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Development and evaluation of multimedia software of vital drug prescription and calculation principles

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Abstract

Background: Considering the advancement of information technology, the use of new educational methods, such as e-learning, is undeniable. The purpose of the present study was to design and evaluate drug dose calculation multimedia software to nursing students.

Methods: After providing educational content, the software was prepared based on research findings in the field of e-learning, including Mayer's multimedia design principles, educational evaluation criteria and an educational materials checklist. Software evaluation was done by a number of multi-disciplinary experts (n=15) and students (n=32) and by polling forms that included the characteristics of electronic resources. SPSS 20 was used to analyze the data. Independent *t* tests, analysis of variance (ANOVA) and Pearson correlation were used to assess the relationship. Also, the data are presented using mean (standard deviation) and frequency (percentages) for numeric and categorical variables.

Results: Software evaluation by students resulted in a mean score of 57.73 (SD=10.964) (range: 14 to 70) of the maximum possible score of 70, indicating that software evaluation was excellent. There was a significant difference between the mean total score provided by female (mean=61.8, SD=6.03) compared to male (mean=52.5, SD=9.02) students ($P<0.05$). Female students rated the software higher than male students ($P<0.05$). Evaluation of the software by multi-disciplinary experts resulted in a mean score of 160.72 (SD=30.796), with scores ranging from 40 to 200 out of a maximum score of 200.

Conclusion: Vital drug prescription and calculation principles multimedia software was developed using Mayer's theory and evidence-based evaluation criteria. Results showed an excellent evaluation of the software by multi-disciplinary experts and students.

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Introduction

Providing learning opportunities for students in order to educate skilled students with the ability to provide effective services in the clinical setting is a major challenge in nursing education.[1] One of the main tasks of nurses and nursing students is the correct drug dose calculation.[2,3] Therefore, students must have the necessary knowledge and ability in the fields of pharmacology and mathematical computation.[4] One of the most important causes of medication mistakes is incorrect drug dose calculation and low pharmacological knowledge,[5] which can lead to prolonged hospitalization and cost increases and in some cases may lead to irreparable damage and even the death of patients.[6,7] Several studies show a deficit in nurses and nursing students in the field of drug dose calculation and the prevalence of medication mistakes.[8] Given the importance of reducing this risk, the need for basic training is indicated.[9]

One of the most common methods of teaching nursing students is through classroom lectures. Although in some situations, lectures are the most appropriate teaching method, the lecture method has some disadvantages such as teacher-centeredness, passiveness of students, lack of attention to individual differences,[10] dependency on particular time and place,[1] and the need for relocating students and multi-disciplinary experts and their

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accommodation and spending additional expenses.[11, 12]

Since the beginning of the 21st century and due to the limitations of current education and information technology advancement,[13] the use of new methods of education, such as e-learning, are beginning to proliferate[14-16] and various sciences, including medicine[10] and nursing, have begun to adapt themselves to these changes.[17] Review studies indicate that e-learning has played an effective role in optimizing the behavior, knowledge and professional competence of students and medical professionals in the health arena.[13] One of the e-learning methods is the use of multimedia software, in which the educational content is transmitted to learners using images, audio, text and educational films[13] and education quality improves using the interactive communication between learners and the teacher.[18]

Combining movies, photos and animations with educational texts increases interest in learning and creates a balance between visual, written, and audio learning.[1] In other words, the aim of using multimedia software[18] is to develop clinical skills, to increase decision-making ability,[19] and to activate students.[20] On the other hand, the use of this method creates appropriate conditions for individual learning fitted to the talents of individuals.[11] Assuming that a multi-media design compatible with human performance is more effective than the non-compatible ones in order to improve learning, programmers can use a human-centered approach to design multimedia training programs because their focus is on using technology to help cognition.[21,22] Conversely, in a technology-centered approach, instead of adapting technology to human needs, the student must adapt to technological advances. Previous experience suggests that a technology-centered approach usually does not lead to sustained improvement in education.[23] Although there are different cognitive, structural and behavioral theories in the field of learning, the Mayer cognitive theory of multimedia learning addresses this specific issue.

Mayer's cognitive theory of multimedia learning consists of three hypotheses: 1. Double channels, that is, a person has two distinct channels for representing and processing visual and verbal stimuli; 2. Limited capacity, that is, the individual is at any moment able to process a limited amount of information per channel; and, 3. Grammar processing, meaningful and profound learning occurs when inclusive learning involves a cognitive process.

