

Computer-Supported Training System for Clinical Engineer

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Abstract. It is required for a clinic engineer to have highly professional knowledge as well as skills for the operation of medical machines. Such knowledge and skills are normally difficult to master only by teaching and practicing at universities with limited time. Therefore, it is expected to have new training system supported by advanced computer system using the information and communication technology (ICT). In this study, a training system with ICT for clinical engineer was constructed. With the system, several problems in operating medical machines were made clear, and solutions and proposals for such problems were given with examples.

Keywords: Information communication technology, Computer training system, Clinic engineer, E-learning system, Skill science, Medical equipment.

1 Introduction

The term of “Clinical engineers” (CEs) means such a person who deals with the operation and maintenance of medical machines for saving the life or curing the disease of patients under the guidance of doctors.

There is a closer relationship in the modern society between medical and engineering, as the result of the fact that high-tech medical machines have been more and more applied in therapy. At the same time, any mistake or misuse of such machines would be closely related to the state of disease of patient or even a human life. The responsibility of the clinical engineer is ever high, and his job contents may change a lot with time. While a clinical engineer is a technician to control medical machines using knowledge on electronics and mechanics, he is also one that with the task to improve the science and technology on clinic engineering [1].

However, it is very difficult for a student to become a qualified CE who has to master so many techniques within so limited period of time. As the results, the CEs feel quite often the lack of knowledge and skill after graduated and start to work in a hospital. Therefore, it is expected to have a new computer-supported training system, better with the use of ICT, for clinical engineers.

In fact, it has been attracting much attention to apply computer technologies in several e-learning systems [2]-[4]. Similarly, it has been considered possible to apply such technologies also in the field of clinic medicine [5] [6], though, there has not yet developed a satisfactory total training system using at the same time both operating information and visual information for CEs.

In this study, aiming the goal of an advanced computer-supported training system being low cost, rich in simulated experiences, and with good repeatability, we proposed one using the up-to-date technologies in our sequential research results on computer-added skill-up training systems [7]-[12]. The system was applied practically upon undergraduates in a medical university to demonstrate its effect.

2 Investigation Research

2.1 Investigation Research on Clinical Engineers

A preliminary investigation on the research subject was done on experienced teaching professors and 4-year students by a questionnaire to ask what they most want to teach or to know.

Questionnaire was first done on highly experienced professors or teachers. On the question of whether or not a computer-supported training system is necessary, all persons answered yes, which confirmed the necessity of such system.

And next questionnaire was done on students. On the question of whether or not you have enough time for practice, the answers are 25% for yes against 75% for no (Fig.1 (a)). On the question of the necessity of such system, 100% is yes (Fig.1 (b)).

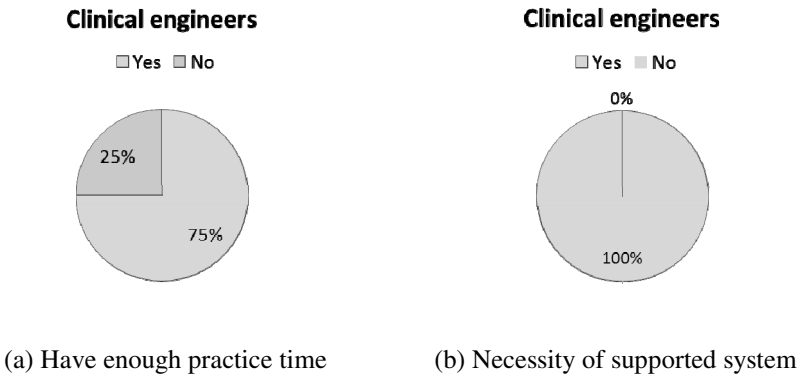


Fig. 1. Questionnaire results on clinical engineers

Further questionnaire was done upon professors from different departments on different medical machines of heart-lung machines, artificial cardiac pacemaker, continuous renal replacement therapy, mechanical ventilator, respectively, and answers were obtained as the following:

- Heart-lung machines: such system is necessary, better with training on mastering different treatments for different diseases and trouble-shooting.
- Artificial cardiac pacemaker: it is necessary, better with training on the confirmation of the mode of artificial cardiac pacemaker, e.g., the simulation of confirmation of such modes used in third degree complete atrioventricular block.
- Continuous Renal Replacement Therapy: simulation system need is particularly high for new students, e.g., simulator can give signs by colors to show if the operations are suitable. It is required also for trouble-shooting during operations.
- Mechanical ventilator: a system capable of measuring the ventilation volume, ventilation number, and circuit the internal pressure, the relationship between O₂ and CO₂, and simulation of blood pressure.

2.2 Investigation Research on Students of Clinical Engineer

Furthermore, we did a questionnaire on the 4th grade students in our university by “did you forget the operation sequence of heart-lung machines after you have become the 4th grade student (before hospital practice). Surprisingly, all 31 students regardless of gender answered with “yes, I forgot”! The reasons may be multiple, but “fewer chances to touch and operate the equipment” becomes the dominant.

