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This article was written following the completion of a doctoral research project involving the investigation of the effectiveness of an online interactive multimedia program on undergraduate nursing students' math knowledge and self-efficacy at 2 universities in northern California. The research was supported by a grant received from Sigma Theta Tau International, Honor Society of Nursing, Beta Gamma.
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Abstract

The use of online learning tutorials to provide instruction in schools of nursing is growing in popularity; however, the outcomes associated with this method of instruction are not well documented. The focus of this experimental study, conducted at 2 universities in northern California, was to determine the effectiveness of an online interactive multimedia-learning tool versus text only, text and images, and multimedia learning explanations on math achievement, math self-efficacy, and student satisfaction. Compared to students in the control groups, students in the interactive multimedia group demonstrated equal posttest and retest knowledge of math; their math self-efficacy scores were also the same. Interactive multimedia group students were more satisfied with the method of learning, reported the technique to be enjoyable and more interesting, and provided sufficient feedback. An online interactive multimedia-learning tool is a realistic and creative method of teaching medication dosage calculations.

Over 8 million families in the United States are estimated to have at least 1 member affected by a severe health problem as a result of a medication or medical error. [1] Making safe medication administration a priority in our schools of nursing will assist in decreasing the number of medication errors in our nation's health care settings. Nurse educators are in a position to develop innovative learning materials that will motivate students to remediate common math concepts that will allow them to competently calculate drug dosages in the clinical setting. Many nursing students are unable to show proficiency in math calculations and have poor math self-efficacy. The study determined whether a 1-hour interactive multimedia online learning tool would serve as an effective learning method when compared with 3 other methods of teaching medication dosage calculations to undergraduate nursing students.

REVIEW OF RESEARCH

Research literature exists concerning basic math proficiency and medication dosage calculation (posology) errors by nursing students and nurses in the United States and other countries around the world. 2–7 Students lacking the necessary mathematical skills are faced with the threat of clinical failure and lowered math self-efficacy. However, empirical research investigating instructional methods, practice time, or helpful solutions that strengthen and enhance students' medication calculation capabilities is lacking. 8–11 Traditional classroom learning environments have been compared with Web-based courses for cognitive effectiveness, increased computer skills, and self-reported affective outcomes. 12,13

Conceptual Framework

The theoretical structure for this research is based on Paivio's dual coding theory, 14 Mayer's cognitive theory of multimedia learning, 15 Sweller's cognitive load theory, 16 and Bandura's concept of self-efficacy within social cognitive theory. 17 Paivio hypothesized there are verbal and nonverbal subsystems that are structurally and functionally distinct at the cognitive level. The use of pictures and words, as described by Paivio, to enhance cognitive coding provide a framework for the construction of multimedia-based instruction delivered via computerized technology. Mayer expanded upon Paivio's idea of pictures to include animation and text as narration and applied the theory to computer-based multimedia presentations. Sweller explained the mental processes of learning, problem solving, and human memory in his cognitive load theory. Moreover, Sweller's theory explains that certain teaching methods can lessen the intrinsic cognitive load of difficult learning material. The concept of self-efficacy within Bandura's social cognitive theory supports the idea that an individual's belief in his/her ability to be successful in any given task has a direct influence on his/her performance, persistence, and behavioral choices. Because many nursing students are unskilled in working with math concepts, previous experiences of failure in math may be triggered and a sense of low math self-efficacy may surface when faced with medication dosage calculations.

Mathematical Capabilities

Pozeh 14 discovered, based on the analysis of a sample, that nursing students' mathematical capabilities were less than those of nonnursing groups. A small comparative descriptive study, conducted by the same researcher, compared the differences between nursing ($n = 56$) and non-nursing majors' ($n = 56$) mathematical test score results. Math and computer anxiety, as well as the number of algebra courses taken prior to admission to the university, were taken into consideration. The 25-item multiple-choice algebra test, developed by the author, was administered via computer. The test included items that required solution of algebraic equations, fractions, and decimals. These are the predominate skills required when nurses calculate dosages of medications and determine intravenous (IV) drip rates. The algebra test had a high reliability ($r = .82$), and a panel of math and nurse experts determined test validity.

