ABSTRACT

The purpose of the study was to assess the effectiveness of supplementing traditional classroom teaching with Web-based learning design when teaching intramuscular injection nursing skills. Four clusters of nursing students at a junior college in eastern Taiwan were randomly assigned to experimental and control groups. A total of 147 students (80 in the experimental group, 67 in the control group) completed the study. All participants received the same classroom lectures and skill demonstration. The experimental group interacted using a Web-based course and were able to view the content on demand. The students and instructor interacted via a chatroom, the bulletin board, and e-mail. Participants in the experimental group had significantly higher scores on both intramuscular injection knowledge and skill learning. A Web-based design can be an effective supplementing learning tool for teaching nursing knowledge and skills.

Traditionally, technology has been applied to facilitate offsite learning (i.e., at locations other than traditional classrooms). Applications have included distance learning, computer-mediated courseware (interactive CD-ROM), and most recently, online courses. The literature about the effects on student learning of using technology for content delivery clusters around offsite delivery—specifically, Web-based online course management technology.

Distance education (i.e., teaching students at different locations) bridges the physical separation between teachers and students, which has expanded teaching and learning in nursing education (Billings, 2007). Likewise, computer-mediated, Web-based education strategies for distance education provide opportunities for active learning and full participation from nursing students (Neiderhauser, Bigley, Hale, & Harper, 1999). In 1994, the government of Taiwan launched a National Informatics Initiative to promote distance education (Ma, 1997). By 1998, more than 100 colleges and universities in Taiwan provided courses via distance learning networks (Young & Fe, 1998). By 2002, 60 of 143 colleges and universities offered courses via distance learning network (Ministry of Education, 2007). Web-based courses are expected to be useful for Taiwanese students because most students feel too intimidated to ask questions in person. It is particularly beneficial for nursing students because they lack access to teachers outside of class. This is because the majority of teachers are responsible for academic and clinical teaching in Taiwan; teachers spend their time in hospitals when they do clinical teaching, which minimizes the opportunity for teacher-student interaction on campus.

Recently, distance education in nursing schools has grown rapidly (Barker, 2004). Waits and Lewis (2003) found that 56% of nursing schools offered distance courses, with computer and video technologies used most often. The Internet and World Wide Web have brought distance
learning to a new level (Billings, 1999). Despite increased use of the Internet to deliver courses, little is known about its effectiveness in teaching nursing skills and knowledge in Taiwan. In addition, changes in learning outcomes when using technology to extend the real-time classroom and to include online review and student discussion have received little attention.

LITERATURE REVIEW

Web-based course or electronic learning (e-learning) means using the Internet to access and participate in online modules or courses (Billings, 2000; Billings & Rowles, 2001). Web-based courses are offered online using course management software. Such software programs use content boards to host modules, e-mail, discussion boards, chatroom, and testing tools to organize information and support online communication. A Web-based course is one delivery method that overcomes the location and time barriers between instructors and students. Some studies of learning outcomes in distance education, either using the Web or other connection networking, in nursing or other allied health revealed no significant differences in course grades or test scores from those of classroom courses (Bachman & Panzarine, 1998; Bata-Jones & Avery, 2004; Buckley, 2003; Mills, 2007; Rosenlund, Damask- Bembenek, Hugie, & Matsumura, 1999; Ryan, Carlton, & Ali, 1999). However, students from a variety of disciplines, including nursing programs, appreciated the time flexibility, convenience, and lack of travel concerns related to Web-based courses (Guernsey, 1998a, 1998b; Hiltz, 1986; Phillips & Santoro, 1989). Likewise, RNs in a post-RN baccalaureate program found the ability to participate in learning activities at the learners' convenience to be the major advantage of a Web-based course (Cragg, 1994b). In addition, expanded distribution of training materials to the public and improved knowledge and skills were also identified as advantages (Horney, MacDonald, Rothney, & Alexander, 2005; Pullen, 2006).

