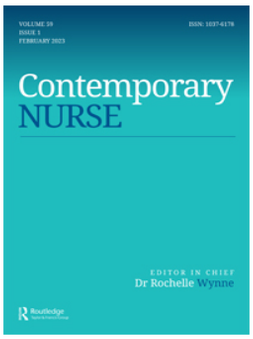

Contemporary Nurse

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rcnj20

Measuring perceived learning gains of undergraduate nursing students in ICT skills: One group pre-test and post-test design

Alexis Harerimana, Sinegugu Evidence Duma & Ntombifikile Gloria Mtshali

To cite this article: Alexis Harerimana, Sinegugu Evidence Duma & Ntombifikile Gloria Mtshali (2023): Measuring perceived learning gains of undergraduate nursing students in ICT skills: One group pre-test and post-test design, Contemporary Nurse, DOI: 10.1080/10376178.2023.2230309

To link to this article: https://doi.org/10.1080/10376178.2023.2230309

Published online: 06 Jul 2023.

Contemporary Nurse, 2023
https://doi.org/10.1080/10376178.2023.2230309

Measuring perceived learning gains of undergraduate nursing students in ICT skills: One group pre-test and post-test design

Alexis Harerimana[a,b]*, Sinegugu Evidence Duma[b] and Ntombifikile Gloria Mtshali[b]

[a]*Nursing and Midwifery, College of Healthcare Sciences, James Cook University, Townsville, Australia;* [b]*Nursing and Public Health, College of Health Sciences, University of KwaZulu-Natal, Durban, South Africa*

(*Received 22 January 2022; accepted 22 June 2023*)

Purpose: This study aimed to measure learning gains during an ICT training intervention in first-year students completing a four-year undergraduate nursing degree.
Methodology: This study adopted a quasi-experimental, one group pre-test and post-test design. The intervention effectiveness was measured using individual single-student normalised gains, g; class average normalised gain, ⟨g⟩; and average single-student normalised gain, g(ave).
Results: In this study, the class average normalised gains, ⟨g⟩ ranged from 34.4% to 58.2%, and the average of single student normalised gains, g(ave) ranged from 32.4% to 50.7%. The overall class average normalised gain ⟨g⟩ was 44.8%, and the average of the single student normalised gain was 44.5%, with 68% of students having a normalised gain of 30% and above, indicating that the intervention was effective.
Conclusion: Similar interventions and measurements are recommended to all health professional students during their first academic year to pave a foundation for ICT usage for academic purposes.

Keywords: digital literacy; ICT skills; learning gains; nursing students; pre-test and post-test; technology

Impact statement

Providing ICT capacity-building interventions at entry level in undergraduate nursing programmes improves students' ability to use technology for academic and professional purposes.

Plain language summary (PLS)

Students entering universities have limited skills in using technology for learning purposes. At the entry level, improving students' knowledge and skills in basic technology skills is fundamental to their academic success and future careers. This study evaluated the success of the intervention where first-year nursing students were trained in basic technology skills, including operating the computer, typing and writing using a word processor and PowerPoint, effective electronic

*Corresponding author. Email: alexis.harerimana@my.jcu.edu.au
This article has been corrected with minor changes. These changes do not impact the academic content of the article.

communication using e-mails and social media, online learning platforms, and access to electronic devices and internet on-and-off campus. The results indicated that 68% of first-year nursing students improved their knowledge and skills in using technology following the intervention. Similar training interventions should be extended to all health professional students during their first academic year.

1. Background

Technology is transforming nursing into a digitally enabled profession (Booth et al., 2021; Essel et al., 2020; Harerimana & Mtshali, 2020; Laukka et al., 2023; Lee et al., 2019; Männistö et al., 2020; WHO, 2020). The use of technologies in health care system, such as digital health, telemedicine, mobile health, big data, and electronic health records, has become a driving force in responding to a global health crisis caused by Covid-19 (Adams & Walls, 2020; Booth et al., 2021; Portnoy et al., 2020; Shruti et al., 2023; Tebeje & Klein, 2021; Ting et al., 2020; Zhou et al., 2020). The use of technology in nursing education and practice requires a certain level of digital literacy (Brown, Morgan, et al., 2020; Holt et al., 2020; Kennedy & Yaldren, 2017; Reid et al., 2023). Therefore, assessing and enhancing nursing students' digital literacy, particularly entry level, is essential given the need for nursing graduates to competently use technology in the dynamic clinical environment (Harerimana & Mtshali, 2019; Kleib et al., 2021; Swaminathan et al., 2021).

Globally, there is a call to educate nurses to be digitally competent to work in technology-mediated healthcare settings (Cummings et al., 2016; Harerimana et al., 2021, 2022; Honey et al., 2020; Veikkolainen et al., 2023). In Australia, Canada and the United States of America, nursing schools are required to provide evidence that informatics is integrated into undergraduate programme curriculum in order to be accredited (Cummings et al., 2016; Harerimana et al., 2022; Hübner et al., 2018; Mather et al., 2018). However, teaching technology in undergraduate nursing schools is in its early stages in Africa (Achampong, 2017; Elewa & El Guindy, 2017; Harerimana et al., 2021).

Developing students' skills and confidence to use technology in education can be achieved through capacity building programmes, effective mentoring and facilitation (Botma et al., 2013; Harerimana & Mtshali, 2021; Lee et al., 2019; Singh & Masango, 2020; Sykes et al., 2014; WHO, 2020). Hough (2019) assessed the basic computer skills – in Californian Community Colleges designated as Hispanic Serving Institutions (HSIs) – and he found that incoming students' skills included: learning software for Word processing (Microsoft Word®), presentations and speeches (Microsoft PowerPoint®), preparing spreadsheets to prepare charts and graphs (Excel®), navigating internet for research and using platforms for online learning and participation. In nursing education, teaching students information and communication technology (ICT) literacy should go beyond basic computer skills and also focus on digital health competencies. Technology Informatics guiding reforms (TIGER), Australian Nursing and Midwifery Federation (ANMF), and Canadian Associations of Schools of Nursing (CASN) provided frameworks for informatics competencies and standards in nursing with an emphasis on computer literacy, information literacy and information management (ANMF, 2015; Borycki & Foster, 2014; Hübner et al., 2018).

ICT skills are crucial for nursing students' success during their academic training and future careers (Gonen et al., 2016; Hallila et al., 2014; Harerimana & Mtshali, 2018; Honey et al., 2020; Nagle et al., 2014). The use of technology in clinical practice has been associated with the provision of quality care, proper documentation, tracking data overtime reduction of medical errors, patient safety, continuity of care, improved care coordination, clinical decision support and evidence-based practice (Alotaibi & Federico, 2017; Booth et al., 2021; Falconer et al., 2018; Swan

et al., 2019). Although the benefits of technology in nursing practice and education have been documented, and there are increasingly frameworks and standards for teaching ICT literacy in undergraduate nursing programmes, many schools do not adhere to the required informatics standards (Forman et al., 2020; Harerimana et al., 2022).