Mayer proposed 10 multimedia principles for the design and production of multimedia materials: the principles of coherence, signaling, redundancy, spatial contiguity, temporal proximity, segmentation, pre- training, modality, personalization, and multimedia principles. The first five principles reduce unnecessary processing, the next three principles facilitate the processing of the essential and the last two principles result in production processing.[21] In addition to considering Mayer's multimedia design principles, the software should contain qualitative and technical characteristics and criteria to ensure its quality, accuracy, usefulness and effectiveness.[24]

Unfortunately, since there is no software design based on learning principles or design information in most studies and in reviewing the literature, no finding was found regarding the design of nursing education software based on Mayer's theory, this study was conducted to design a multimedia software for computing vital medication for nursing students based on Mayer's ten multimedia principles and evidence-based criteria and evaluation of the software by multi-disciplinary experts and nursing students as users.

Material and Methods

Content development

Surveys among several nursing faculties and clinical pharmacologists regarding the nursing curriculum as well as the educational needs of nursing students contributed to creation of educational content. The literature was reviewed and scientific resources were consulted such as drug dosage calculation books and *Fundamentals of Nursing* by Potter and Perry. The entire text was prepared as a recorded lecture, and digital cameras and video camera were used to take photographs and videos from actual scenes. This content included a combination of texts, sounds, images, animations and videos and focused on empowering nursing students in the field of prescription and medication calculation.[7]

Development of multimedia

After preparation of educational materials, the software was written. In this educational software, research findings in the field of e-learning including Mayer's multimedia design principles,[25] educational evaluation criteria and educational materials checklists were used. iSpring Suite 7 was used to record and edit lectures on the educational slides, and the files were then converted to flash. The design of the gallery section was done using Articulate Storyline 2 software. The images of the gallery section and compact CD pages were designed and edited using the Photoshop CS software and finally all of the content and images were prepared in the form of a compact disc autoplay Media Studio 8 software.[7] Before entering the software main program, the help option contains necessary explanations for how the user can work with the software. The software includes index icons about the program, the educational goals, the educational content, the guide, the printed edition, a gallery, and resources that the user can access by clicking on each one. The home page contains educational content, consisting of text, graphics, and sound and associated command keys. While working with the command keys and receiving the educational content, the user browses the software. The educational content page includes two parts of prescribing medicine principles and drug dose calculations as well as vital medicines. For each of these two topics, an audio file and a pdf file were

also provided and attached and the pdf file was put the users' disposal in the printed version. The gallery section contains an album of images with the ability to magnify the pictures as well as an album of the film. The resource page includes the resources used to provide the content of this software. The ability to compute the drug in relation to educational content with the possibility of receiving feedback and observing problem solving has also been designed and added.

Evaluation of the software by multi-disciplinary experts and students

Software evaluation was conducted by 32 nursing students in semesters 2 and 3 in Tabriz Nursing Faculty in 2015 who were part of the intervention group in the research project.[7] In this regard, a polling form consisting of eleven electronic resource features,[21] which asked the students to comment on the use of each feature of the software was designed on a five-point scale from 1 (very low) to 5 (very high). It also included three questions about satisfaction and a question requesting suggested improvements. The minimum and maximum scores were 14 and 70, respectively. A total score between 14-32 was considered weak, 33-51 average and 52-70 desirable. For multi-disciplinary evaluation, 15 faculties' views in the fields of nursing, midwifery, clinical pharmacology, training education, health education and health promotion and information technology management were used. For this purpose, a polling form of 40 criteria of electronic resources was used,[21] which required respondents to comment on each criteria of software use designed on a five-point scale, from 1 (very low) to 5 (very high). In addition, another question was offered requesting suggested improvements. The minimum and maximum scores were 40 and 200, respectively. A total score of 40-93 was considered weak, 94-147 average and 148-200 desirable. Given the different number of phrases for each of the faculty assessment dimensions, in addition to using the mean and standard deviation, percentages were also calculated, and were divided into three classes of less than 33.3% (poor), 33.4-66.6% (average) and more than 66.7% (desirable).

Statistical methods

SPSS 20 was used to analyze the data. Independent *t* tests, analysis of variance (ANOVA) and Pearson correlation were used to assess the relationship. The data are presented using means (standard deviation) and frequencies (percentages) for numeric and categorical variables.

