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The effect of computer-assisted learning versus conventional teaching methods on the acquisition and retention of handwashing theory and skills in pre-qualification nursing students: A randomised controlled trial

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ABSTRACT

Background: High quality health care demands a nursing workforce with sound clinical skills. However, the clinical competency of newly qualified nurses continues to stimulate debate about the adequacy of current methods of clinical skills education and emphasises the need for innovative teaching strategies. Despite the increasing use of e-learning within nurse education, evidence to support its use for clinical skills teaching is limited and inconclusive.

Objectives: This study tested whether nursing students could learn and retain the theory and skill of handwashing more effectively when taught using computer-assisted learning compared with conventional face-to-face methods.

Design: The study employed a two group randomised controlled design. The intervention group used an interactive, multimedia, self-directed computer-assisted learning module. The control group was taught by an experienced lecturer in a clinical skills room. Data were collected over a 5-month period between October 2004 and February 2005. Knowledge was tested at four time points and handwashing skills were assessed twice.

Setting and participants: Two-hundred and forty-two first year nursing students of mixed gender; age; educational background and first language studying at one British university were recruited to the study. Participant attrition increased during the study.

Results: Knowledge scores increased significantly from baseline in both groups and no significant differences were detected between the scores of the two groups. Skill performance scores were similar in both groups at the 2-week follow-up with significant differences emerging at the 8-week follow-up in favour of the intervention group, however, this finding must be interpreted with caution in light of sample size and attrition rates.

Conclusion: The computer-assisted learning module was an effective strategy for teaching both the theory and practice of handwashing to nursing students and in this study was found to be at least as effective as conventional face-to-face teaching methods.

What is already known about the topic?

- Computer-assisted learning (CAL), a type of e-learning, has been used within nursing education since the early 1960s, yet there is limited conclusive evidence attesting to its effectiveness for teaching clinical skills.

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- Supporters of e-learning champion its use for greater flexibility, learner autonomy and cost and time efficiency.
- Most research addresses the use of e-learning for cognitive gain with few studies investigating its role in clinical skills education and training.

What this paper adds

- In this trial CAL was found to be effective when used to teach both the theory and skill of handwashing knowledge to a sample of first year nursing students.
- This study adds to the small but growing body of knowledge which has demonstrated that e-learning is as effective as conventional teaching methods for teaching clinical skills.

1. Introduction

The acquisition of clinical skills is an essential part of learning to be a nurse and a lack of clinical skills competency can compromise patient care and safety. Debate persists about the standards of skill proficiency in newly qualified nurses and the adequacy of conventional teaching methods. Face-to-face lectures and skill demonstrations have traditionally been used to teach clinical skills to pre-qualification students. These sessions typically occur in a clinical laboratory or skills classroom and usually involve the demonstration of a skill followed by an opportunity for rehearsal. It is an expectation that further supervised practice undertaken within the clinical environment will consolidate skill acquisition.

Although conventional teaching methods have been espoused for providing an opportunity for students to learn directly from subject experts (Jeffries et al., 2002), such methods can lack flexibility, do not ensure teaching consistency nor accommodate the diverse learning needs of students (Jeffries, 2001). Furthermore, in recent years, the demands of caring for increasingly acutely ill patients, shorter hospital stays and staffing shortages have curtailed teaching opportunities in many clinical areas, potentially limiting the support available for nursing students to learn in practice. Collectively, these issues have compelled nurse educators to seek alternative methods of clinical skill instruction.

e-Learning has been described as: "learning facilitated and supported through the use of information and communications technology" (Joint Information Systems Committee, 2003) and is a term that is widely evident throughout the literature. This descriptor can be applied to a considerably broad spectrum of technologically enhanced learning strategies potentially causing confusion and ambiguity. For the purpose of this study, the less general term "computer-assisted learning" (CAL) was employed and refers specifically to the use of a computer-based teaching module.