The literature indicates a general assumption that students entering universities and colleges have basic ICT skills, with expectations that they will be technology ready (Harerimana et al., 2022; Hough, 2019; Jenkins et al., 2018). These assumptions result in higher learning institutions such as universities and nursing colleges neglecting the need to conduct ICT skills assessment at entry level, thus leading to inadequate support to address their many and varied requirements (Hough, 2019). Other factors hindering the integration of technology in education, include poor ICT literacy, lack of relevant ICT standards and a framework, resistance to change, lack of awareness and negative attitudes towards ICT, lack of administrative and technical end-user support, and lack of informatics competency assessment (Forman et al., 2020; Harerimana & Mtshali, 2018, 2019; Harerimana et al., 2022; Nwozichi et al., 2019; Staddon, 2020).

Studies have shown that South African secondary schools do not have adequate ICT infrastructure, and students have limited access to computers and trained personnel to teach them ICT literacy (Fares et al., 2021; Padayachee, 2017). Those challenges significantly impact students entering tertiary institutions, as they are not well prepared to use technology. At the beginning of tertiary education, institutions must assess students' knowledge and skills to use technology and devise adequate strategies to uplift their informatics competencies (Røsvik & Haukedal, 2017; Terkes et al., 2019). The purpose of this study was to measure learning gains during an ICT training intervention in first-year students completing a four-year undergraduate nursing degree in a public tertiary institution in South Africa. This study was built on University foundations provided during first-year students' orientation. It was, however, more intense, focused on assessing ICT skills of students and, as such, providing an opportunity for capacity building.

2. Methods

2.1. *Design*

A single group, quasi-experimental pre-test, post-test design was used to measure the effect of an ICT training intervention in first-year undergraduate nursing students. According to Harris et al. (2006), quasi-experimental designs are common in medical informatics literature. One group pre-test and post-test designs do not require a large sample size and are an alternative analytical method when randomisation in a small sample is not feasible (Harris et al., 2006).

2.2. *Population, recruitment & sampling*

The research setting was a public tertiary teaching institution in a metropolitan area in South Africa. The training of nursing students was offered at one of university's five campuses. In 2019 approximately 600 students were enrolled in a 4-year undergraduate nursing programme. A convenience sample that included all first-year nursing students (n = 82) registered in the 2019 academic year, was the population of interest. Students were recruited to participate in the study following ethical approval by the Humanities & Social Sciences Research Ethics Committee (HSSREC) from the University of KwaZulu-Natal. The application reference number was HSS/0028/018PD, approved on 25 January 2018. Students were approached during break-time, the purpose and duration of the study were explained by a principal investigator, who was not involved in the education of those students, and a study information leaflet was provided. Participation in this study was voluntary and required signing an informed consent form before completing pre-test questionnaire.

2.3. *Intervention*

The intervention focused on building first-year nursing students' capacity in ICT skills. The intervention consisted of nursing students' training in basic computer operation. Questionnaires were self-completed by students before and after ICT intervention, which allowed measurement of learning gains and the intervention's success. Table 1 presents the training modules, objectives, and assessment criteria.

Four training sessions were conducted on alternate Saturdays for two hours (10h30–12h30) over two months (March to May 2019). The training intervention was done on weekends to accommodate students' learning needs because the intervention was an additional programme, not a curriculum component.

The intervention was executed using blended learning approaches. Face-to-face interactive sessions, including classroom presentations and demonstrations by the facilitator, hands-on practice sessions by students, and reflective activities, were the main teaching approaches to deliver

Table 1. Training modules, objectives, and assessment criteria.

Training module	Objectives	Assessment criteria
Basic computer operations	Discuss and guide the first-year nursing students on how to operate the computer, use external devices and manage files	On the completion of the training, the student should be able to: • Explain the importance of ICT in nursing education/ practice • Describe various parts of the computer/ Laptop • Operate the computer (switch on and off, use a mouse to interact with elements on the screen) • Connect external devices: USBs, Hard drives, CDs, and projectors • Connect the Monitor, mouse, Keyboard, and Network Cable • Use the computer keyboard and shortcuts • Manage the files saved on the computer • Discuss computer security, passwords and antivirus
Introduction to Microsoft Word®	Discuss and guide the first-year nursing students on how to effectively create and manage MS Word files	On the completion of the training, the student should be able to: • Create a new document • Open and save a document • Use track changes and insert comments • Print the document • Draw a table in Ms Word • Insert pictures into an existing document • Inserting page numbers, • Page setup (margin, orientation, size, columns) • Work with section breaks and page breaks • Paragraph setup (indentation and spacing) • Font setup • Create an automatic table of contents, a list of figures, tables and annexures • Compare two documents in Ms Word (original and revised) • Restrict editing

(*Continued*)

Table 1. Continued.

Training module	Objectives	Assessment criteria
Introduction to Microsoft PowerPoint®	Discuss and guide the first-year nursing students on how to create and manage PowerPoint files	On the completion of the training, the student should be able to: • Create a PowerPoint presentation • Setup style and size of the text • Insert a table in the PowerPoint presentation • Insert a figure in the PowerPoint presentation • Set PowerPoint transition and animation
Introduction to Moodle®	Discuss and guide the first-year nursing students on how to use Moodle to access course contents and participate in forum discussion	On the completion of the training, the student should be able to: • Login into Moodle • Access to the learning contents • Access to learning resources • Participate in a forum discussion • Chat with classmates and or instructor • Upload assignment to Moodle
Online search & databases	Discuss and guide the first-year nursing students on how to access the internet, retrieve information from databases and use referencing software	On the completion of the training, the student should be able to: • Discuss effective search strategies and databases relevant to nursing and healthcare practice • Do an online search and retrieve information from databases • Use referencing software
Using e-mails, social media	Discuss and guide the 1st year nursing students on how to effectively and safely communicate via e-mails and social media	On the completion of the training, the student should be able to: • Write e-mails • Communicate effectively and safely via social media such as WhatsApp, Facebook, Twitter, and Instagram • Discuss ethical behaviours on social media
Access to the ICT tools	Explore the first-year nursing students' accessibility to ICT tools both on-campus and off-campus and discuss the safe and ethical use of digital devices in nursing education and practice	On the completion of the training, the student should be able to: • Access and use the internet from LAN and WIFI on-campus and off-campus safely • Access and use computers, laptops, tablets and smartphones on-campus and off-campus safely • Access and use external devices such as USB flash drives, CDs, and Hard Drives • Discuss ethical considerations of the use of digital devices in nursing and clinical practice

the educational content. Those approaches were supplemented by Moodle®, the university's online training platform. First-year students were encouraged to contact the training instructor with any further coaching needs through scheduled appointments, e-mails, or interactive discussions via Moodle (Figure 1).