Results

According to the principle of personalization for speech, human voice without accent, conversational and standard pronunciation was used. To consider redundancy, signaling and Mayer's multimedia principles, only the key points as a text were included in the slides and related images were added to slides for better understanding of some content. The content section of the prescribing principles and drug dose calculation included 59 slides and the vital drug content section included 33 slides. To minimize boredom, the approximate time of each slide was considered from a few seconds to a maximum of 2 minutes. The gallery section was designed in 3 sections: 1. Album of pictures (including of various injection devices, various injections and various forms of medications); 2. Album of films (teaching the general principles of the use of syringe pump and infusion pump and the animation of 10 principles of prescribing safe medicine); and 3. Common abbreviations in prescribing drugs. For some parts, without the sound of the software, soft music was added. Finally, the software was designed up to 6719 KB capable of running from CD or computer and without the need for Internet. This software is auto-running, which makes it easy to run on personal computers.

Software evaluation by students

Software evaluation was done by 16 nursing students in semester 2 and 16 students in semester 3. Based on the results of Table 1, compared to the maximum possible score (70), the total score of the obtained evaluation, 57.73, was equivalent to 82% of the maximum score, indicating that the software evaluation was high to very high; in other words, from the perspective of the students, the educational software was in the desirable level for all the evaluation criteria.

Based on Table 2, the results of independent *t* tests showed that there was a significant difference between the mean total evaluation score of female and male students (P = 0.004) and the female students' score was higher than that of the male students' score.

Table 1. The mean scores of software evaluation by nursing students in intervention group

Evaluation dimension	Mean (SD)
The usefulness of content	4.10 (0.845)
Understandable	4.13 (0.937)
Clear and legible	4.33 (0.711)
Suitable volume of the content	3.93 (0.907)
Quality of images and videos	4.28 (0.702)
Sound quality	4.10 (0.923)
Artistic scenes features	3.97 (0.07)
Ease of routing operation	4.20 (0.887)
The quality of working with the command keys	4.13 (0.776)
A simple guide to work with the software	4.23 (0.728)
Ease of use on PC	4.27 (0.828)
Satisfaction after use	4 (0.788)
Interested after use	3.093 (0.907)
Recommend to others	4.13 (1.008)
Total	57.73 (10.964)

Abbreviation: SD, Standard deviation.
For each item, the response range is 1-5 and 14 -70 for the total number.

Table 2. Comparison of mean and standard deviation of software evaluation scores by the students based on gender-disaggregation

		Mean	SD	*P* value
The total score of software evaluation by students	Male	52.5	9.02	0.004
	Female	61.8	6.03	

P value obtained from independent *t* test.

Software Evaluation by Multi-Disciplinary Experts

According to Table 3, the results of the independent *t* test for gender comparison showed that there was no statistically significant difference between male and female faculty in terms of total evaluation score ($P = 0.62$). Based on ANOVA, there was no significant difference in the total evaluation score between the levels of education, field of study and academic degree ($P > 0.05$).

The lack of significant differences indicates that the software evaluation scores is independent and not related to the multidisciplinary experts' demographic characteristics.

Based on the results of Table 4, in comparison with the maximum possible score (200), the total score of the obtained evaluation (160.72), which is equivalent to 80% of the maximum score indicating that multidisciplinary experts rated the software at a high level, in other words, from the perspective of the experts, the educational software is in the desirable level for all the evaluation criteria.

Discussion

Drug dose calculation is an important skill for nurses and nursing students and should be included in the nursing student's curriculum. In this regard, new educational methods, including multimedia software can be used to improve the educational process and effective learning.

A vital drug dose calculation (VDDC) application has been developed using a software engineering approach with the participation of nurses, nursing students and other multidisciplinary experts. An integration of Mayer's multimedia design principles, evidence-based evaluation criteria and other literature was used as a guideline to design the application.

Results from evaluation by experts demonstrated that the application has a sufficient level of Mayer's multimedia design principles and other quality criteria required and they approved of it. Results of a systematic review study revealed that the use of multimedia applications can facilitate nursing education and student learning.[8] The results of examining the demographic characteristics of multi-disciplinary experts participating in the software evaluation revealed that there was statistically no significant difference in gender, work experience, field of study and academic degree.

