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An Exercise Material for Electrocardiogram Analysis on the Web

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Web を利用した心電図解析演習教材の提供

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An exercise material for electrocardiogram (ECG) analysis has been developed on the Web. Clinically obtained ECGs were presented on the Web page and trainees were asked questions in the style of multiple choice test to choose the most-likely diagnosis, with an attribute of radio button. By submitting answers, the student would receive his/her score with correct answers and explanations. Responses from students were generally favorable. Although the students felt it difficult to analyze real ECGs, they have realized that they need more practice. These facts suggest that Web presentation in such style will be a useful material for practice in analyses of graphic or image data obtained in such as physiological or microscopic examinations.

Introduction

Along with popularization of the Internet, world wide web (WWW) publishing has been recognized as a useful tool of sending information for individuals, independently of mass media. Using hypertext markup language (HTML) form filling format, Web publishing can be a communicational tool in both directions¹⁾²⁾. Today, most of universities and schools have a facility for computer literacy education. Many of them are in the surroundings ready to connect to the Internet. These circumstances can be used for developing unique teaching materials through Web publish-

ing^{3)~6)}, which has the advantage of audio and visual presentation in addition to the plain text.

In the field of laboratory medicine, various graphic and image data will be obtained for diagnostic use: graphic data such as electrocardiogram (ECG) and electroencephalogram, image data in ultrasonography, microscopic examination of blood picture, urinary sediment, or biopsy specimen. Ability in analyses of those data is essential for medical technologist, thus several questions on data analysis are asked in national examination.

On the basis of these backgrounds, on-line questions through Web publication is expected to be a suitable education material for practice

in data analysis. We have recently held on-line term examinations as an application of WWW to teaching materials, and received favorable responses from students^{7)~9)}. In this study, we have developed an exercise material for ECG analysis to take advantage of Web publishing.

Apparatus and Methods

Server : A Power Macintosh 6100/66 computer (Apple Computer, Inc., Cupertino, CA, USA) equipped with a G3 accelerator card (Sonnet Technologies, Inc., Irvine, CA, USA) was used as a server machine. The server is operated with Macintosh OS (J) 8.1 and connected to SuperTAINS (TAINS=Tohoku University All-purpose, All-round, Advanced Information Network System), the local area network in this university. Personal Web Server 4.0 from Microsoft Corp. (Redmond, WA, USA) was used as a server software.

Clients : Client machines were 40 OptiPlex GXi 133 computers (Dell Computer Corp., Round Rock, TX, USA) operated with Microsoft Windows 95 on MS-DOS. These clients are also connected to SuperTAINS. Microsoft Internet Explorer 5.0 and Netscape Navigator 4.04 were used as Web browsers.

Trainees : The trainees were 36 freshmen (Class of 2002) of the Department of Medical Technology in this college. ECG analysis is a part of the “cardiology” class, which is held in the second semester of the freshmen year.

Method : The training was carried out in the same manner in Web examination as previously described⁸⁾⁹⁾. Twenty two clinically obtained ECGs were presented on a Web page. For each ECG, trainees were asked a question to choose the most-likely diagnosis in the style of multiple choice test constructed by using form filling format, <input> tag with an attribute of radio button (Fig.1). The style is

