Web-Based Instruction of Image Reconstruction Techniques in Nuclear Medicine

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Abstract

Educational technology is helping achieve a major goal of the course. In nuclear medicine, learning in theoretical explanation of image reconstruction is hard for radiological technology students. Design and development research was achieved a goal related to learning. The aims of this study were 1) to develop the web-based instruction of image reconstruction techniques in nuclear medicine 2) to evaluate the effectiveness of web-based instruction using experts and try-out, and 3) testing knowledge of image reconstruction techniques and user's opinion on this instruction were assessed. Three experts were evaluated after contents were completed. Twenty of try-out group were assessed before 3 design experts were performed, respectively. Learning scores before and after were compared in 45 subjects, and also user's opinions were evaluated. The results showed that web-based instruction consist of foundational interested algorithms in nuclear medicine, and images were reconstructed using various parameters. The instruction could see and automatically control the screen of the devices over desktop computer and smartphone. An average of content validity for scale was 0.89. An average satisfaction score of try-out was more than 3.93. In addition, average satisfaction score of design and presentation was 3.90 ± 0.77, and satisfaction score of access and information was 4.05 ± 0.80, respectively. Higher values of learning scores after were found ($p < 0.001$). All user satisfaction scores had a good level. An average user satisfaction score of presentation was 3.74 ± 0.73, and user satisfaction score of content and application was 3.67 ± 0.79, respectively. In conclusion, there were a good level of user satisfaction, and higher value of learning scores after. Web-based instruction help to better understand the foundational theory. This could be used to provide learning material, and to enable self-learning.

Keywords: Web-Based Instruction, Image Reconstruction Technique, Nuclear Medicine

Introduction

Advance in educational technology has immense changes. This is also affecting the learning management system, especially educational media. Many media, i.e., E-Learning, CAI could help to make the imagination and to provide the learning skills correspond with 21st-century skill. Learners are able to understand better, and also can manage the time of day for learning by themselves. Corresponding issue 4 in the concept teaching management (Office of the National Education Commission, 2010), which reported that learning management system must to support all students to be efficient and effective with studying.

Image reconstruction in nuclear medicine is mathematical process that generates tomographic images from special devices, i.e., Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET). Although there are some differences in data acquisition techniques, image reconstruction uses emission data that acquired from many different angles around patient. Filtered back projection (FBP) and iterative algorithms, specially ordered subset expectation maximization (OSEM) are the most commonly used approach for image reconstruction (Bruyant, 2002; Vandenberghe et al., 2001). However, all reconstruction algorithms are difficult for understanding. Most of students have lacked imagination when several parameters have been changed, i.e., number of projections, number of iteration, and number of subset. In this reason, authors would like to develop

the web-based instruction of image reconstruction techniques in nuclear medicine. This media will used for teaching and learning purposes for students in Radiological Technology program, Naresuan University.

Purposes

1. To develop web-based instruction of image reconstruction techniques in nuclear medicine
2. To evaluate effectiveness of web-based instruction using experts and try-out
3. To assess testing knowledge of image reconstruction techniques and students' opinion on this instruction

Materials and Methods

This research has been given approval by research board. It used a process of research and development corresponded to developing process of web-based instruction of image reconstruction techniques in nuclear medicine. There are several devices, for example, 1) web-based instruction of image reconstruction techniques in nuclear medicine 2) evaluation form for accurate contents 3) evaluation form for design 4) ten multiple choice questions, and 5) students' opinion form.

In developing process of the web-based instruction, all contents, animation design, flow chart and story board were performed for each algorithm. Initial and different image reconstruction parameters were demonstrated in various algorithms of back projection, FBP, maximum likelihood expectation maximization (MLEM) and OSEM. In addition, post-processing filters and data acquisition schemes for SPECT were illustrated with animations.

In process evaluation of the web-based instruction, accuracy of contents was evaluated by three experts. Two scales with good item content validity (I-CVI) of 0.78, and S-CVI/Ave of 0.89, respectively were reported. Therefore, results of content validity evaluation passed and then all contents were used to develop the web-based instruction. Twenty of try-out were assessed in several conditions of suitable image, text size, and program of image reconstruction design which each person choose different parameters for each algorithm. Values of mean and standard deviation were analyzed. Reliability of examinations was 0.36 following KR-20 formula of Kuder Richardson.