The data analysis indicated a significant finding ($P < .01$) for the algebra skills' test outcomes, which contributed to the overall multivariate significance. Furthermore, it was discovered that only 18% of the nursing group passed the algebra test with a score of 70% or better, compared to 71% of the non-nursing group passing the same examination at the same level. The nursing group reported higher anxiety toward math, higher mean pretest anxiety, and higher anxiety toward computers when compared to the non-nursing cohort. However, these reported differences were not statistically significant.

Mathematical Self-efficacy

Betz and Hackett 18 looked at the correlation of mathematics self-efficacy with the selection of science-based majors among college females and males. Their study involved the development of the Mathematics Self-Efficacy Scale (MSES), 19 which is grounded in Bandura's self-efficacy theory. 17 Betz and Hackett found males' math-related self-efficacy expectations were significantly stronger ($t = -3.4$, $P = .001$) than those of females attending college. The MSES was used in this current study in order to determine if the treatment levels had an effect on the students' mathematical self-efficacy.

Multimedia Learning

Mayer and Sims investigated the dual-coding theory of multimedia learning pertaining to scientific systems, such as automobile braking systems, the human respiratory system, and the basic bicycle tire pump. 20 The findings indicated that the students with high-spatial ability who received a concurrent multimedia presentation (animation and narration) fared better on a transfer problem test than those high-spatial ability students who were presented with a successive learning explanation or no explanation at all. The results from this study supported the dual-coding theory of multimedia learning. Students who have domain-specific knowledge may not need visual aids when listening to a verbal presentation; however, inexperienced students might benefit from concurrent multimedia explanations. When students were exposed to learning presentations that included verbal and visual explanations concurrently there was a better chance for them to construct multimodal connections.

A small descriptive study by Timpke and Janney 21 described positive cognitive outcomes associated with the use of a computer-assisted instruction (CAI) program consisting of 3 diagnostic tests. Thirty-two nursing students at a large public university in southern California were participants in the study. The computerized review and diagnostic tests included material on basic math review, conversions of one measurement system to another, and medication dosage calculations. The diagnostic sections were grouped in such a manner that the computer analyzed the student's responses and provided feedback to the student and results to the instructor. The same researchers reported that as a result of the CAI, the total cohort of nursing students passed the final mastery examination in posology on the first attempt. Two semesters prior to the use of the CAI program, 11 students out of a group of 28 had failed the final dosage calculation examination. Following the use of the CAI, the students remarked that their math comprehension had improved, and they were able to focus more on studying pharmacology. The program was praised for its convenience, privacy, and specificity.

METHODOLOGY

Design

An experimental multifactorial design was used with 4 undergraduate nursing student groups. Participants were randomly assigned to one of the treatment groups in the study: text only, text and image, multimedia, and interactive multimedia. Mathematical achievement and math self-efficacy were measured 1 week prior to the treatments and were used as covariate data. Mathematical achievement and self-efficacy scores were determined posttreatment and at a 2-week follow-up period. Student satisfaction was measured at the 2-week follow-up period. Student satisfaction scores were analyzed by using a 1-way analysis of variance (ANOVA). The institutional review board at both universities approved the study before participant recruitment. Participants signed an informed consent form prior to the study.

Setting, Population, and Sample

Ninety-six undergraduate nursing students, attending 2 west coast universities, participated in the study. The groups of students were of mixed gender, ethnically diverse, and their ages ranged from 19 to 42 years. Data collection took place at one small private university (n = 50) and at one large public university (n = 46). Both of these universities are located in large cities in northern California. The researcher was given permission to invite students to participate in the study by a faculty member teaching in each school of nursing. Volunteers attending the public university obtained extra credit in an undergraduate nursing skills course for their participation. The participants from the private university volunteered without being offered extra credit from their professor. The nursing students had completed 2 semesters of prerequisite course work before entering their respective nursing programs and 2 semesters of nursing courses (eg, pathophysiology, pharmacology, and nursing theory) during their sophomore year. Of the 96 participants, 84 (87.5%) were female and 12 (12.5%) were male students. This sample is representative of the profession as a whole. 22

Interventions

The treatments used in this study focused on providing basic math review and medication dosage calculation instruction for undergraduate nursing students. There were 4 treatment groups in the study. All of the treatments were 1 hour in duration and contained the same learning material. The first treatment group (T) consisted of participants independently reading and learning from 3 text-based mathematical modules. The text-based instrument was 24-pages long. The modules contained a review of mathematical structures, metric and apothecary measurement conversions, and medication dosage calculation instruction.

