



ORIGINAL ARTICLE

N Yoshida  
T Aso  
T Asaga  
Y Okawa  
H Sakamaki  
T Masumoto  
K Matsui  
A Kinoshita

**Authors' affiliations:**

N Yoshida, T Aso, T Asaga, Y Okawa,  
H Sakamaki, T Masumoto, K Matsui,  
Department of Dental Hygiene, Faculty of  
Health Care Sciences, Chiba Prefectural  
University of Health Sciences, Chiba, Japan  
A Kinoshita, Graduate School of Medical and  
Dental Sciences, Tokyo Medical and Dental  
University, Tokyo, Japan

**Correspondence to:**

N Yoshida  
Department of Dental Hygiene  
Faculty of Health Care Sciences  
Chiba Prefectural University of Health  
Sciences  
2-10-1 Wakaba  
Mihama-ku  
Chiba-shi  
Chiba 261-0014  
Japan  
Tel/Fax: +81 43 272 1781  
E-mail: naomi.yoshida@cpuhs.ac.jp

**Dates:**

Accepted 16 August 2011

**To cite this article:**

*Int J Dent Hygiene* 10, 2012; 61–66  
DOI: 10.1111/j.1601-5037.2011.00528.x  
Yoshida N, Aso T, Asaga T, Okawa Y, Sakamaki  
H, Masumoto T, Matsui, K, Kinoshita A.  
Introduction and evaluation of computer-assisted  
education in an undergraduate dental hygiene

© 2011 John Wiley & Sons A/S

## Introduction and evaluation of computer-assisted education in an undergraduate dental hygiene course

**Abstract:** *Objective:* This paper introduced newly developed computer-assisted learning materials and reports of a survey of junior college dental hygiene students who have used them. *Methods:* We authored new educational material to promote students' basic dental hygiene practice skills using a simulation software generator. A set of five developed materials were tested by 43 female second-year dental hygiene students during the second semester at a college in Chiba, Japan. The evaluation was conducted in the form of a questionnaire including open-ended questions. Students' opinions were analysed using characteristic diagrams, a troubleshooting tool that can be used to visually illustrate the causes and effects of a problem. *Result:* The overall results of the evaluation were positive. The students were given five sets of simulation learning materials (SLMs). Eighty-three percent of the students felt that they could carry out independent study of clinical practice better after the virtual practice. Ninety-three percent of them felt that the exercises should be continued in the future, and eighty-eight percent of them felt that this virtual practice deepened their interest in other classes and training sessions. All of the students found the virtual practice beneficial for their learning. *Discussion:* The present results suggest that the students became conscious of their lack of knowledge through SLMs. These findings indicate that SLMs for practicing basic clinical procedures is beneficial.

**Key words:** computer-assisted education; dental hygiene education; educational systems

## Introduction

In higher education, it has become well known that the use of e-learning can increase the efficiency and potential of teaching. There have been many studies that have examined the effectiveness of computer-based teaching of evidence based medicine (EBM) compared with standard lecture-based approach (1–8). Bogacki *et al.* (9) have shown that computer-assisted learning is statistically equivalent to the traditional lecture, as measured by exams, and many advantages of this approach include greater student–faculty interaction, greater student control over pace, more time for faculty to help struggling students and introduce clinical relevance, less time to maintain course materials and less expense. Rosenberg *et al.* (10) found that computer-aided learning elicited a positive response from students and motivated students to learn. This is true also for other health professionals' education, but in terms of e-learning used in higher education, Japan is reportedly behind some other countries

(11–13). Admittedly, some infrastructure problems exist in technical schools and junior colleges (12–14).