Less positive experiences of Web-based courses also have been reported in the literature. Hardware and software problems have been frequent sources of frustration for students and instructors (Cragg, 1994a; Martin, Klotz, & Alfred, 2007; Phillips & Santoro, 1989; Rosenlund et al., 1999). Establishing and maintaining Internet connectivity has presented problems (Cragg, 1994a, 1994b). The need and cost of both initial and ongoing technical support have been identified as barriers (Mills, 2007; Phillips & Santoro, 1989). In addition, participant training has also been a concern (Phillips & Santoro, 1989; Young, 1997).

The difficulties with hardware, software, and Internet connectivity were also reported by Cragg (1994a, 1994b) in a group of post-RN students who participated in a Web-based course. Problems were prominent especially at the start of the course. However, Cragg found that students were pleased with the positive psychological and social outcomes of the asynchronous networking. Ryan, Carlton, and Ali (1999) evaluated graduate nursing students' perceptions of traditional classroom teaching and World Wide Web modules approach. Classroom methods were rated significantly higher regarding content, interaction, participation, faculty preparation, and communication. Technical skills were rated higher for Web modules.

A comprehensive Web-based course management tool should include course design features (e.g., sample courses, templates for courses, search tool, student Web sites), course management features (e.g., grading, student tracking, assessment tool, quizzes, timed tests), communication tools (e.g., threaded discussion, chatroom, bulletin board, e-mail), and administration functions (e.g., security, technical support) (Klobas & Renzi, 2000; Novitzki, 2000). Wisdom Master version 2.4 software, developed by the Sun Net Technology company in Taiwan with all the major features necessary for a Web-based course management program, is used by more than 70% of Web-based learning users in Taiwan (Sun Net Technology, 2007). More than 100 public and private universities and colleges in Taiwan currently use this software to manage their Web-based courses.

Another method to assess the effect of using technology in traditional (instructor-centered) classroom teaching can be demonstrated by the “Seven Principles for Good Practice in Undergraduate Education” (Chickering & Gamson, 1987). Technology as a lever can facilitate the implementation of the seven principles of best practices in education, which are:

- Encourages contact between students and faculty.
- Develops reciprocity and cooperation among students.
- Uses active learning techniques.
- Gives prompt feedback.
- Emphasizes time on task.
- Communicates high expectations.
- Respects diverse talents and ways of learning.

PURPOSE

The purpose of the study was to determine the effectiveness of teaching the nursing skill and students’ knowledge by combining Web-based course design with traditional classroom teaching methods. The research hypothesis was that students who had access to a Web-based course management tool in addition to traditional classroom instruction would perform better on both knowledge and skill tests than would students who did not use the tool. Due to the semester curriculum design and the time of the execution of the study, the nursing skill of intramuscular injection was chosen as the content of the teaching topic.

METHOD

Design

A two-group experimental design was used in the study (Polit & Beck, 2006). The sample frame consisted of four clusters of second-year nursing students from the same class of a junior nursing college in Taiwan. These students
were studying a fundamental nursing subject when the study was implemented. Two of the four clusters were randomly chosen to be experimental groups by selecting students’ names from a hat. Pretest and posttest of intramuscular injection nursing knowledge and posttest of skill were administered to compare the effects of the intervention.

Participants

Four clusters of second-year nursing students in a 5-year program at a Taiwanese junior college of nursing were recruited for the study. The school educated students in clusters. For each class of the same year, students are divided into four clusters. The first 2 years of education are equivalent to grades 10 through 11 in the United States, with a focus in basic science and fundamental nursing training; the last 3 years of education are equivalent to a 3-year community college nursing program in the United States, with professional nursing and practicum training in different subjects (e.g., medical and surgical, psychiatric, public health). Students obtain an associate degree in nursing upon graduation and are qualified for nursing license board examinations for RNs. Students within one cluster study in the same classroom and live close to each other in the dormitory. Subject teachers go to the individual classroom for each cluster to conduct lectures. Therefore, students in the experimental and control groups did not share the same lecture at the same location. In Taiwan, this is a common way of conducting education for students prior to the university level.