The use of computers in nurse education is not new and studies of CAL have been reported in the nursing literature since the mid 1960s (Bitzer, 1966). e-Learning has been championed for its capacity to individualise learning by de-centralising the teaching process and facilitating learner independence and self-direction (Greenhalgh, 2001). Other recognised benefits include: flexibility and the promotion of active learning (Tegtemeyer et al., 2001), improvements in student motivation and satisfaction (Gleydura et al., 1995), cost efficiency and reductions in instructional time (Jeffries, 2001), consistency of educational delivery (Jeffries, 2001) and accessibility to information available via the World Wide Web (Washer, 2001). It has also been endorsed for its role in the development of students' computer skills and confidence (Leasure et al., 2000).

While a number of nursing studies have compared the effects of CAL with conventional teaching methods on knowledge acquisition (Lewis et al., 2001), considerably fewer have investigated its role in clinical skills education. Of particular note is the lack of published research investigating the effect of CAL on the retention of clinical skills and knowledge. Bloomfield et al. (2008) examined 12 papers in an integrative review of papers published between 1997 and 2006 comparing the effectiveness of CAL with conventional methods for clinical skills education in nursing. The majority of studies originated from the United States of America and employed a randomised experimental or quasi-experimental design comparing CAL with conventional teaching methods such as lecture, demonstration, tutorials or printed materials.

The studies involved a variety of clinical skills including oral medication administration (Jeffries, 2001; Schneider et al., 2006); intravenous therapy administration (DeAmicis, 1997; Tsai et al., 2004); blood pressure measurement (Bauer and Huynh, 1998; Beeson and Kring, 1999; Bauer et al., 2001); electrocardiography (Jeffries et al., 2003; Jang et al., 2005); cardiotography (Wilson and Mires, 1998) and the San-Yin-Jio pressure procedure (Kim et al., 2003). Outcomes measures typically involved the evaluation of skill performance using structured checklists. In some studies, theoretical knowledge was also tested using multiple-choice tests.

Overall, generally positive findings were reported. Studies by DeAmicis (1997), Bauer and Huynh (1998), Kim et al. (2003), Jang et al. (2005) and Schneider et al. (2006) reported higher skill performance scores for students who used CAL when compared to conventional methods, however, statistically significant differences ($p > 0.01$) were found in only three studies. Equivalent skill performance scores were reported in three studies (Beeson and Kring, 1999; Jeffries, 2001; Jeffries et al., 2003) while lower scores were associated with CAL in two of the reviewed studies (Wilson and Mires, 1998; Bauer et al., 2001). Notably, with the exception of a study by Tsai et al. (2004), none of the reviewed studies tested knowledge or skill retention, and this remains a fundamental gap in the literature. Furthermore, a number of these studies were flawed by a lack of rigor indicating the need for more robust research designs.

Handwashing is an essential skill for all nurses and healthcare staff and is crucial not only for basic hygiene, safety and patient care but also for the prevention of potentially fatal hospital acquired infections (ICNA, 2002; RCN, 2003). As such, it is imperative that nursing students

are taught handwashing effectively using methods that ensure both skill proficiency and a sound understanding of the underlying theoretical principles. While previous studies have investigated handwashing from the perspectives such as technique and rates of compliance (Pittet et al., 2000; Naikoba and Hayward, 2001), there is considerably less empirical evidence pertaining to methods by which it is taught. This paper reports on a randomised controlled trial conducted to compare a self-directed CAL module, with conventional methods for handwashing education.

2. Methods

2.1. Aim

The primary aim of the study was to compare the effects of a self-directed CAL module with conventional face-to-face classroom teaching on the acquisition and retention of handwashing skills and knowledge. The hypotheses were:

1. There would be no difference between the knowledge test scores of nursing students taught the theory of handwashing using CAL when compared with those taught using conventional methods.
2. There would be no difference in the handwashing skill performance scores of nursing students taught using CAL when compared with those taught using conventional methods.
3. There would be no difference in the retention of handwashing knowledge and skills in nursing students taught handwashing using CAL when compared with those taught by conventional methods.

2.2. Participants

Study participants were recruited from a total population of first year nursing students ($n = 420$) enrolled in the Common Foundation Programme of a 3-year pre-qualification undergraduate nursing programme at a university in London. A formal sample size calculation was not undertaken due to a lack of information from previous studies however, strenuous efforts were made to recruit the largest possible sample. Recruitment took place on two occasions prior to a lecture at which all students in the sample population were required to attend. Information about the study was provided which included an explanation of the purpose and design of the study and what participation would involve. The inclusion criterion for entry to the study was the ability to use a computer. An information sheet was distributed and students were asked to return a signed consent form if they chose to participate. Subsequently, a total of 245 students (58%) of mixed gender, age, educational background; first language; and computer experience provided written consent to participate in the study.