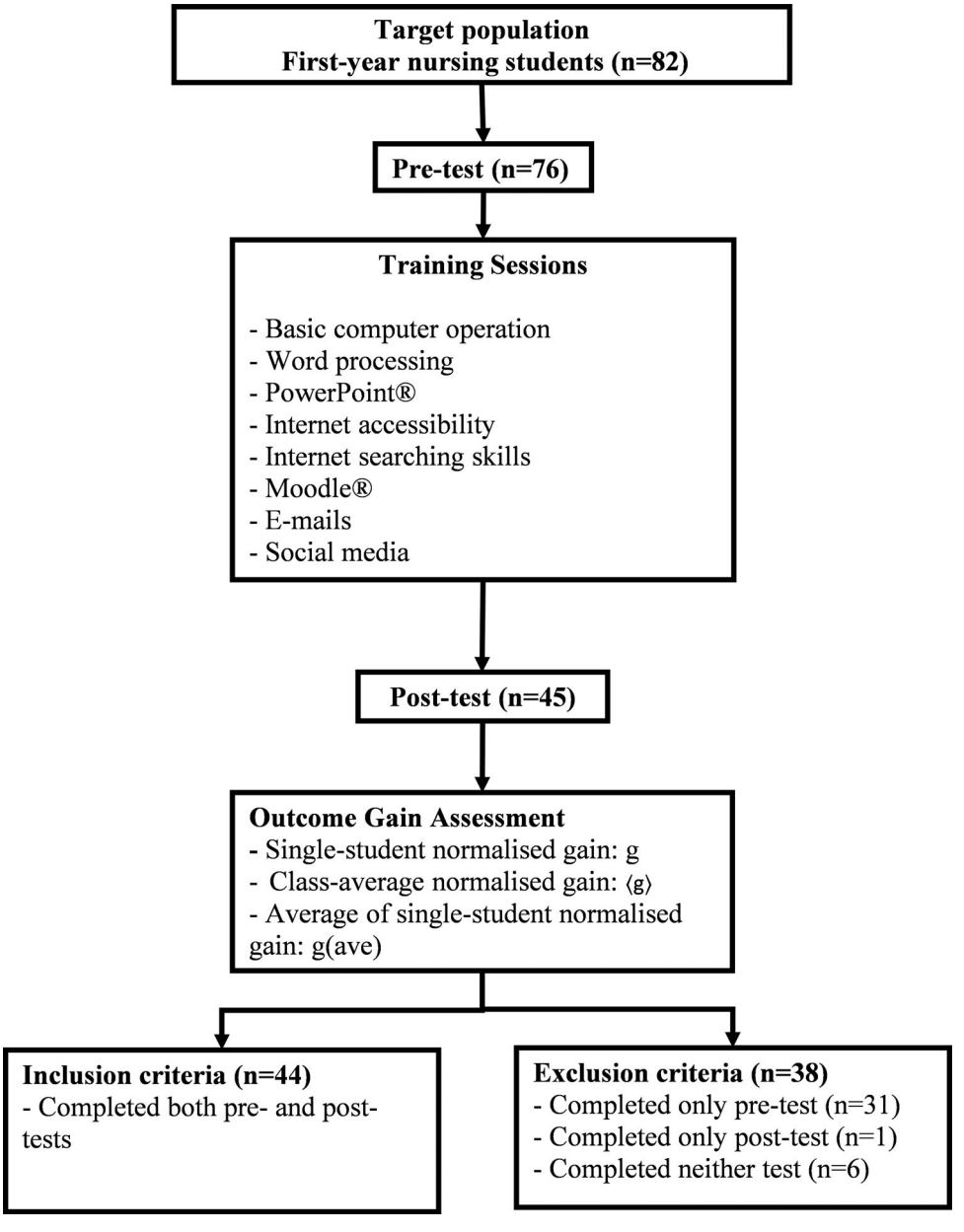

Figure 1. Intervention study flow chart.

2.4. *Measurement & data analysis*

The pre- and post-test evaluation used a self-constructed questionnaire on the perceived ICT skills consisting of eight items. The tool's items were adapted from students' questionnaire for assessing ICT literacy in schools from the European Commission (2017). The questionnaire was developed in collaboration with experts in quantitative methods who were familiar with technology use in tertiary institutions and in the context of South Africa. The self-constructed questionnaire was used in the pre-test phase to obtain baseline data on ICT literacy and test the tool and in the post-test phase to measure success of the intervention.

The items were measured using a five-point Likert scale, and responses ranged from 1 = strongly disagree, to 5 = strongly agree. Cronbach alpha of the instrument was 0.89, which indicated a high reliability of the instrument and reliability of eight items ranged from 0.88 to 0.90. The instrument's validity was done through exploratory factor analysis (EFA) using IBM SPSS® Version 25, and confirmatory factor analysis (CFA) using Amos Version 25. The initial factor analysis screened data using the Kaiser-Mayer-Olkin Measure of sampling adequacy, KMO (> 0.05), and Bartlett's Test of Sphericity (< 0.05). KMO was 0.87, which indicated that the sample was adequate for performing factor analysis. The Bartlett's Test of Sphericity was less than 0.05 ($\chi2 = 343.13$, df = 28, $p < 0.001$), revealing that the relationship among variables was strong to conduct exploratory factors analysis (George & Mallery, 2000; Harerimana & Mtshali, 2020).

The Principal Component Analysis, coupled with the rotation method of Oblimin with Kaiser Normalisation, was conducted to identify the number of factors to be retained. Eight items and a sample size of 76 were computed, and factors with an Eigenvalue > 1 were considered. Two factors were identified, analysed, and explored further in EFA and CFA. Table 2 represents the factor loading by EFA, and items above 0.40 are displayed. Total variance of 71.03% explains the extracted factors. Factor one had five (5) items with factor loading ranging from 0.88 to 0.69, and factor 2 had three (3) items ranging from 0.84 to 0.81. The two identified factors were positively correlated in the CFA model (r = 0.66, $p < 0.001$).

Figure 2 presents diagrammatically the CFA model with unstandardised estimates, while the CFA model with standardised estimates is presented in Figure 3. Both CFA models display items and their associations with identified factors.

In the CFA, several indices were used to identify the extent of model fit, as Hooper et al. (2008) recommended. According to Hooper et al. (2008) and McDonald and Ho (2002) the commonly used reporting fit indices include: Chi-square ($p > 0.05$), CFI (> 0.95), GFI (> 0.95), TLI (> 0.95), RMSEA (< 0.07), and SRMR (< 0.05). In this study, Chi-square goodness of fit statistics indicated a good model fit ($\chi2 = 19.05$, df = 19, $p = 0.45$), and other model fit indices were within acceptable ranges: GFI = 0.94, CFI = 0.99, TLI = 0.99, RMSEA = 0.006, and SRMR = 0.04 ($p < 0.05$).