Students in the same cluster stay in a fixed classroom throughout the school year. Instead of students going to subject teachers, teachers go to the students’ classroom for lectures. In doing so, the order of the school can be easily maintained. Students in the experimental group were instructed not to discuss their experience with students in other groups until after the end of the experiment. Two of the four clusters of students were assigned to each of the control (n = 84) and experimental (n = 84) groups. A total of 168 students were recruited to the study, all of whom were female and between ages 17 and 18. Eighty-eight percent (N = 147) of the participants completed the study. Twenty-one participants did not provide sufficient information to complete the study analysis. On the demographic questionnaire, participants were asked general information about their previous academic year and about their interest in studying nursing (Table 1). Chi-square and two-group t tests were used to test the demographic equivalence between two groups. The only statistically significant difference in the demographic data was the academic grades for the previous semester. On average, participants in the control group had better grades (i.e., better academic performance) in the previous year than did participants in the experimental group. This difference could potentially be interacting with the effects of interventions for participants. Therefore, this confounding factor was controlled for when data were analyzed.

Four research surveys had to be discarded due to too many unanswered questions. The research proposal was reviewed and approved by the university’s research and human subjects committee.

Instruments

Instruments for this study consist of the demographic questionnaire, the Intramuscular Injection Knowledge Assessment Scale, and the Intramuscular Injection Skill Performance Scale. The demographic questionnaire was designed to understand students’ backgrounds in terms of their interests in studying nursing and their overall grade averages in the previous academic year and in nursing skills learning (Table 1).

The Intramuscular Injection Knowledge Assessment Scale and the Intramuscular Injection Skill Performance Scale were used to evaluate the effects of the study intervention. These tools were developed according to the standardized content designed by nursing experts. The

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental (n)</th>
<th>Control (n)</th>
<th>Chi-Square (p)</th>
<th>t Test (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studies nursing by own will</td>
<td>79</td>
<td>68</td>
<td>0.66 (0.20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>46</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>33</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic grade average, previous year</td>
<td>78 (mean = 4.45)</td>
<td>67 (mean = 5.73)</td>
<td>2.94 (143)</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>Grade average of skills test, previous semester</td>
<td>77 (mean = 4.70)</td>
<td>67 (mean = 4.49)</td>
<td>0.71 (142)</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>Has strong interest in practicing nursing skills</td>
<td>80 (mean = 2.32)</td>
<td>67 (mean = 2.12)</td>
<td>1.48 (145)</td>
<td>&lt;0.15</td>
<td></td>
</tr>
</tbody>
</table>

*To increase the recall accuracy, the following ranges of grades (similar to As, Bs and others) instead of exact average scores were used: 8 = 95 to 99; 7 = 90 to 94; 6 = 85 to 89; 5 = 80 to 84; 4 = 75 to 79; 3 = 70 to 74; 2 = 60 to 68; 1 = below 60.

*bTo increase the recall accuracy, the following ranges of grades, instead of exact average scores, were used: 6 = 100; 5 = 90 to 99; 4 = 80 to 89; 3 = 70 to 79; 2 = 60 to 69; 1 = below 60.

*c5 = strong, 1 = least.
accuracy of the textbooks was approved by the Ministry of Education in Taiwan. There were only nine quiz questions on the Intramuscular Injection Knowledge Assessment Scale, for a total maximum score of 9. The nine questions tested different content areas from the lecture about intramuscular injection-related nursing knowledge and was used in an in-class, closed-book written test. Therefore, the internal consistence for reliability of the instrument was not applicable (Strickland, 1999). A total of 76 steps (designed by the same group of nursing experts who designed the textbook, and modified by the instructor) were included in the Intramuscular Injection Skill Performance checklist, with possible scores ranging from 0 to 100. It was designed to be used in the nursing skill laboratory during the students’ return demonstration of the skill. A group of instructors used the same checklist to evaluate students’ skills in the laboratory. In addition, these instructors had used the Intramuscular Injection Skill checklist to evaluate students’ skill performance for many years, and no major issues (e.g., different grading standards) had ever been reported.

Both the Intramuscular Injection Knowledge Assessment Scale and the Demographic Questionnaire were pilot tested on 30 students to ensure the assessment scales were understandable for participants. These 30 students were in the same year as study participants but were excluded in the study.