In dental hygiene education, it is very important for students to have opportunities to treat actual patients during clinical training (15). Although dental hygienists in Japan are currently expanding their sphere of activity to meet changing social needs, recently, fewer patients are participating in clinical training. As a result, students are exposed to only a limited number of cases in the course of their studies (16, 17). Reasons for this include a change in patients' perceptions, safety issues and debates over the legality of students' direct involvement in healthcare activities (18). The limited variety of cases encountered by undergraduate students in the course of their studies represents a serious impediment to their growth and development as healthcare professionals, which affects their decision-making skills in clinical situations. Students who complete simulations have shown improvement in their clinical decision-making skills (19).

To compensate for students' lack of clinical experience, educators at Tokyo Medical and Dental University (TMDU) are promoting the development, use and dissemination of 'simulation learning materials' (SLMs) that provide a simulated experience of actual clinical situations through interaction with a computer (20–24). We authored new educational materials for dental hygiene students at a junior college using the simulation software generator developed by TMDU, which promotes the practice basic of dental hygiene skills at Chiba Prefectural University of Health Science. The paper introduced these SLMs and reports of a survey of junior college dental hygiene students who have used them.

## Materials and methods

Five educators, who are engaging in dental hygiene education, authored the computer-simulation materials. Each educator's specific area of expertise is oral surgeon, public health and dental hygiene. We developed five SLMs using the simulation software generator. The materials consisted of multiple choice step-by-step questions with clinical photographs that simulated basic decision-making processes in the field of dental hygiene. At first, scripts and visual aids were made. Next, the TMDU SimPrac Generator was distributed to other universities and institutes through a contract allowing access to the TMDU server for the generation of original learning materials.

Figure 1 is an example of the newly developed SLM for 'topical fluoride'. This process is as follows. The SLMs provided to a student are displayed when a folder is selected. On opening a given folder, both visual and written explanations are provided together to support understanding of the patient and/or the situation. If an image is too small, it can be enlarged by selecting a higher-resolution image.

There are two modes. Figure 1 is student mode and Fig. 2 is authoring mode. In both of two modes, three individual screens appear in the upper half of the monitor, where applicable information is displayed. In this example, starting from the left, there is a picture of a clinical situation, patient details and



Fig. 1. Screenshot of student mode. Example of the newly developed simulation material for dental hygiene skills.

then the patient's intraoral photograph. Students can go through each mock clinical situation. Students can also learn to react to the situation through photographs and animations. The lower half of the screen includes instructions for the student. When students give an incorrect answer, they can easily see their mistake. On the exit screen, all of the correct answers appear together with explanations, allowing students to confirm their understanding.

Students were trained to operate the computer software using a tutorial material entitled 'How to fry an egg' before they began to use the newly developed SLMs. Figure 2 shows a screenshot of the simulation software generator used to author the SLMs.

Towards the last month of their 2-year course, 43 junior college dental hygiene students were asked to participate in this study. The students had no previous experience with the computer simulated learning materials.

This study received approval from the Chiba Prefectural University of Health Science ethics committee and was conducted in January 2010. All the students were given a general oral description of the study and an explanation on ethical matters; they understood the voluntary nature of the study and how their information would be used.

A set of five materials were authored and tested by a class of second-year dental hygiene students during the second semester at a college in Chiba, Japan. The class consisted of 43 students. Topics presented in this class were as follows: (i) plaque disclosing, (ii) tooth luxation, (iii) dental health, (iv) topical fluoride and (v) a new patient who had cerebral infarction. After using them, the students were asked to evaluate the exercises on a four-point scale and to give their opinions freely. There were seven close-end questions and open-end questions.