To reiterate students who completed both pre-test and post-test questionnaires (n = 44) were included in measurements of the intervention effectiveness – using Hake's criteria for individual

Table 2. Factor loading by EFA (Pattern Matrix of the factors and items).

Pattern matrix[a]		
	Component	
Items	1	2
Ms Word Usage	.884	
Basic computer operation	.880	
Internet search & databases	.825	
Ms PowerPoint usage	.817	
E-mail usage	.693	
ICT tools access		.842
Social medial platforms usage		.827
Moodle usage		.811

Notes: Extraction method: Principal Component Analysis. Rotation method: Oblimin with Kaiser Normalisation.
[a]Rotation converged in four iterations.

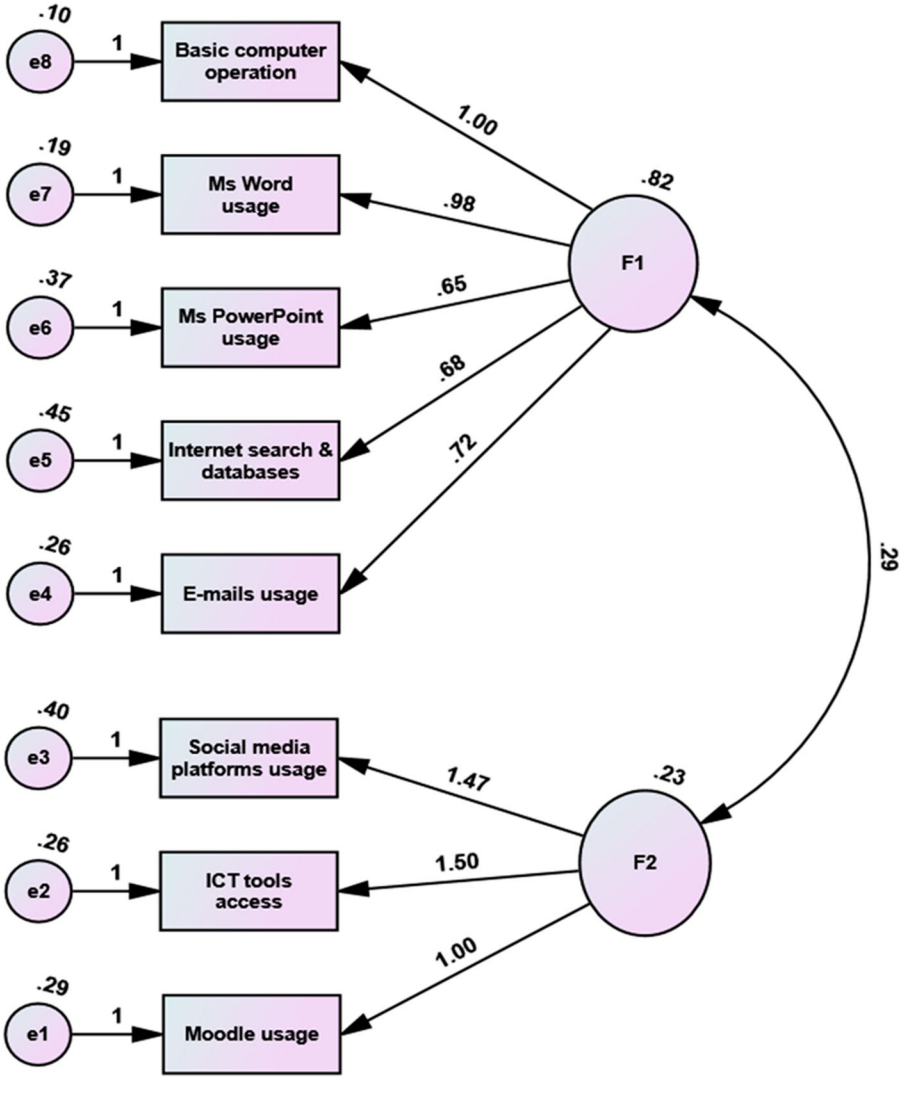

Figure 2. CFA model with unstandardised estimates for first-year nursing students' ICT literacy.

single-student normalised gains, **g**; class average normalised gains, **⟨g⟩**; and average single-student normalised gains, **g(ave)**. In line with Coletta and Steinert (2020); Colt et al. (2011); Hake (1998, 2002); and McKagan et al. (2017), the following parameters were calculated:

(1) Individual single-student normalised gains, g:

$$g = [post\text{-}test - pre\text{-}test]/[1 - pre\text{-}test]$$

(2) Class average normalised gain ⟨g⟩:

$$\langle g \rangle = [\langle \%post\text{-}test \rangle - \langle \%pre\text{-}test \rangle]/[100 - \langle \%pre\text{-}test \rangle]$$