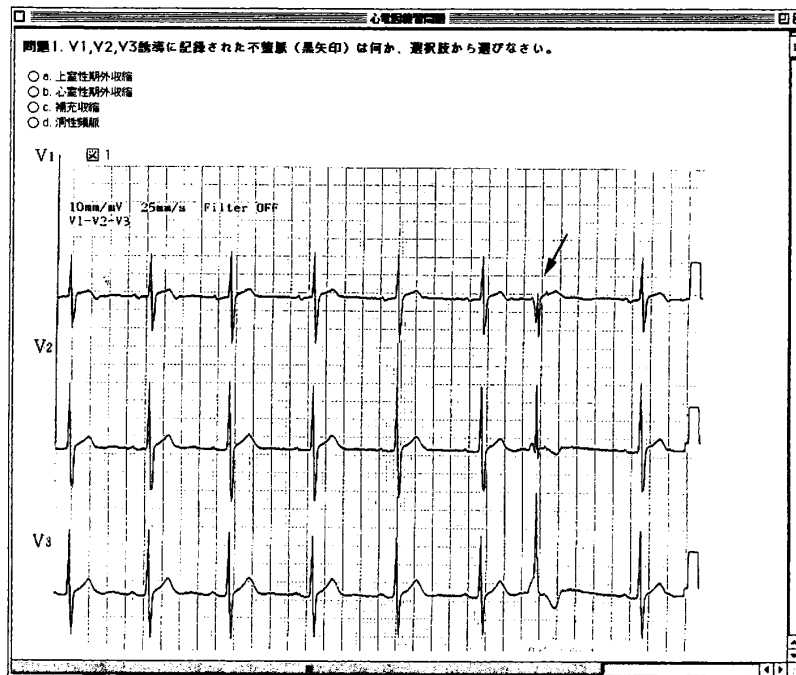


Figure 1. A presented ECG and the multiple choice questions. The examinee is requested to choose most-likely diagnosis.

Table 1. Questions in the questionnaire.

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1. How is your general impression?
 2. Which exercise do you like in web style or printed style?
 3. Were the questions difficult?
 4. Are the explanations useful?
 5. Do you need personal result file for retrieving?
 6. Is web exercise useful for analysis of the graphic and image data?
 7. Do you want to have similar exercise in other subjects?
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according to the National Examination for Medical Technologist. Upon submission of answers, the form was checked by client-side script to prevent accidental submission without starting exercise⁹⁾. Processing of the submitted answers was carried out on the server using active server pages, which contain server-side scripts¹⁰⁾¹¹⁾. Each submitted answer was compared with the correct answer, and score was calculated. Concurrently, two HTML (in fact, as active server pages with *.asp* extension) files were created:

1) a temporary result file to present the trainee's result and explanations. It would be overwritten when the next student submits the answer and the rewritten file was sent to the next person. This document contains 22 sets of question, correct answer, explanation and the score was put at the end.

2) a score accumulation file of all the results, kept on server-side for the teacher's use. This contains only submitted and correct answers along with trainee's name and score. Optionally, personal result file can be created in this system. This is for use so that the student can retrieve one's own result at anytime⁹⁾.

After reviewing the result, the students were led to the questionnaire page. Seven questions listed on Table 1 were asked to express their impression as a score in the grade

1-5. At the end of the page, text-field was presented so that students could freely describe their comments, which were analyzed by picking up some key words or phrases.

Results and Discussion

Because this was the first experience for the freshmen to see real ECGs, average score was considerably low. Asking 22 questions in total, the scores were in the range of 6-18, average was 9.06 and the most frequent score was 7. Thus, most of the students over 70% answered such as the questions were very difficult (Fig. 2). However, they seemed to have realized that they need more practice in ECG analysis, by analyzing their comments (Table 2). We think this is one of the effect of this exercise, giving an incentive to hard practice.

As Web publishing has the advantage of audio and visual presentation, it is suitable for exercise in analysis of graphic and image data. Nearly 70% of students agreed our view and judged as the training material in this style is "useful", furthermore they wanted to have similar exercise also in other subjects, *e.g.* microscopic examinations (Fig. 3).

Presenting score along with explanations was received with favorable comments. Most students (80%) said that reviewing of the result with explanation would be useful and tutorial in exercise and preparation for the next examination (Fig. 4). In addition, sixty percent of the students wanted to keep their personal result files. We consider that presenting explanation is one of the main reason to receive such a favorable evaluation.

In general, the half of the students was favorable to the Web exercise and 30% was neutral (these trainees gave score 3) (Fig. 5). According to the typical comments, the exer-