Students' opinions were analysed using characteristic diagrams, a troubleshooting tool that can be used to visually illustrate pros and cons of their experience during the

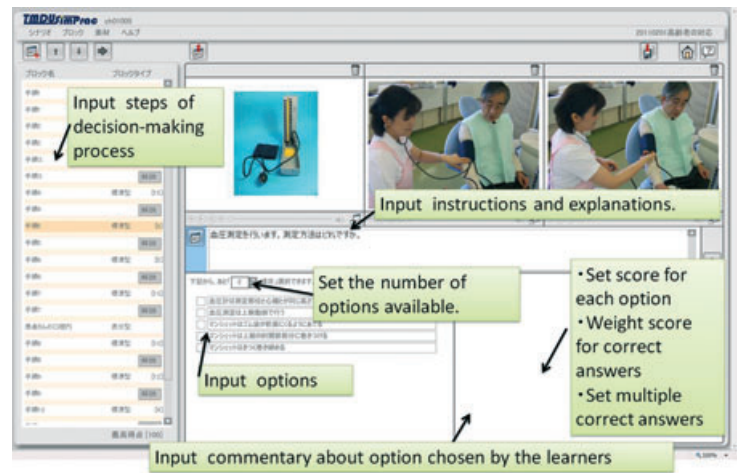


Fig. 2. Screenshot of authoring mode.

simulation. The characteristic diagram is used not only in business but also in data to resolve problems in regard to quality control (23, 25, 26). This approach is often organized into four 'M's': Man, Machine, Material and Method to obtain visualization of problems on a fishbone diagram.

## Results

Figure 3 shows the results of a questionnaire administered to the 43 second-year dental hygiene students who tested the materials.

The overall results of the evaluation were positive; in particular, 88% of the participants were interested in the contents of the exercise (item 1). Furthermore, all of the participants felt that the exercise provides beneficial learning for dental hygiene students (item 3), 88% felt that the exercise deepened their interests in lectures and pre-clinical exercise (item 4), 93% felt that the simulation virtual practice should be continued in the future (item 6) and 83% felt that they acquired the

self-learning ability about clinical knowledge, as shown by item 7.

Many students provided comments about their experiences in the exercises. Figures 4 and 5 show students' answers to the open-ended questions. These results also tended to be on the positive side, but some provided additional feedback that will help with the implementation of future SLM. Advantages and improvements extracted from open-end questions were reorganized according to the four M's of the quality control technique and regarded as benefits and improvement of these SLMs. Their comments were used to create a characteristic diagram. Advantages and improvements extracted from free descriptions were reorganized according to the four M's. Advantages of these SLMs were identified including 'easy to use', 'relevant content/feedback', 'self-learning/self-pacing', and 'interactive/learner centric', and a characteristic: 'What are advantages in this exercise?' Areas for improvements were identified such as their learning environment of communication infrastructure should be improved and the score display

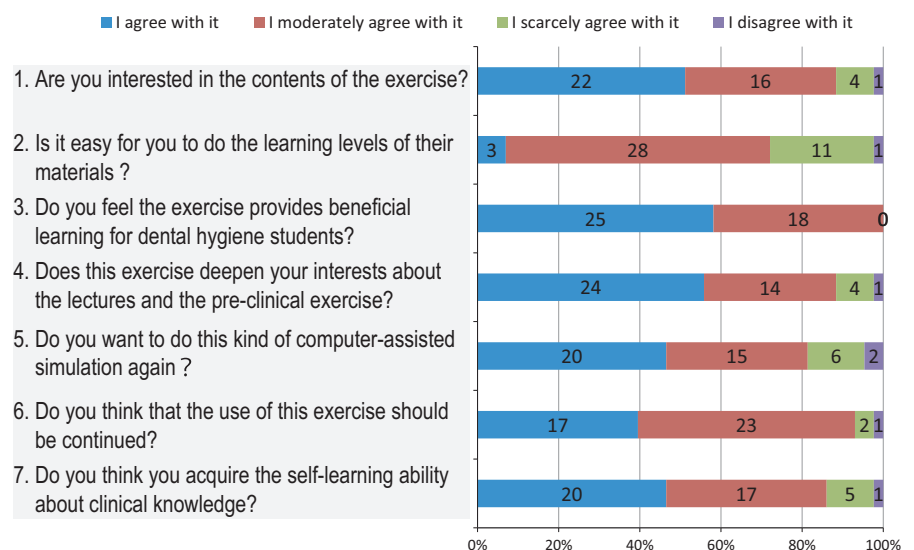


Fig. 3. Results of the overall evaluation of the virtual practice as evaluated by 43 second-year dental hygiene students in 2-year courses.