**Intervention**

All participants learned the intramuscular injection-related nursing knowledge and skill in a traditional classroom setting (students belonging to the same cluster stayed in their own classroom). Students in the experimental group then had access to a Web-based course managed by Wisdom Master version 2.4 software. The study’s intervention was the Web-based course management programs. Wisdom Master version 2.4 was purchased from Sun Net Technology Company and installed on the school server. The researcher attended a training course for the Wisdom Master version 2.4 and subsequently designed the Web-based course with support from information technology service personnel with multimedia expertise.

For this study, the teaching of intramuscular injection nursing skill in the classroom was videotaped and audiotaped using a digital camera. The digitized content was edited using Adobe Premiere® software and was uploaded to a password-protected Web site on the school server to be available for the Web-based course. The lecture notes on intramuscular injection-related nursing knowledge presented in classroom were formatted into a PowerPoint® presentation and uploaded to the same Web site. Students in the experimental group were encouraged to access the course Web site. The material showed in the course Web site was exactly as it was covered in class. These students were also able to e-mail, post their questions and comments on the bulletin board, and interact in a chatroom. The instructor and students could respond to each other using all of the communication tools available in the Web-based course. The instructor could also monitor students’ activities in the Web site designer view and prompt students to encourage their involvement. Consequently, for this group, learning was not limited in the classroom: These students were able to control their viewing of the demonstration of the nursing skill, contact others online with questions, and discuss the course content.

**Procedures**

**Preparation and Pretest.** Students were informed by the investigator that joining this study would not affect their academic grades and that they were free to withdraw from the study at any point in time. Only aggregate data would be presented in public. All personal identification information would be kept confidential and would be deleted after the study was completed. Oral consent from students was obtained due to the nature of study (it is culturally acceptable to use only oral consent from Taiwanese students). In addition, students were informed about their freedom to withdraw from the study at any time. The random assignment for control and experimental participants was done by cluster because students within each session were closely learning and living together in the school (i.e., they stayed in the same classroom for most of their courses and lived near each other in the nursing dormitory, which is common in junior nursing college settings in Taiwan). A total of 84 students were assigned to the control group, and 84 were assigned to the experimental group. When the intramuscular injection skill is taught, major concepts such as dosage calculation and injection angle should be discussed; therefore, all students received an initial test on their knowledge of intramuscular injection nursing skill, and this score was used as the baseline of their knowledge for the study. It was not feasible to conduct the pretest on participants’ intramuscular injection nursing skill before they learned the skills. Therefore, the intramuscular injection skill had only posttest scores to compare between the two groups.

**Experiment and Posttest.** All students (both control and experimental groups) were shown the intramuscular injection skill in their own classroom by the same instructor. Students assigned to the experimental group underwent orientation to the Wisdom Master version 2.4 software by the instructor in the computer laboratory. Students were given instructions about how to obtain a login ID and password to access the course Web site.

Online instruction about how to use Wisdom Master version 2.4 was available on the course Web site, and students were free to review this if problems occurred. The researcher monitored students’ activities on the Web-based course. Six weeks after initial classroom lectures, all participants (control and experimental groups) were given a posttest on intramuscular injection skills and knowledge. The Intramuscular Injection Skill test was evaluated by a group of 10 instructors for the entire class of students using the standard Intramuscular Injection Skill Assessment Scale; however, only 147 cases were
used for statistical analysis. Each instructor evaluated 5 students for each cluster independently. These instructors did not have previous knowledge of students’ Web-based course experiences in this study and thus were blind to the experiment.

RESULTS

Four participants in the experimental group and 17 participants in the control group withdrew from the study before the experiment was completed. This resulted in 147 participants comprising the sample used for statistical analysis, for an 88% response rate. Fewer participants in the experimental study withdrew from the study possibly because Web-based teaching is a novel experience for them. Students tend to have greater interest in learning if different teaching strategies are used.

Effects of Knowledge Learning

Normality of the data was tested using the One-Sample Kolmogorov-Smirnov test on the dependent variable which was the differences between pretest and posttest scores. The test statistics was 0.053 (not significant at the 0.05 level), and distribution of the data was normal. The effects on learning intramuscular injection knowledge were determined by comparing pretest and posttest scores on the Intramuscular Injection Knowledge Assessment Scale. The one-group t test was used for the pretest and posttest results within the same study group, and the two-group t test was used to compare scores between the two study groups. Both groups had significant knowledge gain on intramuscular injection knowledge when compared with the pretest and posttest within the same group (Table 2).