Participants in the second treatment group (TI) independently read the same modules as the first group; however, these modules were enhanced with images. The third treatment cohort (TIA) consisted of participants who viewed the same 3 modules as the T and TI groups; however, these students viewed the 3 multimedia modules via a computer screen. These 3 modules were displayed on a single Web page, and the participants scrolled down as they viewed the information provided on the computer screen. These participants were physically separated from the fourth group. The fourth treatment group (TIAI) also viewed 3 multimedia modules divided on interlinked Web pages, with the modules consisting of text, image, animation, and interactivity. A screen shot of one interactive multimedia page is illustrated in Figure 1. The complete tutorial can be viewed at http://maagnursing.com/MedCal using Internet Explorer as a browser.

At the beginning of each module the student had access to the learning objectives. Each interactive module builds upon previous learning material and contains interactive review questions following the introduction of each mathematical or medication dosage calculation concept. The student must answer the review questions before advancing to the next page of the tutorial. As shown in Figure 1, immediate cognitive feedback is given to the student once the student answers a review question.

Instruments

Three criterion-based tests involving basic math problems and medication dosage calculations were designed by the researcher in order to determine the participants' mathematical abilities. The textbook Clinical Calculations 23 was referenced during the construction of the math tests. Each parallel test consisted of 25 multiple-choice questions. Eleven of the 25 questions pertained to the multiplication and division of fractions and decimals, conversion of percentages to fractions and ratios, and conversion of metric and household systems problems. The remaining 14 questions pertained to medication dosage and intravenous calculations. These tests were determined by the researcher to be of similar difficulty as the Bindler-Bayne Mathematics Test for Nursing. 24 Three nurse educators from 2 universities, as well as a math expert teaching in a university setting, determined the content validity of these tests. The test-retest reliability coefficients of .77 to .82 were determined for the math exams. Rank orders were preserved from one testing period to another, indicating stability over a period of time. The Kuder-Richardson Formula 20 reliabilities ranged from .78 for pretreatment math test, .79 for posttreatment math test, and .80 for follow-up treatment math test. Calculators were not allowed during the testing period.

Mathematical self-efficacy was measured using the MSES developed by Betz and Hackett. 19 Each item on the 34-item MSES requires the respondents to specify their level of confidence on a 10-point scale ranging from no confidence at all to complete confidence. Final MSES scores represent average item scores and range between 0 and 9. The first subscale (SE1) of the MSES includes 18 items that represent mathematical comprehension, computational ability, and application of mathematical principles. The second subscale (SE2) consists of 16 items, and this part of the instrument requests students to report their confidence level in receiving a letter grade of an A or B in college mathematical coursework. Since this study was focused primarily on nursing students' math-computational skills, the researcher decided to use the students' math SE1 scores during data analyses.

The Student Satisfaction Survey, developed by the researcher, assessed the participants' satisfaction with the instructional method they received during the study. The participants were asked to rate aspects of the learning modules on a scale of 1 to 5 (1 indicating strongly disagree and 5 indicating strongly agree). Average item scores were obtained. Coefficient alpha was .95 based on the 93 participants who completed the survey at the end of the study. A professor teaching in a school of education at one university reviewed the Student Satisfaction Survey for content validity and concluded the survey to be valid based upon content matter. Statements from the survey are shown in Table 1.

Data Collection Procedure

The researcher recruited all participants during a regularly scheduled class at both universities. Participation in this research was purely voluntary and the outcomes of the study were not used in the grading process. The participants in this study had received previous instruction on medication dosage calculations during past academic courses; however, IV drip-calculations were a new concept introduced to these participants just prior to this study.

The participants were given the MSES 19 first and then the 25-item pretreatment math test. On average, the participants completed the MSES in 5 minutes. The students were allowed 40 minutes to complete the math tests given during the study. Exactly 1 week later, the students were randomly assigned to 1 of 4 treatment groups. Each group was granted 1 hour to complete the instructional treatment. Directly following each treatment, the participants were administered the MSES and then within 2 or 3 minutes a posttreatment math test was administered to each student.