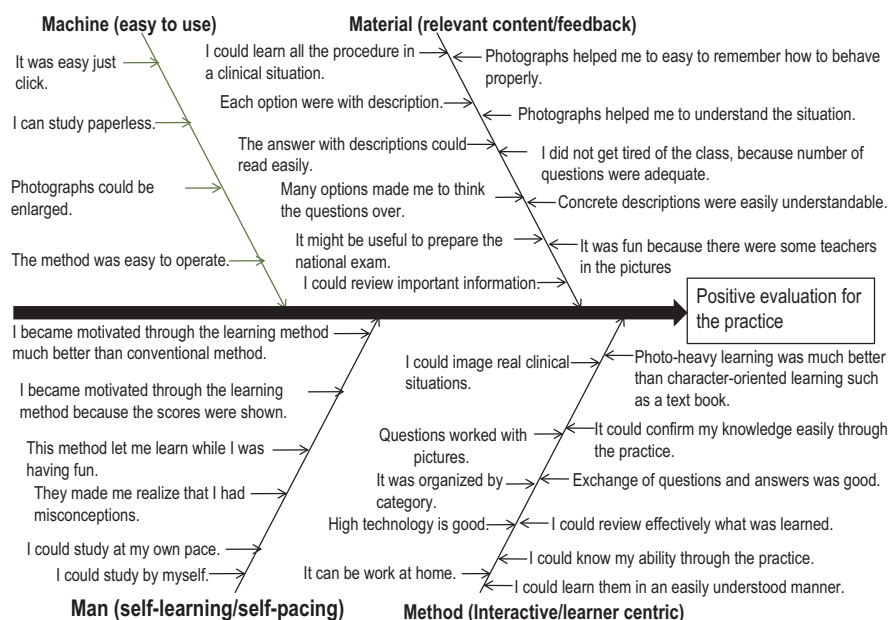


Fig. 4. Positive evaluation analysed by characteristic diagram.

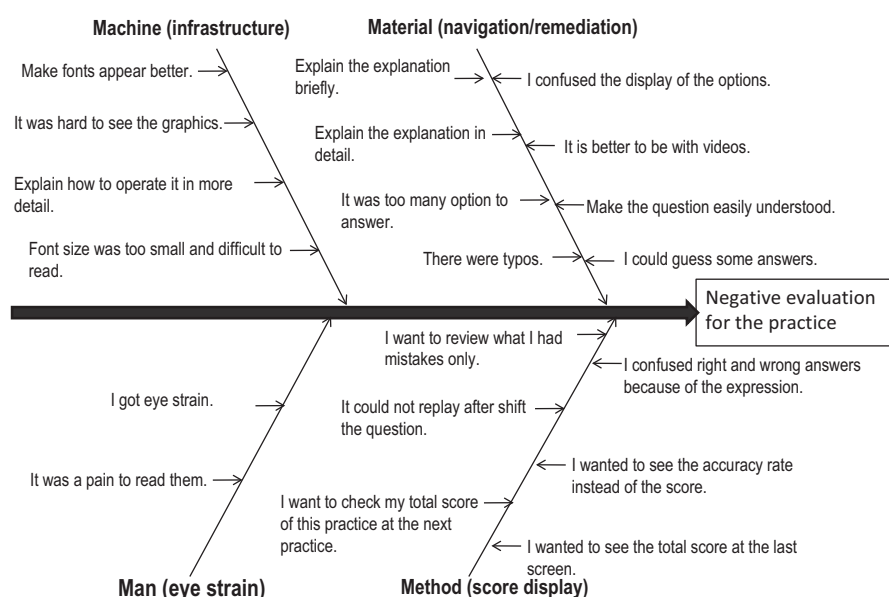


Fig. 5. Negative evaluation analysed by characteristic diagram.

was needed to make better. Others areas mentioned were 'infrastructure', 'navigation/remediation', 'eye strain' and 'score display' based on the moments to the question 'what are improvements in this exercise?'