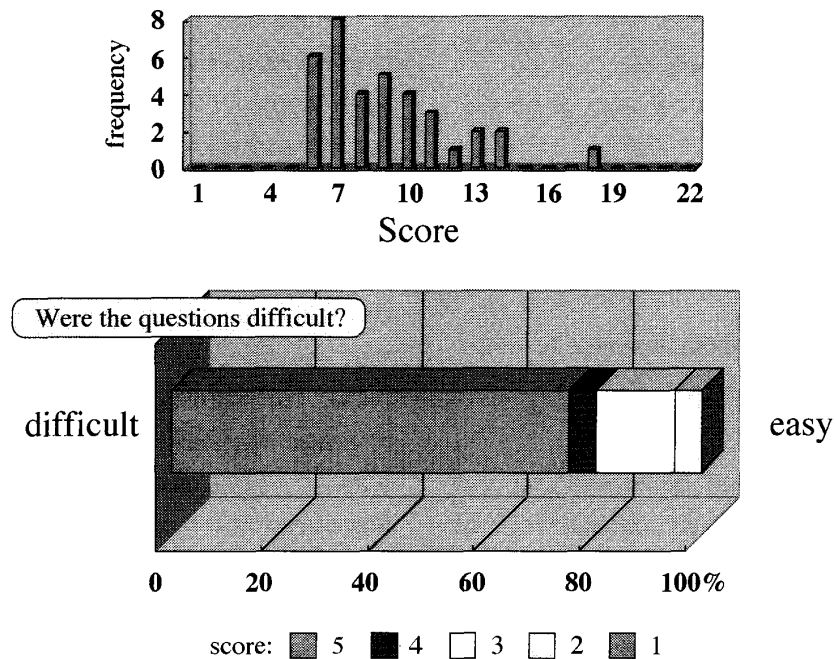


Figure 2. Frequency distribution of the score (above) and feeling of difficulty (below).

Table 2. Comments from students related to incentive to practice.

- This is the first time to see real ECG data. I did not know how to analyze.
- The ECGs looked almost the same.
- I couldn't distinguish those data. This exercise is tutorial.
- I realized that ECG analysis is not so easy.
- I realized that I need more practice.

cise is “cool”, they felt fun and “enjoyed”, they were prompted to review it again. They wanted to have the exercise in such style also in the future. Thus, Web exercise seems to have somewhat metal effect, additional advantage that the trainee can practice at ease. On the other hand, a few students prefer the style on paper, because looking at the display make their eyes smart.

The present on-line exercise system has several points to be improved and taken in consideration. In nature, this system includes numbers of image files for questions. These ECGs are currently presented in full-scale with

significantly large file size. On the other hand, file in minimal size is advantageous for the speedy downloading. As for the purpose of data analysis, it is preferable that presented image would be just in a size within the display so that trainees can get a view of whole ECG. In fact, it is not easy to present whole ECG on the screen with adequate signal size to analyze, particularly in the case of 12-lead ECG. This problem might be solved by the combination of whole view image (signals are scaled down) with enlarged part view where the signal is irregular and therefore should be analyzed. Division of one bigger image into several smaller pieces would speed up the downloading.

Another point to be considered is frequency of usage by students. Certainly they answered to the questionnaire such as “it is useful”, “I want to have it also in another subject”, “It prompts me to review it”, but it is quite questionable whether they actively utilize those materials just offered on the Web. We teachers have to make efforts to give them a

Web Exercise in Electrocardiogram Analysis

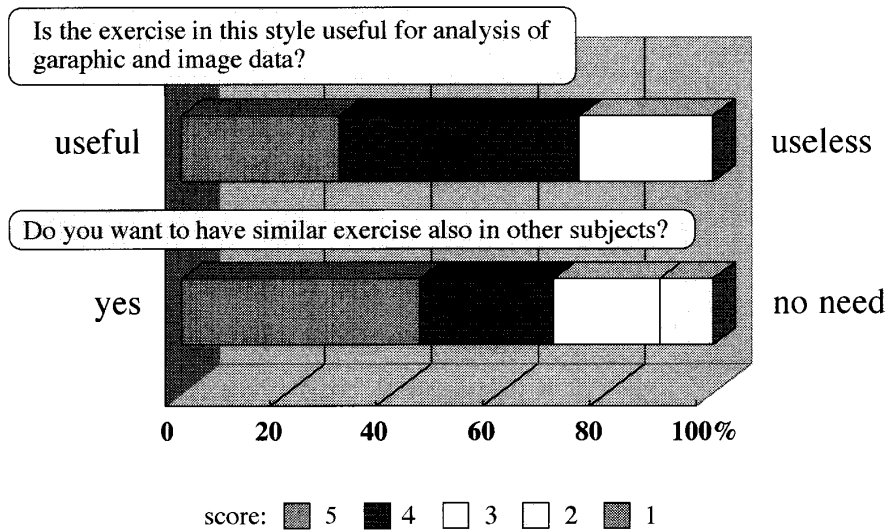


Figure 3. Students' evaluation of Web exercise, on usability for data analysis.