Participation was voluntary and students were informed that the assessments were formative and that results would not contribute to their grades or affect their academic progress. Ethical approval was obtained from the university ethics committee prior to recruitment and each participant was issued with a unique code that was used on all written data to ensure anonymity.

2.3. Design

The study employed a randomised controlled design. After recruitment, participants were sequentially allocated a number which became their unique code. A computerised random number generator was then used to assign participants to the intervention (CAL) or control (conventional teaching method) group using these codes. Assignment to study groups was, therefore, concealed until after all participants had been recruited. Blinding of participants to study groups was not possible and the information about group assignment was communicated to all participants via a group e-mail.

Data were collected at four time points during the study between October 2004 and February 2005. Baseline data, generated from a participant questionnaire and a handwashing knowledge test, were collected from all participants immediately prior to the teaching intervention. The knowledge test was repeated immediately following the teaching session (immediate follow-up); 2 weeks later (2-week follow-up) and a further 8 weeks later (8-week follow-up). Handwashing skills were assessed at both the 2-week follow-up and the 8-week follow-up. The study design is depicted in Fig. 1.

2.4. Teaching interventions

Two teaching methods were compared. Both were of 90-min duration and were designed to facilitate the acquisition of handwashing skills and knowledge in the context of nursing practice. Up-to-date literature and policies were drawn on to ensure that content was relevant and reflected current recommended practice (DoH, 2001; ICNA, 2002; RCN, 2003). All content and teaching resources, including a custom-made video depicting a demonstration of the recommended six-step handwashing technique (Ayliffe et al., 1978), were subjected to expert review and were piloted prior to the main study.

2.4.1. Conventional face-to-face lecture and demonstration

Participants in the control group ($n = 113$) were taught in an on-campus clinical skills room by one of a small team of experienced nurse lecturers. A standardised teaching pack was used which contained: a set of lecture notes; a set of black and white overhead transparency slides; the handwashing demonstration video; and a list of additional reference material. Following a short lecturer-led presentation, participants watched the video and were then offered the opportunity to practice the recommended handwashing technique. Any questions about the subject matter which arose during the session were answered by the lecturer.

2.4.2. The CAL module

Participants in the experimental group ($n = 118$) worked independently through a self-directed CAL module via an individual computer terminal in an on-campus computer-room. The module was purposefully developed