After web-based instruction of image reconstruction were developed completely. Three design experts were performed. Mean and standard deviation were analyzed. Learning scores before and after were compared in 45 subjects, and also user's opinions were evaluated. Data were analyzed by mean, standard deviation and dependent t-test ($p < 0.05$). All evaluation forms were performed by experts. In addition, variations in the value of numeric rating scales following Likert method, consider the following:

Table 1 Variations in the value of numeric rating scales following Likert method

Mean	Level
4.50 - 5.00	Excellent
3.50 - 4.49	Good
2.50 - 3.49	Moderate
1.50 - 2.49	Poor
1.00 - 1.49	Worst

Results

Web-based instruction consist of foundational interested algorithms in nuclear medicine. Images and animations were reconstructed using various parameters. The instruction could see and automatically control the screen of the devices over desktop computer and smartphone. An average satisfaction score of twenty try-out was more than 3.93 as shown in Table 2. However, students suggested that presentation of image reconstruction program was fixed different parameters for each algorithm with animations and images due to taking a long time for image processing. After web-based instruction were developed such as image reconstruction technique obtained from different projections shown in Figure 1, three design experts were performed. The results showed that average satisfaction score of design and presentation was 3.90 ± 0.77, and satisfaction score of access and information was 4.05 ± 0.80, respectively. Higher values of learning scores after were found ($p < 0.001$) as shown in Table 3. All user satisfaction scores had a good level. An average user satisfaction score of presentation was 3.74 ± 0.73, and user satisfaction score of content and application was 3.67 ± 0.79, respectively as shown in Table 4.

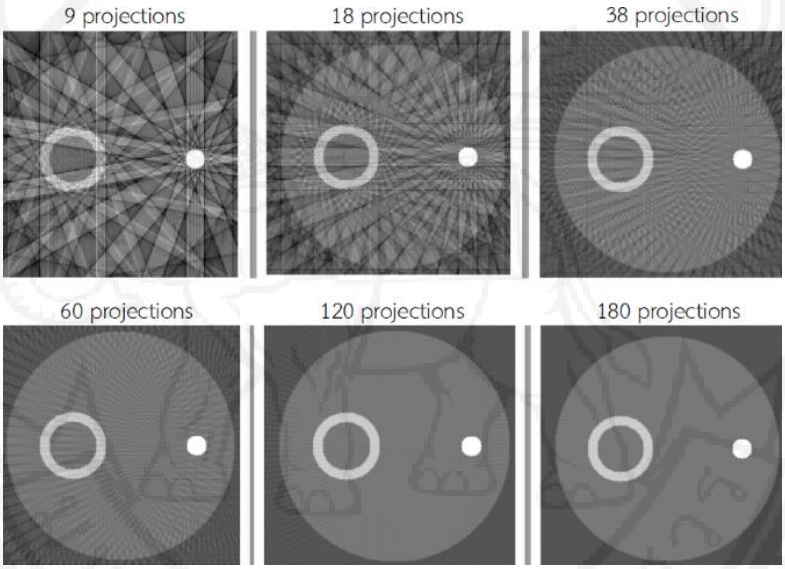

Figure 1 Images obtained from different projections for filtered back projection technique

Table 2 Satisfaction scores of try-out

What is level in	Mean	Level
1. Good arrange in web-based instruction contents	4.20 ± 0.46	Good
2. Clear images	4.13 ± 0.52	Good
3. Clear presentation of image reconstruction program	3.93 ± 0.80	Good
4. Multiple choice examinations	4.10 ± 0.63	Good
5. Design of web-based instruction	4.35 ± 0.62	Good

Table 3 Users' learning scores

Study	n	Total	Mean	p-value
Before	45	10	5.20 ± 1.69	< 0.001
After	45	10	6.24 ± 1.55	

