair.

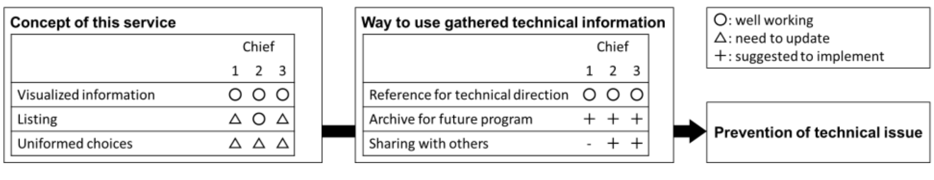

Fig. 5. Framework of codes

4 Discussion

In this study, a system was designed and implemented to accelerate connectivity tests by sharing technical information among technical support staffs. The result of the implementation itself was acceptable, in that there was high utilization and positive feedback from a variety of countries. Both on-site and chief engineers provided positive feedback about concept A. Most on-site engineers considered the transmission site easy to use (97%) and effective for describing their technical environments (93%). Chief engineers also valued the intuitive aspect of visual information on the reference site in helping them offer technical direction to the remote sites. In summary, the concept A design goal of sharing technical information among the chief engineer and on-site engineers was easily met by this system. The multi-site information listing was the key element of concept B. Chief engineer interviews revealed that the listing provides them a single source of information to reference for technical direction. Additionally, most on-site engineers agreed that chief engineers were able to offer them useful guidance to prevent technical issues or to troubleshoot (90%). Because technical interventions vary by the program, the relationships among the chief engineer and on-site engineers, and especially the principles of the chief engineer, the listing offers a sufficiently generic and customizable source of information to guide technical direction.

Some opportunities for improving this system have already been identified. The number of choices was the major issue for concept A. While most on-site engineers felt that the system offered sufficient choices to describe their technical environments well, all three chief engineers requested additional categories and choices. The balance between simplicity for on-site engineers and concreteness for chief engineers should be improved by refining the technical categories and category choices. The key element of concept B, the scrollable listing for chief engineers, should also present the information more flexibly. It can be hard to absorb all the details of all participating institutions at one time on a single page. Tailored test item lists were not designed to transmit to chief engineers, even though 96% of on-site engineers found them useful. This test item information could also be presented through both sites to help align the understanding of chief engineers and on-site engineers. Other improvements could build on chief engineers' suggestions of archiving and sharing site technical profiles with others. Archiving technical profiles for future programs would offer a practical benefit for remote medical education because participating institutions typically collaborate repeatedly.

There are limitations to this study. One is the number of subjects, especially those evaluating the reference site. Because the reference site was evaluated by only three chief engineers through interviews, quantitative evaluation is needed in future research. Further limitations concern the technical environment of remote medical education. While this research study was conducted between February and April, 2020. Because the technology and style of remote medical education will continue to change, flexibility in the choices and arrangements of input items will be important of ensuring the longevity of this system.

5 Conclusion

To effectively share technical information among participating institutions for remote medical education, we designed two types of websites: the transmission site, for on-site engineers, and the reference site, for chief engineers. The system enabled on-site engineers to use pictograms to choose items in five categories to describe their site technical environments, and share this technical information with the chief engineer. It also enabled chief engineers to easily view all the technical information for all participating sites. Regarding evaluation, there was high use with positive feedback regarding system quality from various countries. Feedback from technical support staff offered further ideas for improving the system.

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