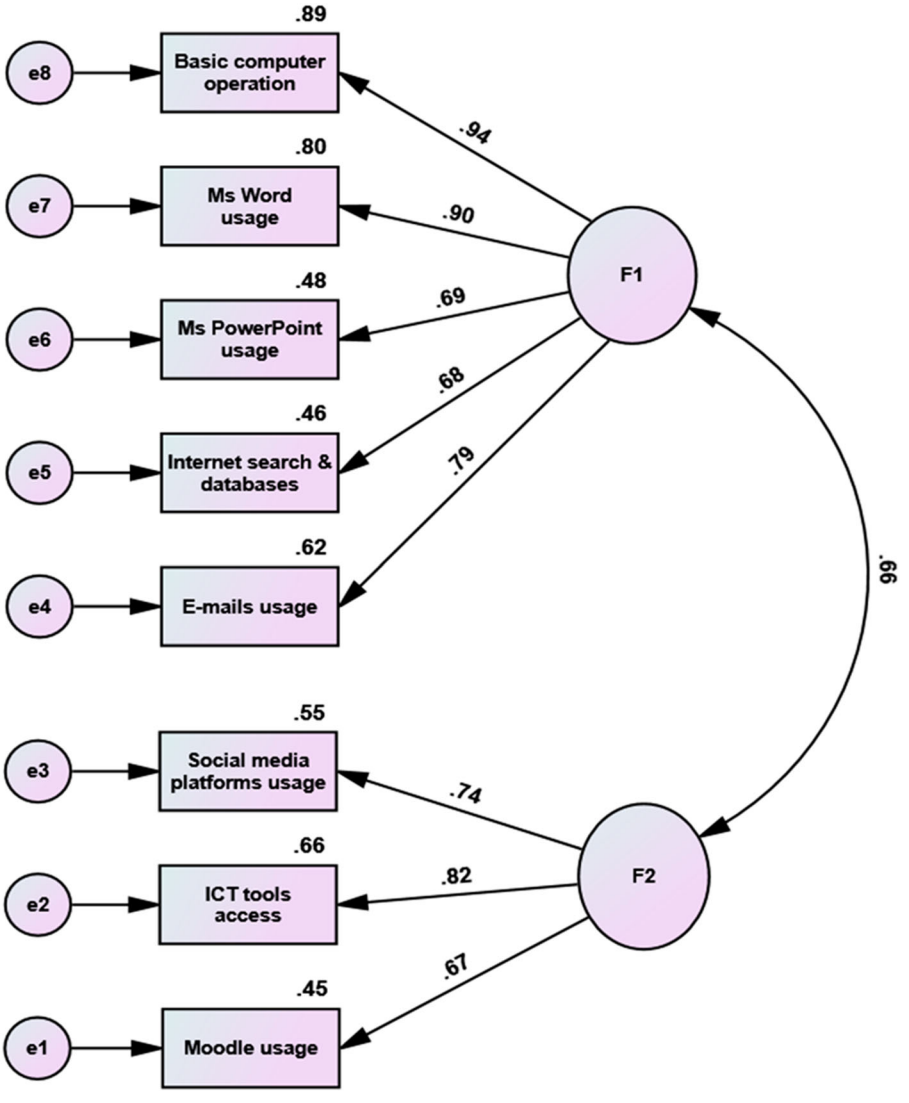

Figure 3. CFA model with standardised estimates for first-year nursing students' ICT literacy.

(3) Average individual single-student normalised gain, g(ave):

$$g(ave) = [\Sigma from\ 1\ to\ N\ (g_i)]/N.$$

Individual single-student normalised gains, g, were calculated to identify variability between individuals and (g_i) to characterise student growth or improvement in cognitive knowledge. Average of individual single-student normalised gains, g(ave) was used to relate individual students' gains to class average gains. By plotting the Histogram of individual student's gains, the mean of the Histogram is the class average gain (McKagan et al., 2017).

In this study, negative gains – where post-test scores were inferior to pre-test score, g(ave) – were calculated by replacing individual single student normalised gains, g by Zero (Coletta & Steinert, 2020; Colt et al., 2011). Furthermore, normalised gains of 30% were considered the

minimum value at which an educational intervention would be regarded as effective (Colt et al., 2011). Normalised learning gains is a commonly used measure to assess the educational effectiveness of pedagogy (Coletta & Steinert, 2020; Hake, 1998; Pentecost & Barbera, 2013). The results from normalised learning gains were interpreted according to the recommendations from Hake (1998), which indicate that normalised gains of > 0.7 = high learning gains, 0.7–0.3 = medium learning gains, and < 0.3 = low learning gains. Colt et al. (2011) indicated that a class average normalised gain ⟨g⟩ of 30% indicates the success of intervention.

Normalised gain is not pre-scores biased, and Coletta and Steinert (2020) stated that it is important to show the correlation between pre-test and normalised scores to show that such correlation is not a result of pre-test score being a predictor of the gain. In the current study, there was no significant correlation between pre-test scores and normalised gains (g) ($r = -0.155$, $p = 0.32$), and R-squared was 0.024. There was a correlation between post-test and normalised gain ($r = 0.705$, $p < 0.001$), and R-squared was 0.49.

A paired T-test was conducted to compare the mean percentage for post-test and pre-test scores with a statistical significance of $p \leq 0.05$. Paired T-test was conducted after checking data for normality, assuming that the differences between pairs were normally distributed. According to Mishra et al. (2019) Shapiro–Wilk Test is used for testing normality when there is a small sample size (n < 50), and when a sample size is at least 50, other methods such as the K-S Test, Histogram, z value, box plot, P–P Plot, Q-Q Plot could be used to test the normality of continuous data. As the sample size was less than 50 of those included in learning gains assessment, Shapiro–Wilk test and Histogram were used to explore the normality of data in pre-and post-test scores. Shapiro–Wilk Test for pre-test scores ($p = 0.28$), and for post-test scores ($p = 0.25$), indicating a normal distribution data ($p > 0.05$).

3. Results

Seventy-six (76) out of 82 (92.7%) of first-year nursing students completed the pre-test, and 45 (54.9%) completed the post-test. For the purpose of measuring learning gains, 44 (53.6%) students who completed both pre-test and post-test were included in measuring success of the intervention. The age of first-year nursing students who participated in this study ranged from 17 to 30 years (M =18.86, SD =2.18), with 75% (n = 33) being under 20 years old. Female students comprised 68.2% (n = 30) of the cohort. Students were from rural areas (n = 22, 50%), urban areas (n = 16, 36.4%), and peri-urban (n = 6, 13.6%) areas.

Table 3 presents pre and post-training intervention results in basic ICT literacy. There was a statistically significant positive gain ($p < 0.05$) evident in all eight areas measured in this study; basic computer operations, Microsoft Word®, Microsoft PowerPoint®, Moodle®, internet searches and databases, e-mails, social media, and access to ICT tools. The terms pre and post represent scores at the beginning and the end of the training intervention.

Table 3 shows the improvement in self-reported knowledge and skills to use the technology, with class average normalised gain ⟨g⟩ ranging from 34.4% to 58.2%, and average of single student normalised gain, g(ave), ranging from 32.4% to 50.7%. In eight areas of training, the highest improvement in self-reported knowledge and skills was observed on the use of Moodle® with 58.2% of class average normalised gain ⟨g⟩ and 50.7% (SD = 41.8) for average of single student normalised gain, g (ave). The lowest improvement in knowledge and skills was observed in basic computer operation with 36.6% of class average normalised gains ⟨g⟩, and 34.7% (SD = 30.5) for average of single student normalised gain, g(ave) and social media with a class average normalised gain ⟨g⟩ of 34.4% and 32.4% (SD = 39.8) for single student normalised gain g(ave).

Overall, the mean percentage for post-test was 83.5% (SD = 9.7), and pre-test was 70.7% (SD = 12.6). Paired T-test indicated statistically significant differences between post-test and pre-test

Table 3. Pre-test and post-test scores and learning gains (n = 44).