The third phase of the data collection process occurred exactly 2 weeks following the treatment phase at each university. The researcher returned to the classroom and administered the MSES, 19 and a follow-up treatment math test was administered within 2 minutes following the completion of the MSES. Directly following the follow-up treatment math test the students completed the Student Satisfaction Survey. Ninety-six students completed the 3 MSESs and math achievement tests. Three students chose not to complete the satisfaction survey; therefore, the satisfaction survey results were analyzed based on 93 instead of 96 responses.

Data Analysis

Result scores from the 3 math tests and self-efficacy scales, as well as the student satisfaction survey results, were analyzed using descriptive statistics. Differences in scores on the math tests and the MSES between participants at each university were examined using t tests. A 1-way analysis of covariance (ANCOVA) was carried out for the main effect (treatment) and the covariates (pretreatment math test and math self-efficacy results) on the dependent variables (posttreatment, and follow-up treatment math achievement and self-efficacy). An ANOVA was done to determine the overall significance of the outcome variable, student satisfaction scores. The level of significance was set at $P <= .05$ for all analyses.

RESULTS

Summary Findings

An overview of the descriptive statistics obtained from the pretreatment, posttreatment, and follow-up treatment math tests and self-efficacy (SE1), as well as student satisfaction survey results, are presented in Table 2. The results show that the math test and math self-efficacy scores did not increase significantly over the course of the study.

Sample Statistics

An independent-samples t test was carried out to determine if mean pretreatment math-test and math SE1 scores differed significantly between the participants at the 2 universities. The differences were insignificant, $t = -0.31$, $P = .76$ and $t = 1.00$, $P = .32$, respectively. These results illustrated no significant mean pretreatment and posttreatment math-test or math SE1 score difference between participants at the 2 universities, and therefore the researcher decided to combine the 2 samples of students before conducting further data analyses.

A detailed analysis was conducted to identify differences in math-test and math self-efficacy scores based on treatment at the follow-up time point. The results of the analyses are illustrated in Table 3. An ANCOVA was computed to determine if the use of an interactive multimedia learning explanation would result in greater follow-up treatment math-test scores when compared with the use of different treatment levels. The ANCOVA results were not significant except for the pretreatment math-test covariate ($P = .00$).

The strength of the relationship between the treatment factor (between subjects) and the dependent variable was moderate ($[eta]^2 = 0.08$), with the treatment factor accounting for 8% of the variance on the dependent variable, while keeping the pretreatment math SE1 and pretreatment math-test scores constant. The relationship of the covariate, pretreatment math-test scores, and the dependent variable was strong ($[eta]^2 = 0.41$), thereby indicating that 41% of the variance on the dependent variable was due to the students' pretreatment math-test scores. A similar analysis was computed to determine if the use of an interactive multimedia learning explanation would result in higher follow-up treatment math self-efficacy scores when compared with the use of different treatment levels. Assuming homogeneity of slopes an ANCOVA was computed, but the findings were nonsignificant except for pretreatment math SE1 ($P = .00$); the results are shown in Table 5. The results of the 2 ANCOVA analyses do not support the hypothesis that the interactive multimedia learning explanation resulted in greater posttreatment mean math achievement and math self-efficacy scores. While these results do not support the hypothesis of the study, they clearly indicate that the interactive multimedia learning explanation results in similar learning outcomes as those obtained through more traditional methods of mathematical remediation.

Bivariate Correlations

A Pearson product-correlation coefficient was computed between the 3 math tests and the 3 math self-efficacy scale results. The pre-math SE1 correlated with pretreatment and posttreatment math tests ($r = .20\text{-}.22$, $P < .05$), demonstrating a significant correlation. The posttreatment math SE1 correlated with the posttreatment math test ($r = .28$, $P < .01$). Also, the follow-up treatment math SE1 correlated significantly with the posttreatment math-test results ($r = .31$, $P < .00$). The correlations of math self-efficacy with math achievement were significant for 4 out of the 9 correlations. In this study, math self-efficacy was in general a good predictor of math achievement.

Student Satisfaction

The means and standard deviations for the students' satisfaction scores are provided in Table 6. The results indicated that the highest mean score of 3.83 (SD = 0.89) was reported by the students participating in the interactive multimedia method of instruction, indicating a moderately high satisfaction with the method of delivering the learning material. A 1-way ANOVA was computed to determine if the interactive multimedia tool yielded significant increase in satisfaction scores, $F(3, 89) = 0.76$, MSE = 0.99, $P = .52$. An effect size was calculated and the result was 0.30. In order to explore further, post hoc comparisons were made with Tukey's procedure. This analysis compared the TIAI group satisfaction scores against the 3 other treatment groups' scores combined. The results of the ANOVA were tested at the .05 level and no significant findings were found ($t = 1.43$, $P = .15$) for student satisfaction scores.