When the difference between the two groups of participants was examined to determine the effects of the intervention on the knowledge improvement, the control group had higher average test scores than did the experimental group in both the pretest and the posttest. However, the experimental group had greater increased knowledge on the posttest than did the control group. There was no significant differences on the knowledge gain (posttest minus pretest scores) between groups (t_{138} = 13.9, p > 0.05). Potential confounding variables of grade average in the previous year and knowledge pretest score were examined. Grade average in the previous year was significantly related to the knowledge gain with a Pearson correlation of 0.19 (p < 0.05). The knowledge pretest scores were negatively correlated to the knowledge gain (Pearson r = –0.77, p < 0.00). This means that higher pretest scores were associated with lower knowledge gain. Analysis of covariate (Burns & Grove, 2005) with knowledge pretest scores and grade average in the previous year were used as the covariates to further examine the learning effects between the two groups of participants. Results indicated significant differences on the knowledge gain between the two groups, F(1, 1) = 197.16, p < 0.00. This means that when controlled for the confounding variables, the interventions had positive effects on learning for participants in the experimental group (Table 3).

Learning Effects on Intramuscular Injection Skill

The learning effect of Intramuscular Injection Skill test is shown in Table 4. Because it was not feasible to test participants’ intramuscular injection skill before they learned and practiced it, there were no pretest scores on the Intramuscular Injection Skill test to provide a baseline. Participants in the experimental group had significantly higher posttest scores (5.27 on a 100-point scale) (Table 4) using the two-group t test.

Participation in the Web-Based Course

Students’ participation in the Web-based course were monitored by the study. On average, students watched the intramuscular injection content on the Web 3.2 times, visited the bulletin board 3 times, and posted a message on the bulletin board 1.2 times during the 1.5-month study period (time from pretest of intramuscular injection knowledge to completion of the intramuscular injection skill performance examinations). Student contact with the instructor via e-mail was nominal probably because cultural constraints limited students’ ease in engaging with authority.

DISCUSSION

This study was designed to detect the learning effects of combining a Web-based learning module with classroom lectures. The results showed positive effects on both learning nursing intramuscular injection knowledge and skill when participants had online access to the Web-based course after attending classroom lectures. In this study,
participants in the experimental group viewed the teaching content an average of 3 times. Participants could also submit their comments and questions by e-mail, on the bulletin board, and in the chatroom, and instructors and other students could respond. The learning and teaching activities were not limited to the traditional classroom setting. This result is consistent with the finding of Thiele, Allen, and Stucky (1999) that students were more likely to collaborate with peers and receive timely and useful feedback from faculty when they used the Internet to interact. Use of a Web-based learning tool is especially beneficial for students in Taiwan. Most nursing instructors are required to lead a clinical practicum during the semester. Sometimes this presents difficulties for students in locating their instructors after the classroom lectures. The Web-based course design gives students another method for asking questions to the teacher responsible for the content.

Combining the use of Web-based course management tools with traditional classroom teaching has proven to be effective in teaching nursing skills. However, its execution requires additional time and effort by the faculty, and good technology support is needed to digitize the teaching content and upload the edited learning module to the Web site. Software and hardware support are also important to ensure smooth connections between users. Because the research Web site was available to the experimental group via a high-speed Internet connection throughout the campus and because participants were residing in dormitories with Internet access, few technical problems were encountered during the study period.

The positive reactions from participants were notable, suggesting additional benefit. Students in experimental groups had never used a Web-based course management tool, and they were excited to learn and share their experience with their peers. The instructor was encouraged to make teaching more effective outside of the traditional classroom setting.

Another way to assess the usefulness of a teaching tool would be to evaluate it in terms of principles of education that result in increased student performance (Chickering & Ehrmann, 1996; Chickering & Gamson, 1987). The seven principles for good practice in undergraduate education developed by Chickering and Gamson (1987) were used to benchmark this study.