## Discussion

This study indicated that students recognized the benefits and satisfaction applied to these SLMs (Figs 3 and 4). We, therefore, conclude that this virtual practice was beneficial. Rosenberg *et al.* (10) demonstrated that computer-aided learning can elicit positive responses from students to consequently motivate students to learn. Although there were not enough communication infrastructures at the college, these exercises were

found to be beneficial for the students and other similar studies had similar positive results (21–24). It may be helpful to create more SLMs for students enrolled in dental hygiene programmes. Such SLMs can often be created in a quick and efficient manner (21, 27). Educators who teach dental hygiene students should create the simulations using this software, because they can integrate cases in a quick and efficient manner into the structure of their curricula. The SLMs may help to address the lack of direct client experiences encountered by learners. It may provide a method for dental hygiene students to become self-directed lifelong learners. Dental hygiene students learn quite effectively when they can act independently, in a self-paced manner, to solve problems in the context of what they will be doing upon completion of their education.

Rosenberg *et al.* (10) recommended that computer-aided learning be used as an adjunct to conventional teaching or as a means of self-instruction. SLMs will be recommended as an adjunct teaching material to the conventional patient-oriented teaching. Open-ended questions about advantages of this exercise indicated that students recognized the benefits and enjoyed the use of these learning materials. The advantages identified by learners align with parameters suggested for well-designed e-learning programmes (28). Areas for improvements were that the visual learning environment should be improved. Students' positive and negative evaluations and comments can help to improve the development of future SLMs. As this is an ongoing project, additional materials involving a variety of new scenarios are currently being created, and the evaluations in this study will help to improve dental hygiene education.

Tokyo Medical and Dental University approved that educators from other institutes can create SLMs, download their files and use them with their students. We were non-specialist computer users, and we were able to author SLMs using the simulation software generator without much difficulty; it took approximately 2 h to create one set of materials when digital recourses were available and the scenario was clear (21, 27). Before that, it took 1–4 h to make these SLMs' scenarios in this time. It was showed time efficient and also cost-effective for educators who make material. The computer-based simulation software was found to be effective in modifying the learning environment, realizing performance improvements and cost reduction, thus enhancing students' motivation.

This study conducted with only one study group without the controls for comparison. The results of this study were subjective as they focused on the attitude or feeling of the students who used the SLM. There was no attempt to measure the outcomes of the learning. Therefore, it was difficult to clarify the effect of SLMs, particularly, when to use it and how to use it effectively. It would be helpful to compare the outcomes from these SLMs with more conventional approaches.

These results suggest that the SLMs for practicing basic decision-making processes in dental hygiene are effective for dental hygiene education, even if there were some infrastructure problems. Simulation has been used to teach clinical decision-making as well as technical procedures in other areas (29). Simulations currently being used are multimedia computer systems, which includes patient-centred and case-based programmes (30). Some benefits include improvements in acquisition and retention of knowledge compared with traditional lectures (31). There is nothing better than direct contact with patients for students to gain clinical skills. However, changes in dental hygiene practice that limit instruction time and patient availability as well as advances in technology are contributing to greater use of simulation technology in dental hygiene education in future. The use of simulation has been proposed as the next significant step in the evolution of dental hygiene education. As computer-assisted learning seems to be an effective and enjoyable strategy for achieving positive outcomes, it is desirable to provide high-quality e-learning materi-

als that can be shared with instructors teaching future dental hygienists nationwide.

## Acknowledgements

The teaching materials developed in this research were supported by a Chiba Prefectural University of Health Sciences Grant-in-Aid for collaborative research (2009, Naomi Yoshida, representative) 'Development and evaluation of computer-assisted education in an undergraduate dental hygiene course'.