Table 4 Satisfaction scores of users

What is level in	Mean	Level
Presentation		
1. Interesting in web-based instruction	3.56 ± 0.66	Good
2. Linking to pages within web-based instruction	3.71 ± 0.69	Good
3. Clear image position, text and graphic work	3.78 ± 0.74	Good
4. Toolbars in web-based instruction	3.80 ± 0.84	Good
5. Speed presentations	3.80 ± 0.76	Good
6. Text color and background	3.82 ± 0.68	Good
Average	**3.74 ± 0.73**	**Good**
Content and Application		
1. Concise information	3.56 ± 0.76	Good
2. Interesting in web-based instruction contents	3.51 ± 0.63	Good
3. Good arrange in web-based instruction contents	3.62 ± 0.81	Good
4. Clear images	3.62 ± 0.89	Good
5. Balance between texts and images	3.78 ± 0.77	Good
6. Enable self-learning	3.89 ± 0.88	Good
Average	**3.67 ± 0.79**	**Good**

Consideration on areas needing further investigation, most students could not understand the formula for image reconstruction algorithms. However, concepts of image reconstruction algorithms were assigned with animations. In addition, speeds and stable connection to the internet were affected the use of web-based instruction.

Discussion

Web-based instruction of image reconstruction techniques in nuclear medicine consisted of foundational interested algorithms in nuclear medicine. In developing process of the web-based instruction, many animations and images obtained from various parameters were developed for learning in theoretical image reconstruction. Previous design of program, students had to choose different parameters for each algorithm. However, there were limitations of processing times, computers and internet efficiencies. Therefore animations and many images were reconstructed using different parameters in the web-based instruction indeed. This might be a weaknesses of interesting in web-based instruction. However, web-based instruction help to better understand the foundational theory. This could be used to provide learning material, and to enable self-learning correspond with 21st-century skill, and issue 4 in the concept teaching management (Office of the National Education Commission, 2010). Overall user satisfaction scores had a good level, and also higher values of learning scores after were found ($p < 0.001$) as previously (Chailapo, Poksupphiboon and Sopa, 2016). This implied that web-based instruction could provide learning material, and students achieved the learning objectives. Some words reported that "the pre-test-post-test design, used here for the purpose of research, is in itself a good way of focusing the students' attention on the learning matter" (Ranade, 2006). A disadvantage was only one issue focus on image reconstruction algorithms, and also no any audio. This may have a small value of satisfaction score for interesting in web-based instruction was 3.51 ± 0.63. Developing models of instrument and acquisition technique in further study would a guideline for practical applications in nuclear medicine.

Conclusion

Web-based instruction of image reconstruction techniques in nuclear medicine consist of foundational interested algorithms in nuclear medicine, animations, and many images were reconstructed using different parameters, including filter post-processing. The instruction could see and automatically control the screen of the devices over desktop computer and smartphone. There were average satisfaction score of design and presentation was 3.90 ± 0.77, and satisfaction score of access and information was 4.05 ± 0.80, respectively. In addition, an average user satisfaction score of presentation was 3.74 ± 0.73, and user satisfaction score of content and application was 3.67 ± 0.79 in a good level, respectively. Web-based instruction could be used to provide learning material, and to enable self-learning.

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References

Bruyant, P. P. (2002). Analytic and Iterative Reconstruction Algorithms in SPECT. *The Journal of Nuclear Medicine, 43*(10), 1343-1358.

Chailapo, T., Poksupphiboon, A., & Sopa, P. (2016). Online Learning Media Development: Design for Interactive Media Production. *The Journal of Social Communication Innovation, 4*(2), 134-143.

Office of the National Education Commission. (2010). *National Education Act, B.E. 2542 (Issue 2) B.E. 2545 and (Issue 3) B.E. 2553.* Bangkok: Office of the National Education Commission.

Ranade, M. D. (2006). Development of CAI Presentations for Science Teaching and Overview of Research Findings. *International Journal of Science and Mathematics Education, 4*(4), 763-789.

Vandenberghe, S., D'Asseler, Y., Van de Walle, R., Kauppinen, T., Koole, M., Bouwens, L., Van Laere, K., Lemahieu, I., & Dierckx, R. A. (2001). Iterative Reconstruction Algorithms in Nuclear Medicine. *Computerized Medical Imaging and Graphics, 25*(2), 105-111.