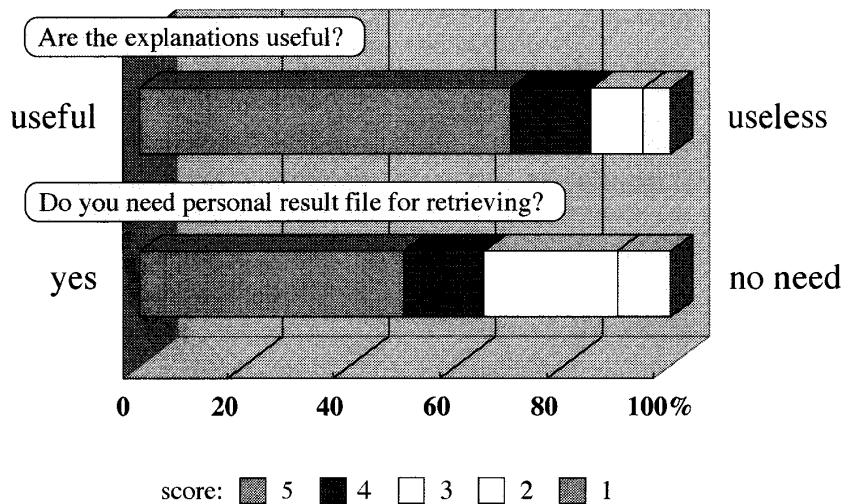


Figure 4. Students' evaluation of Web exercise, on presenting explanation.

motivation, *e.g.* by using the material in a class, releasing it as a preparation for the examination. When the result of exercise is reflected to the class teaching and questions for examination, the students may get highly concerned with the exercise. Contrary, the material become useless without such feedback¹²⁾. The relationship between usage of Web exercise and result of written examination will be reported in future.

In conclusion, the students were relaxed

and enjoyed the web exercise. This style of presentation will be useful for reviewing and exercise, particularly for a practice in analyses of graphic and image data in such as physiological and microscopic examination, which are required for essential understanding in the field of laboratory medicine.

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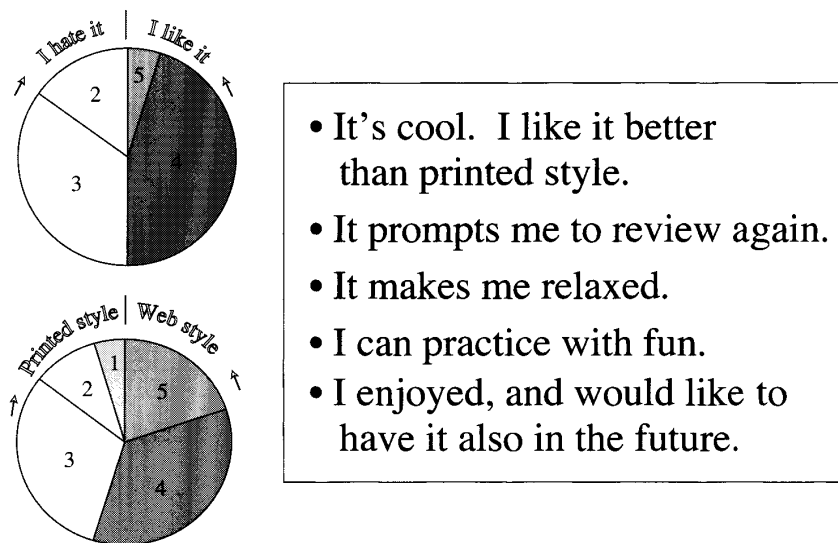


Figure 5. Distribution (left top) and comments (boxed) on general impression from the students and preference (left bottom) of Web exercise.

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