Another questionnaire was put upon the 4th grade students by a question “do you want to use a computer simulation system capable of simulated experience in preparation and review of your text. The answers divided into different training items, in which 90% of students answered “yes”.

It is confirmed through preliminary investigation that such a training system with simulation paying attention operation method and practice skills is very necessary. Based on the results, this study takes the multimedia training as main research subject to solve problems in clinic engineering education, and a total computer-supported training system capable of knowledge learning and skill-up was studied.

3 Propose of Education and Training System

3.1 Learning Support by Questionnaire

The mode selection and trouble shooting in mechanical ventilator operations were selected as research subjects in the construction of education system.

Electronic textbook for learning was prepared from the materials investigated on above two subjects. Ask and answer method was used, which are further connected to explanations by voice, animations and sounds, operated and displayed with the personal computer or mobile phones. A training system was then constructed.

To support knowledge learning, questions and answers and explanations was filed into “ask and answer” textbook using software (Q & A mode question set). An example was demonstrated in Fig.2 on the training term of “mechanical ventilator: modes and trouble-shooting”. It can be understood that simple and repeatable training, with real-time response, is obtained (Fig. 3).

If clicking the ① “Challenge a question” term in Fig. 2, questions and selections, and selected answers are demonstrated as shown in Fig. 4. Explanation can be referred by selecting ② “View the answer” after the answer. To Select the ③ O button if recorded by personal report, or the ④ X one, so one can even know his ⑤ correct answer rate and ⑥ challenge number, and therefore is evaluated.

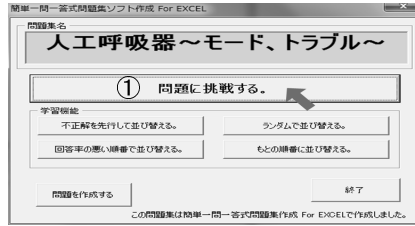


Fig. 2. Display of Q & A mode question set

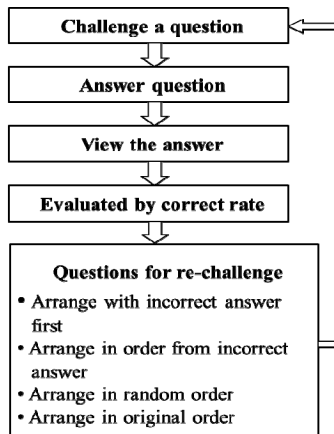


Fig. 3. Learning support by Q & A mode

The above training using the system shows that a student obtains knowledge not only from reading the textbook, but looking for answers to a selected question with real-time evaluation. The effect was confirmed by practice.



Fig. 4. Real-time evaluation

3.2 Teaching of Troubleshooting

How to treat medical troubles or how to do operations without trouble is one of the main subjects for a clinical engineer. However, a textbook cannot answer all questions for trouble shooting because of the complexity and variety in different operations, different systems and even different hospitals by shipment time and manufacturers of medical equipment. Recently due to some medical accidents reported, safety education has been taken into considerable account in CE education. In this study for first of all, accidents from system troubles or operation mistakes most popularly related to CEs are confirmed, with related education and training methods provides.

Here we take the trouble shooting case on mechanical ventilator such as water condensation, too dry or too wet in respiratory tract, etc. Proper steps and check-points were set, and learning was progressed by confirming such check-points. Alarm sound, lighting images, and animation on operations were prepared for efficiency.

Way of example, the checkpoints, countermeasures, and operations of trouble shooting in mechanical ventilator are listed as following.

- Reconfirm the connection to breathing circuit
- Check the heated humidifier for any damage
- Drain off water in water trap
- Check the warmness of heated humidifier
- Co-use with artificial nose is prohibited

A clinic engineer works on the operation and maintenance of medical machines which needs both knowledge and skill. It is important for him to become skilled by repeated practice. For developing a more effective training method for clinic engineer, we proposed a computer-supported system including the learning of textbook knowledge, operation method and trouble-shooting with the use of multimedia.

4 Conclusions

In this study, a training system for the knowledge and skill required for a clinical engineer was constructed. A preliminary investigation was firstly carried out to clarify the research subject and problems in conventional training. Based on the investigation, the mode selection and trouble shooting in mechanical ventilator operations were selected as research subjects. An Ask-and-answer method was used, which are further connected to explanations by multimedia such as voice, animations and sounds, operated and displayed with the personal computer or mobile phones. The effect was confirmed by practical training on medical university students.

Because it is understood that the most important training for a clinic engineer is with closely and repeated touch to the operation machines, and real-time response, the next step of this study is to increase the operation ability of the system. Further, it is considered to introduce more animation elements and game factors (e.g., well point and competition system) to develop better training system interesting the yang students.

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