DISCUSSION

In regard to the first research question concerning an increase in cognitive outcomes following a short interactive multimedia presentation of remedial math concepts and medication dosage calculation instruction, this study did not render statistically significant increases in mean math-test scores at the posttreatment and follow-up treatment periods. The results indicated that a 1-hour intervention is not sufficient to correct the deep-seated math problem that has been documented by educators for many years. However, this study showed that the computer-based learning modules did not impede the students' learning. Aberson et al 25 have published a similar result for an Internet-based interactive tutorial used for 2 statistics courses. Therefore, further research is needed to determine if increased learning can be achieved by providing multimodal online learning modules that nursing students can use at their convenience for longer periods of time.

The present study did not compare the achievement outcomes associated with the interactive multimedia-learning tool, launched by a Web browser, with learning outcomes achieved from face-to-face instruction. However, the learning outcomes associated with the interactive multimedia tool were compared with outcomes associated with 3 other learning methods. The study's results indicated that the online tutorial could be used to introduce material that is generally discussed in the classroom environment with similar cognitive outcomes. The undergraduate students involved in Aberson et al's study 25 indicated that the tutorial was easy to use and they would like to see more tutorials offered in the future.

The second research question concerning the interaction effect of the learning method on students' math self-efficacy mean scores was not significant. The students' (n = 96) scores did not significantly increase over the course of the study, and overall the students demonstrated a "moderate amount" of math self-efficacy at the beginning, as well as at the end of the study (Table 2). Hodge 3 reported that math self-efficacy was not correlated with nursing students' mathematical achievement. However, the results garnered from the present study indicated a moderate correlation; specifically, the correlation among posttreatment math-test scores and posttreatment math SE1 results (r = .28, P = .01) indicated a significant finding.

The last research question asked about the students' satisfaction with the different treatments used in the study. The group reporting the highest satisfaction score was the interactive multimedia group; however, these results were not significantly different from those of the other groups. The literature indicates that online interactive learning experiences are more satisfying and meaningful than traditional learning methods. 26,27 These innovative learning methods are widely accessible, self-paced and intuitive, enhance cognitive outcomes, and promote the learning of computer skills. 15

CONCLUSION AND RECOMMENDATIONS

The results from the present study are limited because of the short treatment time, a lack of strong student motivation, and the use of a small convenience sample. In general, the assessment of the effectiveness of multimedia learning launched via an Internet browser is a research challenge. Researchers have attempted to compare Internet-based learning with face-to-face learning and have reported similar learning outcomes. 25,28 Despite the lack of significant findings for increased math scores and math self-efficacy results, students' satisfaction with the interactive multimedia learning method suggests that this method might motivate students to review math concepts needed to calculate medication dosages.

A descriptive research design could be implemented in the future by creating student focus groups, open-ended questionnaires, or interviews in order to identify students' attitudes and feelings during math remediation. Extraneous variables not studied in the present study could be identified, such as motivation constructs, math-test anxiety, and attitudes toward computer-centered learning. Nurse educators could determine the effectiveness of multimedia-learning tools versus the traditional lecture-based delivery of remedial math concepts and medication calculations. Math-test results, math self-efficacy outcomes, and students' perceptions of both methods of instruction could determine the best approach to learning remedial math concepts at the university level. Nurse researchers are able to determine best practices and influence the nursing curriculum, while ultimately decreasing the number of medication errors made in the clinical setting.