The creation of the Computer-Assisted Education System for Clinical Simulation in Medical and Dental Practice Training was carried out under the auspices of the Ministry of Education, Culture, Sports, Science and Technology Support Programme for Distinctive University Education: 'Establishment of a Computer-Assisted Education System Involving Clinical Simulation for Medical and Dental Practice Training' (Atsuhiko Kinoshita, coordinator).

A part of this study appeared in the 18th International Symposium on Dental Hygiene in Glasgow, 1–3 July, 2010.

## References

- Mattheos N, Stefanovic N, Apse P *et al.* Potential of information technology in dental education. *Eur J Dent Educ* 2008; **12**(Suppl.): 85–92.
- Gallagher JE, Dobrosielski-Vergona KA, Wingard RG, Williams TM. Web-based versus traditional classroom instruction in gerontology: a pilot study. *J Dent Hyg* 2005; **79**: 7, Epub 2005 Jul 1.
- Salyers VL. Web-enhanced and face-to-face classroom instructional methods: effects on course outcomes and student satisfaction. *Int J Nurs Educ Scholarsh* 2005; **2**: 11p, (24 ref).
- Boynton JR, Green TG, Johnson LA, Nainar SM, Straffon LH. The virtual child: evaluation of an internet-based pediatric behavior management simulation. *J Dent Educ* 2007; **71**: 1187–1193.
- Davis J, Chryssafidou E, Zamora J, Davies D, Khan K, Coomarasamy A. Computer-based teaching is as good as face to face lecture-based teaching of evidence based medicine: a randomised controlled trial. *BMC Med Educ* 2007; **7**: 23.
- Kulier R, Coppus S, Zamora J *et al.* The effectiveness of a clinically integrated e-learning course in evidence-based medicine: a cluster randomised controlled trial. *BMC Med Educ* 2009; **9**: 21.
- Cook DA, Levinson AJ, Garside S, Dupras DM, Erwin PJ, Montori VM. Internet-based learning in the health professions: a meta-analysis. *JAMA* 2008; **300**: 1181–1196.
- Greenhalgh T. Computer assisted learning in undergraduate medical education. *BMJ* 2001; **322**: 40–44.
- Bogacki RE, Best AI, Abbey LM. Equivalence study of dental anatomy computer-assisted learning program. *J Dent Educ* 2004; **68**: 867–871.
- Rosenberg H, Grad HA, Matear DW. The effectiveness of computer-aided, self-instructional programs in dental education: a systematic review of the literature. *J Dent Educ* 2003; **67**: 524–532.
- Okubo N, Ohsako T, Hirabayashi Y, Nakayama K. Current status of E-learning universities and colleges – analysis of web sites and literature review-[in Japanese]. *Bulletin of St. Luke's College of Nursing [in Japanese]* 2004; **30**: 81–93.
- Ministry of education, culture, sports, science & technology in Japan. A report on active promotion for using ICT in education)