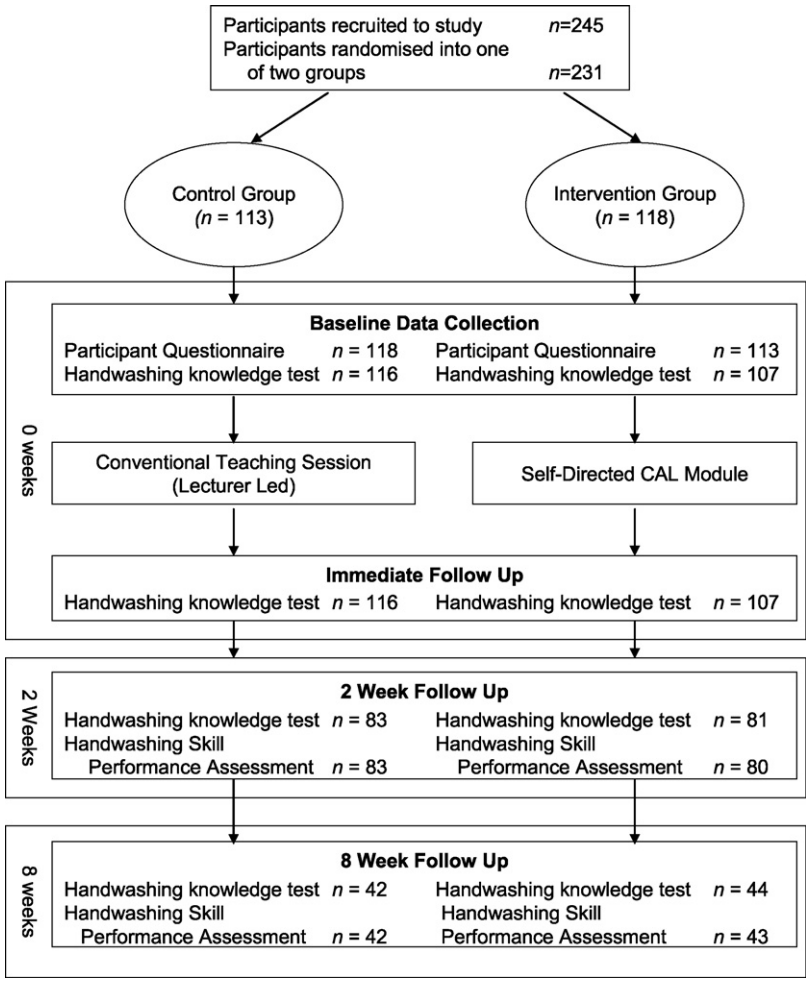

Fig. 1. Study design and sample size.

for the study with the assistance of a learning technologist and had been tested during the pilot study. The theoretical content was identical to that of the conventional teaching session and interactive activities; animated multimedia, high quality photographs and links to relevant websites were also included to stimulate interest and promote learner engagement. The handwashing demonstration video was embedded within the module and could be viewed by participants as required. After a brief orientation to navigational features, participants were instructed to work through the module independently for the duration of the session.

2.5. Outcome measures

2.5.1. Knowledge gain

Baseline knowledge and knowledge gain was measured using a purposefully developed paper and pencil multiple-choice test that consisted of 20 questions. Each had four responses from which the participants were required to choose one correct answer. Tests were positively marked with one mark awarded for each correct response, yielding a total maximum score of 20. Test–retest reliability was assessed using a group of first year nursing students ($n = 38$) who were also enrolled in the undergraduate nurse programme at the study site but were not involved in the main study. These students completed the test on 2 occasions, 2 weeks apart. Scores were analysed and a Spearman's rho correlation co-efficient of 0.78 indicated adequate stability.

2.5.2. Handwashing skill performance

The ability to perform the recommended handwashing procedure was tested under Objective Structured Clinical Examination (OSCE) style conditions by trained examiners, blinded to group assignment. Each participant was assessed individually by an examiner in a clinical room using a 17-item skill performance checklist. A numerical system was used to determine scores. Two marks were allocated to each of the eight items that involved two hands, such as washing the thumbs, and one mark was assigned to each of the remaining 11 items. This enabled a total maximum score of 25 marks. The assessment tool had originally been developed as a 13-item checklist at another British university and had been used extensively to test the handwashing competency of nursing students at that

institution. After permission for its use had been obtained, the checklist was amended with the addition of four items to enhance its comprehensiveness. To ensure content validity the checklist was subject to expert review. It also underwent extensive field testing during the pilot study and no modifications were required.

A small team of lecturers who assessed handwashing performance received instruction in the use of the tool and were blinded to the participants' group assignment. Inter-rater reliability was determined using a technique in which the investigator assumed the role of expert rater and co-rated a minimum of three participants with each assessor. Scores were compared and any discrepancies were discussed before a final score was agreed upon. A simple calculation, based on the number of agreed items ticked by both assessors, compared with the total number of agreements possible was used to further verify reliability between the raters. Values of 0.80 or above were calculated, which indicated an acceptable level of inter-rater reliability.

3. Analysis

Data analysis was carried out according to a pre-established analysis plan using the SPSS (version 14) statistical software package. Expert advice was sought from an experienced statistician throughout the data analysis process. Statistical tests of a non-parametric nature were employed and a conventional level of significance of 0.05 was used to detect differences. Chi-squared analysis was used to test for differences in the demographic characteristics of participants in the two study groups. The Mann–Whitney *U*-test was used to check for significant differences in the handwashing knowledge test scores between the control group and the intervention group at each phase of the study and was also used to compare the handwashing skill performance assessment scores. The Wilcoxon signed ranks test was used to compare scores from the handwashing knowledge test achieved by the participants at different points in the study.