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REFERENCES

1. The Commonwealth Fund. New study estimates eight million American families experienced a serious medical or drug error. April 15, 2002. Available at: http://207.189.207.4/media/releases/davis534_release04152002.asp. Accessed October 29, 2002. [Context Link]

2. Blais K, Bath JB. Drug calculation errors of baccalaureate nursing students. Nurs Educ. 1992;17:12–23. [Context Link]

3. Hodge MB. Effects of Gender, Math Self-Efficacy, Test Anxiety, and Previous Math Achievement on Posology Errors of Baccalaureate Nursing Students [dissertation]. Los Angeles, Calif: Faculty of the School of Education, University of Southern California; 1997. [Context Link]

4. Pozehl BJ. Mathematical calculation ability and mathematical anxiety of baccalaureate nursing students. J Nurs Educ. 1996; 35:37–39. [Context Link]

5. Segatore M, Edge DS, Miller M. Posology errors by sophomore nursing students.

Nurs Outlook. 1993;41:160–165. [Context Link]

6. Weeks KW, Lyne P, Torrance C. Written drug dosage errors made by students: the threat to clinical effectiveness and the need for a new approach. Clin Effect Nurs. 2000;4:20–29. [Context Link]

7. Allen S, Papas A. Enhancing math competency of baccalaureate students. J Prof Nurs. 1999;15:123–129. [Context Link]

8. Bayne T, Bindler R. Effectiveness of medication calculation enhancement methods with nurses. J Nurses Staff Dev. 1997; 13:293. Request Permissions [Context Link]

9. Craig GP, Sellers SC. The effects of dimensional analysis on the medication dosage calculation abilities of nursing students. Nurs Educ. 1995;20:14–18. [Context Link]

10. O'Shea E. Factors contributing to medication errors: a literature review. J Clin Nurs. 1999;8:496–504. Buy Now [Context Link]

11. Leasure AR, Davis L, Thievon SL. Comparison of student outcomes and preferences in traditional vs. world wide web-based baccalaureate nursing research course. J Nurs Educ. 2000;39:149–154. [Context Link]

12. Ryan M, Carlton KH, Ali NS. Evaluation of traditional classroom teaching methods versus course delivery via the world wide web. J Nurs Educ. 1999;38:272–277. [Context Link]

13. Mayer RE, Anderson RB. The instructive animation: helping students build connections between words and pictures in multimedia learning. J Educ Psychol. 1992;84:444–452. [Context Link]

14. Paivio A. Mental Representations: A Dual Coding Approach. New York: Oxford University Press; 1986. [Context Link]

15. Mayer RE. Multimedia Learning. Cambridge: Cambridge University Press; 2001. [Context Link]

16. Sweller J. Cognitive load during problem solving: effects on learning. Cog Sci. 1988;12:257–285. [Context Link]

17. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev. 1977;84:191–215. [Context Link]

18. Betz NE, Hackett G. The relationship of mathematics and self-efficacy expectations to the selection of science-based college majors. J Voc Behav. 1983;23:329–345. [Context Link]

19. Betz NE, Hackett G. Manual for the Mathematics Self-Efficacy Scale Review Set. Redwood City, Calif: Mind Garden Inc; 1993. [Context Link]

20. Mayer RE, Sims VK. For whom is a picture worth a thousand words? Extensions of a dual-coding theory of multimedia learning. J Educ Psychol. 1994;86:389–401. [Context Link]

21. Timpke J, Janney CP. Teaching drug dosages by computer. Nurs Outlook. 1981;29:376–377. [Context Link]

22. California Board of Registered Nurses. Annual school report. 2000–2001. Available at: http://www.rn.ca.gov/policies/pdf/2000%2D2001%20annual%20school%20report.pdf. Accessed October 21, 2002. [Context Link]

23. Kee JL, Marshall SM. Clinical Calculations. Philadelphia: Saunders; 2000. [Context Link]

24. Bayne T, Bindler R. Bindler–Bayne Mathematics Test for Nursing: Form A. Spokane, Washington; 1983. [Context Link]

25. Aberson CL, Berger DE, Healy MR, Kyle DJ, Romero VL. Evaluation of an interactive tutorial for teaching the central limit theorem. Teach Psychol. 2000;27:289–291. [Context Link]

26. Brown K. Online, on campus: proceed with caution. Science. 2001;293:1617–1619.

[Context Link]

27. Sery-Ble OR, Taffe ER, Clarke AW, Dorman T. Use of and satisfaction with a browser-based nurse teaching tool in a surgical intensive care unit. Comput Nurs. 2001;19:82–86. Ovid Full Text [Context Link]

28. Wegner SB, Halloway KC, Garton EM. The effects of internet-based instruction on student learning. J Async Lrn Ntwrk. 1999;3:98–106. [Context Link]