Variable	Pre-test Mean ±SD	Post-test Mean ±SD	Difference Mean ±SD	Paired T-test T	d.f	*p* value	% ⟨g⟩	% g(ave) ± SD
I can perform basic computer operations	3.58 ± .91	4.10 ± .53	.52 ± .82	4.18	43	.000**	36.6	34.7 ± 30.45
I can use Microsoft Word®	3.35 ± .89	4.21 ± .56	.86 ± 1.01	5.65	43	.000**	52.1	47.5 ± 36.01
I can use Microsoft PowerPoint®	2.20 ± 1.11	3.40 ± 1.05	1.20 ± 1.43	5.55	43	.000**	42.9	41.5 ± 33.27
I can conduct internet searches & databases	3.63 ± .94	4.19 ± .60	.56 ± .91	4.09	43	.000**	40.9	35.4 ± 36.42
I can use e-mails	3.91 ± 1.19	4.38 ± .71	.47 ± 1.01	3.08	43	.004**	43.1	38.5 ± 50.65
I can use social media platforms	3.72 ± 1.11	4.16 ± .92	.44 ± 1.03	2.82	43	.007**	34.4	32.4 ± 39.79
I can use Moodle®	3.90 ± 1.05	4.54 ± .48	.48 ± .91	3.48	43	.001**	58.2	50.7 ± 41.85
I can access ICT tools	3.97 ± .85	4.44 ± .48	.64 ± 1.11	3.82	43	.000**	45.6	42.4 ± 40.28

Notes: $\langle g \rangle$ is the class average normalised gain: $\langle g \rangle = [\langle \%post\text{-}test \rangle - \langle \%pre\text{-}test \rangle]/[100 - \langle \%pre\text{-}test \rangle]$. $g(ave)$ is the average single-student normalised gain: $g(ave) = [\Sigma from\ 1\ to\ N\ (g_i)]/N$. **$p$.value < .001

scores (t = 7.48; df = 43; $p < 0.001$). The relationships between single student normalised gain and socio-demographic variables were explored; however, there were no statistically significant relationships ($p < 0.05$).

The success of intervention was explored using individual single-student normalised gains, g; class average normalised gain ⟨g⟩ and average of single student normalised gain g(ave). The ⟨g⟩ was 44.8%, and g(ave) was 44.5% (SD = 30.7). Sixty-eight per cent of students (n = 30) had a

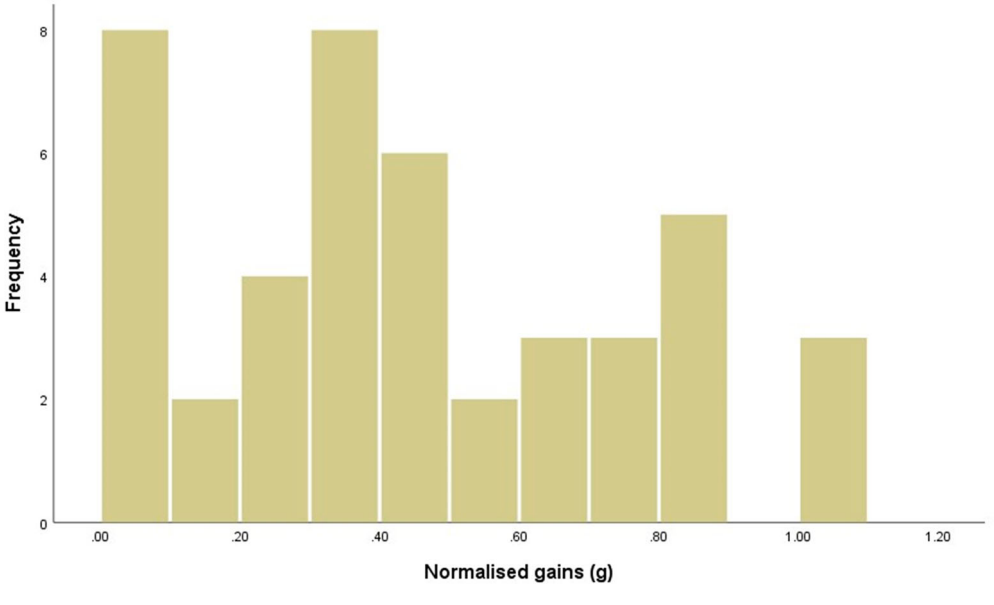

Figure 4. Histogram of normalised gains in ICT skills (n = 44).

normalised gain of 30% and above, indicating success of the intervention. Figure 4 demonstrates the distribution of single student normalised gains.

4. Discussion

This study demonstrated the importance of basic ICT training intervention to improve digital skills among first-year nursing students in order to use educational technology and in preparation for clinical practice. ICT training intervention yielded significant results, with 68.2% of students having normalised gains of 30% and above, which indicated an acceptable level of success of a training intervention in basic ICT skills, as recommended by Colt et al. (2011) and Hake (1998). Using the computer is an important prerequisite for nurses and nursing students to access and use health information (Gürdaş Topkaya & Kaya, 2015). Nurses use technology to access data, manage electronic health records and provide care via e-Health and telehealth applications (Brown, Pope, et al., 2020; McCarthy et al., 2019; Skiba, 2017). The nurses' ability to use computers has been reported to improve nurses' decision-making, competencies and quality of patient care (Gürdaş Topkaya & Kaya, 2015). Computer literacy is a vital determinant of technology use in health care sector (Gürdaş Topkaya & Kaya, 2015).

The significant class average normalised gains $\langle g \rangle$ were observed across all eight areas of training; basic computer operations, Microsoft Word®, Microsoft PowerPoint®, Moodle®, internet searches and databases, e-mails, social media, and access to ICT tools. The highest class normalised gains being reported were from skills to use Moodle® (58.2%). This study demonstrated that nursing students – at the start of undergraduate nursing programmes – must be equipped with a baseline level of skills as a foundation for technology and informatics practice capabilities, which can be progressively built upon. The literature shows that with basic ICT literacy, students are expected to have adequate writing skills (Abdelrahman & Mohammed, 2013), present well-designed PowerPoints (Brock & Joglekar, 2011; Inoue-Smith, 2016), and communicate effectively with peers and teachers using e-mails and social media platforms (Cetinkaya, 2017; Harerimana & Mtshali, 2019, 2020; Kustijono & Zuhri, 2018). The ability to use internet search and ICT tools is crucial for first-year students' academic success and accessibility to up-to-date electronic resources, such as e-books, e-journals, and e-thesis (Soni et al., 2018).

Review of the literature revealed that first-year nursing students do not necessarily have the foundational or expected level of digital literacy when they enter nursing programmes, and at many universities, students' digital literacy is assumed (Harerimana et al., 2022; McNally et al., 2019; Nuuyoma et al., 2023; Reid et al., 2023). Training and educating future nurses in ICT skills is crucial to providing new ways for effective and timely care, documentation, and evidence-based practice (Adereti & Olaogun, 2019; Edwards & O'Connor, 2011; Gürdaş Topkaya & Kaya, 2015; Hussey & Kennedy, 2016; McCarthy et al., 2019; Nes et al., 2021). Studies show that educational training improves students' learning interest, cooperative learning, research skills and information attainment (Gernsbacher, 2015; Yang et al., 2019).