4. Findings

Of the 245 students who consented to participate in the study, 14 withdrew prior to the first phase of data collection due to undisclosed reasons. Baseline data were collected from 231 participants, however, attrition increased thereafter and 145 participants had withdrawn before the 8-week follow-up. Reasons for withdrawal from the study were not analysed as many participants who withdrew exercised their ethical right to do so without providing a reason. The small number of participants who did explain their withdrawal from the study identified conflicting commitments, personal issues and time pressures.

4.1. Comparability of participant attributes

There was diversity among the 231 students who completed the baseline questionnaire with variations reported in relation to: age, gender, first language and educational background. Participants were aged between 17 and 55 years, with the largest number belonging to the 18-year age group. Most participants were female (84%, $n = 193$) and 69% ($n = 152$) reported English as their first language. Mixed educational backgrounds were represented including: GCSE (11%, $n = 24$); National Vocational Certificate (14%, $n = 29$); Higher National Certificate including A-levels (36%, $n = 78$); Diploma (9%, $n = 19$); and first degree or above (10%, $n = 22$).

Most participants reported previous experience with computers (range 2 months to 19 years) with the majority rating their ability to use a computer as either "good" (53%, $n = 116$) or "fair" (37%, $n = 81$). Many (68%, $n = 150$) of participants reported that they had never used CAL before. Just under half the participants (45%, $n = 99$) reported that they had previously been employed in a post that required handwashing. Most of these ($n = 73$) reported this to be that of a health care assistant.

Chi-square analysis revealed no significant differences ($p > 0.05$) when participant characteristics were compared between the study groups at baseline, at the 2-week follow-up or at the 8-week follow-up.

4.2. Handwashing knowledge test scores

Scores from the 223 participants who completed the baseline handwashing knowledge test ranged from 0 to 16 (median 9). When these scores were compared between the study groups, no significant differences emerged ($U = 6135$, $p = 0.753$). Significantly higher scores were achieved at the immediate follow-up ($Z = -12.235$, $n = 222$, $p < 0.000$) and both groups scored a median of 14. No significant differences were detected when the test scores were compared between the intervention and control group ($U = 5951$, $p = 0.578$). Likewise, handwashing knowledge scores at the 2-week follow-up were significantly higher than at baseline ($Z = -10.024$, $n = 164$, $p < 0.000$). Both the intervention group ($n = 83$) and the control group ($n = 81$) achieved a median score of 13 with no significant differences detected between the groups ($U = 3324$, $p = 0.149$).

Fewer participants ($n = 86$) completed the handwashing knowledge test at the 8-week follow-up and no significant differences ($U = 828$, $p = 0.201$) were detected when the scores of the intervention ($n = 42$) and control group were compared ($n = 44$). Both groups achieved a median score of 13. Similarly, Time 3 scores were significantly higher than the baseline scores ($Z = -7.166$, $n = 86$, $p < 0.000$). These results are summarised in Table 1.

4.3. Handwashing skill performance scores

The handwashing skills of 163 participants were assessed at the 2-week follow-up and 85 participants were tested again at the 8-week follow-up. At the 2-week follow-up the median score for participants in the both the control group ($n = 83$) and the intervention group ($n = 80$) was 22. Analysis found no significant differences when the scores for the two groups were compared ($U = 3077$, $p = 0.415$). At the later follow-up (week 8) the scores

Table 1
Comparison of handwashing knowledge test scores between study groups.

Study phase	Intervention group	Range	Median	Mann–Whitney *U*-test
Baseline	Intervention ($n = 116$)	2–16	9	$U = 6135$
	Control ($n = 107$)	0–16	9	$p = 0.753$
Immediate follow-up	Intervention ($n = 115$)	7–19	14	$U = 5951$
	Control ($n = 107$)	6–19	14	$p = 0.578$
2-Week follow-up	Intervention ($n = 83$)	4–18	13	$U = 3324$
	Control ($n = 81$)	3–19	13	$p = 0.149$
8-Week follow-up	Intervention ($n = 42$)	8–17	13	$U = 828$
	Control ($n = 44$)	5–17	13	$p = 0.201$

NS: $p > 0.05$.