- [in Japanese], 2011. Available at: [http://www.mext.go.jp/a\\_menu/koutou/itaku/1307264.htm](http://www.mext.go.jp/a_menu/koutou/itaku/1307264.htm) (accessed 17 July 2011).
- 13 Onuki M, Maruyama H. Current state and the future of e-learning in physical therapy education [in Japanese]. *Rigakuryoho Kagaku* 2007; **22**: 547–551.
- 14 National institute of multimedia education in Japan. A report on using ICT in education [in Japanese]. 2008. Available at: <http://www.code.ouj.ac.jp/wp-content/uploads/eLearning2008-jp.pdf> (accessed 17 July 2011).
- 15 Kuriwada S, Kuribara N, Inukai K *et al.* Present status of the clinical discipline system at Tohoku University School of Dentistry—Part 1: review of the number and clinical progress of patients during the past 28 years [in Japanese]. *Tohoku Univ Dent J* 1998; **17**: 172–182.
- 16 Yoshida N, Endo K, Kondo K, Takagi Y. Present status of clinical training dental hygiene education in Tokyo Medical and Dental University [in Japanese]. *JJDEA* 2004; **20**: 260–265.
- 17 Yoshida N, Endo K, Komaki M. Dental hygiene education in Japan: present status and future directions. *Int J Dent Hygiene* 2004; **2**: 179–184.
- 18 Yoshida N, Endo K, Kondo K *et al.* Career history and perceptions of Dental Hygiene education programs – Questionnaire mail-in survey of alumni of the school of dental Hygiene in Tokyo Medical and Dental University – [in Japanese]. *J Stomatol Soc* 2005; **72**: 77–83.
- 19 Johnson LA, Cunningham MA, Finklestein MW, Hand JS. Geriatric patient simulations for dental hygiene. *J Dent Educ* 1997; **61**: 1278–1281.
- 20 Yoshida N, Mataka S. Influence of patients' perception on their acceptance and understanding of dental care within an education system. *J Med Dent Sci* 2002; **49**: 143–149.
- 21 Yoshida H, Sunaga M, Yoshida N, Kinoshita A. Development and evaluation of a new computer assisted education software for dental hygienist students to practice the subgingival scaling and root planing [in Japanese]. *JJSDH* 2009; **4**: 58–63.
- 22 Yoshida N, Horie A, Sunaga M, Kinoshita A. Application and evaluation of computer-assisted education systems in Dental Hygiene education [in Japanese]. *J Jpn Soc Periodontol* 2009; **51**: 346–352.
- 23 Ohya A, Yoshioka T, Kohase H *et al.* Implementation and assessment of faculty development for making simulation teaching materials [in Japanese]. *JJDEA* 2008; **24**: 88–101.
- 24 Kubota T, Cho Y, Kajiwar M, Baba R, Kikuchi K, Kinoshita A. The use of a computer-assisted simulation system in undergraduate education of laboratory technologists [in Japanese]. *Official Journal of Japanese Society of Laboratory Medicine* 2007; **55**: 517–521.
- 25 Ishimoto T, Katayama I, Morita T. The effects of QC activities in central supply room -a review of central supply room performance for improvements and cost reduction [in Japanese]. *Bulletin of Kumamoto University, School of Health Sciences* 2009; **5**: 1–8.
- 26 Ohya MM, Maikuma Y, Sato M *et al.* Training program for the preparation of a clinical training course in clinical skills laboratory [in Japanese]. *JJDEA* 2008; **24**: 80–87.
- 27 Sayoko Yamashita S, Jungheim NO, Kinoshita A *et al.* The development and evaluation of multimedia medical simulation software for medical and communication training. Proceeding of the third international wireless ready symposium. Available at: <http://wirelessready.nucba.ac.jp/e-proceedings2009.html> (accessed 17 July 2011).
- 28 Childs S, Blenkinsopp E, Hall A, Walton G. Effective e-learning for health professionals and students—barriers and their solutions. A systematic review of the literature—findings from the HeXL project. *Health Info Libr J* 2005; **22**(Suppl. s2): 20–32.
- 29 Phillips J, Berge ZL. Second life for dental education. *J Dent Educ* 2009; **73**: 1260–1264.
- 30 Janda MS, Mattheos N, Nattestad A *et al.* Simulation of patient encounters using a virtual patient in periodontology instruction of dental students: design, stability, and learning effect in history-taking skills. *J Dent Educ* 2004; **8**: 111–119.
- 31 Yasuda K, Tanaka H, Takahashi H, Yasuda Y, Maezumi T, Nakao A. Is a lecture using a self e-learning program effective in paramedical education? [in Japanese] *JJSEM* 2006; **9**: 312–319.

Copyright of International Journal of Dental Hygiene is the property of Wiley-Blackwell and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.