In this study, ICT training intervention was an additional programme, not a curriculum component. Due to the increasing use of technology in healthcare education of healthcare professionals, it is essential to formally teach digital literacy content at entry level of nursing programmes, integrate informatics into undergraduate nursing curriculum, and continuously assess students' digital capabilities (Choi et al., 2020; Harerimana & Mtshali, 2019; Harerimana et al., 2022; Nsouli & Vlachopoulos, 2021). The assessment of technology-related interventions in health professional education should use standardised measurement, such as normalised learning gains and devise adequate educational programmes.

Training interventions to enhance ICT skills should be expanded to the clinical practice to support nurses who rely on ICT systems to provide patients' health care services. Nurses'

experiences in ICT correlate with their working conditions (Kirchhoff et al., 2021). However, older and experienced nurses who have not had to use ICT in their undergraduate programmes struggle to use technology in their daily activities compared to younger and middle-aged nurses (Brown, Pope, et al., 2020; Kleib & Nagle, 2018). It would be essential to provide a targeted educational intervention to improve informatics competencies for this group (De Leeuw et al., 2020; Fackler, 2019; Kleib & Nagle, 2018).

5. Limitations of the study

This study had a small sample of participants who completed the pre and post-test evaluation (n = 44), and only first-year nursing students were targeted. This limits the ability to generalise the findings. Furthermore, lack of randomisation in this study limits the ability to conclude a causal association between the intervention and outcome. Future randomised controlled trials with an adequately powered sample should be designed to test the effectiveness of this ICT teaching intervention. Further studies should target second, third, and fourth year nursing students to monitor the impact of ICT capacity building in undergraduate nursing programmes.

6. Implications and recommendations

ICT literacy is an essential requirement for undergraduate nursing students as they prepare to work in a technology-rich healthcare environment. Due to the need to prepare digitally competent nurses, assessing students' ICT literacy at entry level is recommended and should be repeated at each year level. This study recommends integrating ICT literacy into undergraduate nursing curricula and implementing interventions to improve students' digital skills. Addressing the digital skills gaps and integrating ICT literacy into nursing curricula requires nursing accreditation and registration agencies to update undergraduate course accreditation guidelines that reflect the development and assessment of ICT literacy. Furthermore, ICT capacity building and support should go beyond educational institutions, expand to clinical settings, and be integrated into nurses' induction, onboarding, and continuous professional development programmes.

7. Conclusion

This study highlighted the importance of appropriate ICT training interventions for undergraduate nursing students early in their career. Those interventions serve as a foundation for future use of technology both in the classroom, research and clinical practice. Similar training interventions and measurements of learning gains should be extended to all health professional students during their first academic year to enhance their ICT literacy and use of technology for academic purposes and in preparation for clinical practice to improve health outcomes.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by University Capacity Development Programme (UCDP) at the University of KwaZulu-Natal.

References

Abdelrahman, B., & Mohammed, O. N. (2013). The impact of using the word processor to develop EFL learners' writing skill at Al-Imam Mohammad Ibin Saud Islamic University. *IUG Journal of Humanities Research*, *21*(2), 1–26. https://doi.org/10.12816/0013730

Achampong, E. K. (2017). Assessing the current curriculum of the nursing and midwifery informatics course at all nursing and midwifery institutions in Ghana. *Journal of Medical Education and Curricular Development*, *4*, 238212051770689-4. https://doi.org/10.1177/2382120517706890

Adams, J. G., & Walls, R. M. (2020). Supporting the health care workforce during the COVID-19 global epidemic. *JAMA*, *323*(15), 1439–1440. https://doi.org/10.1001/jama.2020.3972

Adereti, C. S., & Olaogun, A. A. (2019). Use of electronic and paper-based standardized nursing care plans to improve nurses' documentation quality in a Nigerian teaching hospital. *International Journal of Nursing Knowledge*, *30*(4), 219–227. https://doi.org/10.1111/2047-3095.12232

Alotaibi, Y. K., & Federico, F. (2017). The impact of health information technology on patient safety. *Saudi Medical Journal*, *38*(12), 1173–1180. https://doi.org/10.15537/smj.2017.12.20631

ANMF. (2015). *National informatics standards for nurses and midwives*. Australian Nursing and Midwifery Federation. http://anmf.org.au/documents/National_Informatics_Standards_For_Nurses_And_Midwives.pdf.

Booth, R. G., Strudwick, G., McBride, S., O'Connor, S., & López, A. L. S. (2021). How the nursing profession should adapt for a digital future. *BMJ*, *373*(1190), 1–5. https://doi.org/10.1136/bmj.n1190

Borycki, E. M., & Foster, J. (2014). A comparison of Australian and Canadian informatics competencies for undergraduate nurses. *Studies in Health Technology and Informatics*, *201*, 349–355. https://doi.org/10.3233/978-1-61499-415-2-349

Botma, Y., Hurter, S., & Kotze, R. (2013). Responsibilities of nursing schools with regard to peer mentoring. *Nurse Education Today*, *33*(8), 808–813. https://doi.org/10.1016/j.nedt.2012.02.021

Brock, S., & Joglekar, Y. (2011). Empowering PowerPoint: Slides and teaching effectiveness. *Interdisciplinary Journal of Information, Knowledge, and Management*, *6*(1), 085–094. https://doi.org/10.28945/1366

Brown, J., Morgan, A., Mason, J., Pope, N., & Bosco, A. M. (2020). Student nurses' digital literacy levels. *CIN: Computers, Informatics, Nursing*, *38*(9), 451–458. https://doi.org/10.1097/CIN.0000000000000615

Brown, J., Pope, N., Bosco, A. M., Mason, J., & Morgan, A. (2020). Issues affecting nurses' capability to use digital technology at work: An integrative review. *Journal of Clinical Nursing*, *29*(15–16), 2801–2819. https://doi.org/10.1111/jocn.15321

Cetinkaya, L. (2017). The impact of WhatsApp use on success in education process. *The International Review of Research in Open and Distributed Learning*, *18*(7), 59–74. https://doi.org/10.19173/irrodl.v18i7.3279

Choi, E. P., Ho, M., & Smith, R. (2020). A remotely conducted paediatric bootcamp for fourth-year medical students. *Medical Education*, *54*(7), 668. https://doi.org/10.1111/medu.14187

Coletta, V. P., & Steinert, J. J. (2020). Why normalized gain should continue to be used in analyzing preinstruction and postinstruction scores on concept inventories. *Physical Review Physics Education Research*, *16*(1), 1–7. https://doi.org/10.1103/PhysRevPhysEducRes.16.010108

Colt, H. G., Davoudi, M., Murgu, S., & Rohani, N. Z. (2011). Measuring learning gain during a one-day introductory bronchoscopy course. *Surgical Endoscopy*, *25*(1), 207–216. https://doi.org/10.1007/s00464-010-1161-4