Table 2
Comparison of Time 2 and Time 3 handwashing skill performance assessment scores.

Assessment episode	Group	Range	Median	Mann–Whitney *U*-test
2-Week follow-up	Intervention ($n = 83$)	9–25	23	$U = 3077$
	Control ($n = 80$)	2–25	22	$p = 0.415$
8-Week follow-up	Intervention ($n = 42$)	18–25	23	$U = 649.5$
	Control ($n = 43$)	13–25	22	$p = 0.024$

NS: $p > 0.05$.

differed significantly ($U = 649.5$, $p = 0.024$). The intervention group ($n = 42$) achieved a significantly higher median score of 23 compared with a median of 22 for the control group ($n = 43$). These findings are summarised in Table 2.

4.4. Handwashing knowledge and skill retention

When the differences in the handwashing knowledge test scores achieved at the immediate and 2-week follow-up were analysed, neither the intervention group ($n = 81$) nor the control group ($n = 77$) showed any change in median scores. Furthermore, when changes in the median scores were compared between the immediate and 8-week follow-up a decrease of 1 mark was evident for both the groups. Likewise, a decrease in the median scores was identified for both the groups when median scores for the 2- and 8-week follow-up were compared. No significant differences between the groups were found at any point in this analysis. A summary of these findings, including the changes in scores, is presented in Table 3.

For both groups, the difference in the handwashing skill performance assessment scores achieved at the 2-week follow-up and the 8-week follow-up was not large enough to achieve statistical significance ($Z = -1.868$, $p = 0.136$). Furthermore, analysis revealed no significant differences in the changes in handwashing skill performance scores from Time 2 to Time 3 when the two groups were compared ($U = 693.5$, $p = 0.171$).

4.5. Assessment for potential bias related to participant attrition

The high rate of participant attrition throughout the study necessitated further analysis of data generated from the handwashing knowledge test and the skill performance assessments to assess for the potential of bias. As such, the scores achieved on the immediate follow-up knowledge test were compared between those participants who dropped out of the study prior to the 2-week follow-up (median 13) and those who did not (median 14). No significant differences were detected in theses scores ($U = 4792.5$, $p = 0.221$).

A further 78 participants withdrew from the study before the final (8 weeks) follow-up. Subsequently, the 2-week follow-up knowledge test scores of participants who continued in the study (median 13) were compared with those who dropped out of the study after completing this

Table 3
Increases in knowledge test scores for the control and intervention group.

Study phase	Group	Increases in median scores	Mann–Whitney *U*-test
Immediate to 2-week follow-up	Intervention ($n = 81$)	0.0	$U = 6566.0$
	Control ($n = 77$)	0.0	$p = 0.784$
Immediate to 8-week follow-up	Intervention ($n = 42$)	−1.0	$U = 802.5$
	Control ($n = 41$)	−1.0	$p = 0.747$
2–8-Week follow-up	Intervention ($n = 41$)	−1.0	$U = 845.0$
	Control ($n = 42$)	−0.5	$p = 0.509$

NS: $p > 0.05$.

test (median 13). Again no significant differences were found ($U = 3002.5$, $p = 0.286$).

Handwashing knowledge test scores were also compared between study drop-outs and non-drop-outs within the intervention and control groups. Scores for the intervention group revealed no significant difference between the study drop-outs (median 13.5) and non-drop-outs (median 14) at the immediate follow-up ($U = 1344$, $p = 0.290$) or at the 2-week follow-up ($U = 733$, $p = 0.239$).

Similarly, when the knowledge test scores (immediate follow-up) for the control group were compared no significant differences ($U = 1047.5$, $p = 0.514$) were detected between the study drop-outs (median 13) and non-drop-outs (median 14). Comparison of the test scores at the 2-week follow-up also revealed no significant differences ($U = 760.5$, $p = 0.705$).