The use of multimedia software provides a way for the learners to repeat and practice[26] and enables each person to spend a different time for learning.[27] The VDDC application trains the drug dose calculation in a simple and audio-visual way, enabling the student to receive the

Table 3. Examining the individual-social characteristics of the multi-disciplinary experts evaluating the software

Variable		No. (%)	Evaluation Score	
			Mean (SD)	*P* value
Gender	Male	7(46.7)	70.1(14.55)	0.62
	Female	8(53.3)	83.63(11.01)	
Education level	Master	3(20)	78.42(10.49)	0.358
	PhD student	4(26.7)	68.83(14.83)	
	PhD	8(53.3)	81.19(14.86)	
Field of Study	Nursing	10(66.7)	76.12(14.68)	0.576
	Midwifery	1(6.7)	96.25(-)	
	Clinical pharmacy	1(6.7)	60.25(-)	
	Training educational science	1(6.7)	71.15(-)	
	Health education and health promotion	1(6.7)	82.5(-)	
	Management of medical information technology	1(6.7)	88.75(-)	
Academic degree[a]	Instructor	2(13.3)	73.25(7.76)	0.882
	Assistant professor	4(26.7)	82.65(14.95)	
	Associate professor	2(13.3)	78.25(25.45)	
	Full professor	1(6.7)	71(15)	
Job experience[b]	Up to 10 years	5(33.4)		
	11-20 years	7(46.7)		
	21-31 years	2(13.3)		

[a] The status of 6 persons is not known.
[b] The status of 1 person is not known.
An independent t test was used to compare the evaluation score between male and female faculties, and ANOVA was used for comparison of other variables.

Table 4. Multimedia software evaluation scores based on the responses of the multi-disciplinary experts

Evaluation dimension	No. of phrases	Domain	Mean (SD)	Percentage scores
Mayer's Multimedia Design Principles	10	50	37.27 (6.892)	74.5
Research evidence				
Content	7	35	29.53 (6.105)	84.4
Setting learning goals	4	20	16.68 (2.748)	84.35
Feedback	1	5	3.40 (1.056)	68
Motivation	3	15	11.47 (3.314)	76.5
Designing software display	9	45	37.40 (6.456)	83.1
Applicability	4	20	16.40 (2.473)	82
Accessibility	1	5	4.38 (0.719)	87.6
Reusability	1	5	4 (1.033)	80
Total	30	150	123.45 (23.904)	82.3
Total	40	200	160.72 (30.796)	80

necessary training in this regard, without any time and place limitation.

Studies show that the use of multiple examples is one of the best ways to train clinical skills and that practice, repetition, and feedback have a satisfactory outcome for learners.[28] In the design of the VDDC application, simple, multiple, and tangible examples were used. After completing educational content, questions about the educational content were designed and included for students' self-assessment so they can have access to the answers for future reference.

Standard high-quality and auto-run file formats are another characteristics of the VDDC application which leads to easy running of the program on personal computers with Windows 2000 or later. The program can be run offline and is always accessible on portable high-capacity storage devices such as CDs.

Using new educational technologies can motivate and increase student satisfaction and efficiency.[29] The results of the VDDC application evaluation by the students indicate that, from the viewpoint of the students, the software has a desirable level of evaluation criteria and the learners were highly satisfied with its use. Although there was a statistically significant difference in gender, the evaluation score of the female students was higher than that of the male students. To the best of our knowledge, no published research was found that might explain this difference.

The results from another study conducted in this field showed that after training, the intervention group's (education with VDDC application) *drug calculation ability* significantly increased ($P<0.05$) compared to the control group. However, no significant difference was seen between the two groups in terms of *medicinal calculation ability* after training ($P>0.05$). However, an e-learning program can reduce the lecture time and cost of repeated topics, such as medication, suggesting that it can be an effective component in nursing education programs.[7]

The limitations of this study include the small sample size as well as the use of a special educational topic (vital drugs), which provides challenges to the possibility of generalization of findings to other educational professions and topics.

Conclusion

Vital drug prescription and calculation principles multimedia software was developed using Mayer's theory and evidence-based evaluation criteria. The study results showed an excellent evaluation of the software by multi-disciplinary experts and students.

Ethical approval

This study was approved by Ethics Committee of Tabriz University of Medical Sciences with the code number TBZMED. REC.1394.749. In order to collect the data, informed consent was obtained from each participant.

Competing interests

The authors declare that there is no conflict of interest.

Authors' contributions

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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