Educational practices fostered in the experiment group are detailed below, following the seven principles:

- Encourages contact between students and faculty: Taiwanese nursing students are not used to asking questions in the classroom due to fear of authority, large class size, and fear of making mistakes in public. Fewer students contact instructors for answers to questions after class than during class. This study used the available services (e.g., e-mail, chatroom, bulletin board) in the Wisdom Master version 2.4 program to create a less intimidating environment for Taiwanese students to encourage them to ask questions, post their concerns, receive prompt feedback, and facilitate contact with faculty.
- Develops reciprocity and cooperation among students: Encouraging learning among peers was important in this study. The interactions between students and faculty encouraged other students in the group to join the online discussion simply due to peer pressure. The learning process continued even after the classroom lectures were over.
- Uses active learning techniques: The Web-based course gave students the control over when and how often they wanted to view the content. The faculty monitored the involvement of students and gave prompt encouragement and guidance to the slower learners and provided additional resources to the faster learners.
- Gives prompt feedback: In this study, unlike with traditional classroom lectures, students did not have to wait for the next class to obtain feedback. Students used the chatroom for synchronized communication, as well as e-mail and the bulletin board for asynchronous feedback. The faculty logged into the course Web site at least once per day. Students were guaranteed to receive feedback within 24 hours. However, the amount of time for faculty to spend on the Web-based course management needed to be monitored and more support was needed for faculty who maintained the Web-based course.
- Emphasizes time on task: It is normal for nursing students to procrastinate and not study until the week before term examinations. With the Web-based course, those students who took time to study and post questions on the

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<th>TABLE 3</th>
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<tr>
<td>Comparing Model-Estimated Marginal Means</td>
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<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>Experimental</td>
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<tr>
<td>Control</td>
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<table>
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<th>TABLE 4</th>
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<tr>
<td>Two-Group Posttest on Intramuscular Injection Skills</td>
</tr>
<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>Experimental</td>
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<td>Control</td>
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Communicates high expectations: In traditional classroom teaching, teachers concentrate their efforts in classroom presentation and teaching content. However, teachers’ motivation is important to those students who are poorly prepared, to those unwilling to exert themselves, and to those who are bright and well motivated. The Web-based course creates a convenient environment for faculty to express their high expectations to students, and students have greater means to improve their performance and meet instructor expectations.

- Respects diverse talents and ways of learning: The Wisdom Master version 2.4 program allowed the contents to be presented in text, video, and audio formats. This is helpful for students who have difficulty quickly absorbing abstract concepts or writing down important notes. Being able to log in to the Web-based course site and review course content on demand ameliorates these problems by providing another chance for students to learn and overcome learning problems by themselves.

LIMITATIONS

Because all participants were from one nursing school in Taiwan where students take the same classes and learn, study, and live in the same environment (classrooms and dormitories), the results of this study may have limited generalizability. At the same time, the uniform circumstances of the participants limited variability of many lifestyle factors that may affect learning. The environment did affect the experimental design. To keep participants in the control group from learning about the experiment, the assignment of participants was done by cluster instead of individually. The effect of learning from the study may not accurately reflect differences among individual participants. Skill evaluation was conducted by one evaluator per student, so individual differences in subjective evaluation of skill performance could contribute to the score differences observed, although a standardized checklist was used. Finally, the small sample size may not have enough power to detect the difference of learning effect between groups.

IMPLICATIONS

The proposed method has various implications for the nursing profession. This method can be applied to teaching different nursing education content at different levels. Instructors from entry level, advanced, and continuing nursing education courses can use Web-based courses to bridge the distance between students and teaching facilities. The flexibility of a Web-based course tool provides a new way of teaching and learning for students in a conservative culture. The cost effectiveness of using a Web-based course to teach nursing skills should be studied in the future. In addition, the learning outcomes of the length of time spent in the Web-based supplemental tool should be further investigated.

CONCLUSION

The effect of combining traditional classroom teaching with a Web-based course tool was tested in a group of second-year students in a nursing program in Taiwan. Results showed that the Web-based course tool was an effective supplement for gaining nursing knowledge related to and the skill of intramuscular injection. Because nursing education is skill based as well as knowledge based, this practice promises benefit across nursing education. Replication of the method in different nursing programs and different nursing schools would increase the generalizability of the study.

REFERENCES