Furthermore, no significant differences were detected ($U = 3004$, $p = 0.420$) when the handwashing skill assessment scores achieved at the 2-week follow-up were compared between those participants (median 23) who dropped out of the study before the final 8-week follow-up and those that did not (median 22). Again, these scores were also compared according to group. For the intervention group, findings revealed no significant difference between scores achieved by study drop-outs (median 23) and those who did not (median 22) ($U = 774$, $p = 0.536$). Likewise, no significant difference ($U = 733.5$, $p = 0.645$) were detected between drop-outs (median 22) and non-drop-outs (median 22) in the control group.

5. Discussion

The goal of this study was to compare the effects of CAL versus conventional teaching methods on the acquisition and retention of handwashing knowledge and skills. The findings support the use of a self-directed CAL module as an alternative to a face-to-face teaching session. This finding is similar to those from earlier studies reported in the nursing literature that found inconclusive evidence to support the superiority of one method over another (DeAmicis, 1997; Beeson and Kring, 1999; Jeffries et al., 2003).

Both teaching methods resulted in knowledge gains. This was not unexpected, especially at the immediate follow-up, given the short interval of time between the teaching intervention and the test. The knowledge scores of both groups at both the 2- and 8-week follow-up also revealed improvements when compared with baseline scores. These findings suggest cognitive gain and knowledge retention and the similarity in the scores of both groups implies that in this study the participants' capacity to learn the theory of handwashing was not influenced by the method by which it was taught.

Handwashing skill performance, when first assessed, was variable across the sample, however, relatively high median scores (22) were evident. This may have been attributable to the nature of handwashing as a motor skill. Gagne (1985), who emphasised the importance of both internal and external factors to motor skill development, also identified the influence of previously learned skills in this process. Known as "part skills", these are recalled and integrated as the new skill develops (Gagne, 1985). Handwashing, in the context of nursing practice, is not a technically complex skill and comprises many of the fundamental motor components that are required for handwashing in other situations. It is also likely that most participants would have learned how to wash their hands in the social context and were familiar and well-rehearsed in many of the component motor actions required for the recommended handwashing technique.

The higher level of skill demonstrated by both groups at the 8-week follow-up may be explained by greater familiarity, hence less anxiety, of participants with the assessment procedure. Furthermore, this assessment was conducted after the participants had completed their first practice placement in the healthcare setting. Working in an environment where regular handwashing was required would have provided opportunities to practice and refine handwashing skills, potentially increasing proficiency.

The significantly higher handwashing skill performance scores achieved by the intervention group at the 8-week follow-up may have been influenced by the opportunity participants had to self-direct their own learning experiences. Being able to focus on specific aspects of the learning materials and watch the handwashing video more than once may have reinforced key elements of the handwashing procedure, thereby enhancing skill development and retention. This is supported by Bauer and Huynh (1998), who investigated the effectiveness of CAL for the acquisition of blood pressure measurement skills.

6. Limitations

The major limitation of this study is the high rate of participant attrition which, despite the initial large sample size, increased as the study progressed. This had the considerable potential to introduce bias, which may have influenced the findings. However, comparisons of data collected from participants who withdrew from the study before it was completed and those who did not, suggest that this was unlikely. Nevertheless, the sample size at Time 3 was below that necessary for the achievement of statistical power. Therefore, findings from this phase of the study must be interpreted with caution, and future research is recommended with a larger sample to investigate the effect CAL on clinical skill retention further. Furthermore, as participation in the study was voluntary, data collection sessions were additional to scheduled classes. It is likely that this contributed to participant attrition thus the timing of data collection must be taken into account when designing future studies.

Despite this limitation, the strength of this study lies in the use of a rigorous trial design that addressed many of the flaws evident in previous research.

7. Conclusion

Clinical skills proficiency underpins all nursing practice and the acquisition of clinical skills, informed by relevant theoretical knowledge, represents a crucial element in the process of learning to be a good nurse. It is essential that the most effective strategies are employed for clinical skills education and that these are supported by current

research. While the major findings of this study confirm previous research in demonstrating equivalency between CAL and conventional teaching methods, this is in itself a valuable finding. Given the ongoing debate about clinical skills education, and the increasing use of e-learning within education, the findings are timely and provide evidence that CAL is at least as effective as conventional methods when used to teach handwashing. While further research is required to investigate the application of CAL to a wider variety of clinical skills, the study findings provide impetus to look beyond conventional skills teaching practices to more innovative, flexible methods.

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