Cummings, E., Shin, E. H., Mather, C., & Hovenga, E. (2016). Embedding nursing informatics education into an Australian undergraduate nursing degree. *Studies in Health Technology and Informatics*, *225*, 329–333. https://doi.org/10.3233/978-1-61499-658-3-329

De Leeuw, J. A., Woltjer, H., & Kool, R. B. (2020). Identification of factors influencing the adoption of health information technology by nurses who are digitally lagging: In-depth interview study. *Journal of Medical Internet Research*, *22*(8), e15630. https://doi.org/10.2196/15630

Edwards, J., & O'Connor, P. A. (2011). Improving technological competency in nursing students: The passport project. *The Journal of Educators Online*, *8*(2), https://doi.org/10.9743/JEO.2011.2.2

Elewa, A. H., & El Guindy, H. A. (2017). Nursing students' perception and educational needs regarding nursing informatics. *International Journal of Nursing Didactics*, *7*(3), 12–20. https://doi.org/10.15520/ijnd.2017.vol7.iss3.197.12-20

Essel, H. B., Awuni, T. B., & Mohammed, S. (2020). Digital technologies in nursing and midwifery education in Ghana: Educators perspective, practice and barriers. *Library Philosophy and Practice*, *2020*, 1–16. https://digitalcommons.unl.edu/libphilprac/3722.

European Commission. (2017). *Survey of schools: ICT in education. Final report, country fiches and background material*. Belgium. http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=1814.

Fackler, C. A. (2019). Retaining older hospital nurses: Experienced hospital nurses' perceptions of new roles. *Journal of Nursing Management*, *27*(6), 1325–1331. https://doi.org/10.1111/jonm.12814

Falconer, E., Kho, D., & Docherty, J. P. (2018). Use of technology for care coordination initiatives for patients with mental health issues: a systematic literature review. *Neuropsychiatric Disease and Treatment*, *14*, 2337–2349. https://doi.org/10.2147/NDT.S172810

Fares, K., Fowler, B., & Vegas, E. (2021). *How South Africa implemented its computer science education program*. Center for Universal Education at Brookings. https://www.brookings.edu/wp-content/uploads/2021/10/How-South-Africa-implemented-its-CS-education-program_FINAL.pdf.

Forman, T. M., Armor, D. A., & Miller, A. S. (2020). A review of clinical informatics competencies in nursing to inform best practices in education and nurse faculty development. *Nursing Education Perspectives*, *41*(1), E3–E7. https://doi.org/10.1097/01.NEP.0000000000000588

George, D., & Mallery, P. (2000). *Spss for windows: Step by step*. A Pearson Education Company.

Gernsbacher, M. A. (2015). Why internet-based education? *Frontiers in Psychology*, *5*(1530), 1–4. https://doi.org/10.3389/fpsyg.2014.01530

Gonen, A., Sharon, D., & Lev-Ari, L. (2016). Students' voice: The hopes and fears of student-teacher candidates. *Cogent Education*, *3*(1), 1–9. https://doi.org/10.1080/2331186X.2016.1139438

Gürdaş Topkaya, S., & Kaya, N. (2015). Nurses' computer literacy and attitudes towards the use of computers in health care. *International Journal of Nursing Practice*, *21*, 141–149. https://doi.org/10.1111/ijn.12350

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

Hake, R. R. (2002). Relationship of individual student normalised learning gains in mechanics with gender, high-school physics, and pretest scores on mathematics and spatial visualisation. In *Physics Education Research Conference*, Boise, Idaho. https://web.physics.indiana.edu/hake/PERC2002h-Hake.pdf.

Hallila, L. E., Al Zubaidi, R., Al Ghamdi, N., & Alexander, G. (2014). Nursing students' use of internet and computer for their education in the college of nursing. *International Journal of Nursing & Clinical Practices*, *1*(1), 108–113. https://doi.org/10.15344/2394-4978/2014/108

Harerimana, A., & Mtshali, N. G. (2018). Internet usage among undergraduate nursing students: A case study of a selected university in South Africa. *Journal of Nursing Education and Practice*, *8*(8), 75–85. https://doi.org/10.5430/jnep.v8n8p75

Harerimana, A., & Mtshali, N. G. (2019). Types of ICT applications used and the skills' level of nursing students in higher education: A cross-sectional survey. *International Journal of Africa Nursing Sciences*, *11*, 100163–15. https://doi.org/10.1016/j.ijans.2019.100163

Harerimana, A., & Mtshali, N. G. (2020). Using exploratory and confirmatory factor analysis to understand the role of technology in nursing education. *Nurse Education Today*, *92*), https://doi.org/10.1016/j.nedt.2020.104490

Harerimana, A., & Mtshali, N. G. (2021). E-learning in nursing education in Rwanda: A middle-range theory. *Journal of Nursing Education and Practice*, *11*(7), 78–90. https://doi.org/10.5430/jnep.v11n7p78

Harerimana, A., Wicking, K., Biedermann, N., & Yates, K. (2021). Integrating nursing informatics into undergraduate nursing education in Africa: A scoping review. *International Nursing Review*, *68*(3), 420–433. https://doi.org/10.1111/inr.12618

Harerimana, A., Wicking, K., Biedermann, N., & Yates, K. (2022). Nursing informatics in undergraduate nursing education in Australia before COVID-19: A scoping review. *Collegian*, 527–539. https://doi.org/10.1016/j.colegn.2021.11.004

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association*, *13*(1), 16–23. https://doi.org/10.1197/jamia.M1749

Holt, K. A., Overgaard, D., Engel, L. V., & Kayser, L. (2020). Advanced practice nurses in primary care in Switzerland: An analysis of interprofessional collaboration. *BMC Nursing*, *19*(1), 1–12. https://doi.org/10.1186/s12912-019-0393-4

Honey, M., Collins, E., & Britnell, S. (2020). Education into policy: Embedding health informatics to prepare future nurses—New Zealand case study. *JMIR Nursing*, *3*(1), e16186. https://doi.org/10.2196/16186

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. In *The 7th European Conference on Research Methodology for Business and Management Studies*. Regent's College.

Hough, J. W. (2019). *Assessment and support for basic computer skills at community college Hispanic serving institutions in California* [Thesis]. University of Arkansas. https://scholarworks.uark.edu/etd/3128/

Hübner, U., Shaw, T., Thye, J., Egbert, N., de Fatima Marin, H., Chang, P., O'Connor, S., Day, K., Honey, M., & Blake, R. (2018). Technology informatics guiding education reform – TIGER. *Methods of Information in Medicine*, *57*(S 01), e30–e42. https://doi.org/10.3414/ME17-01-0155

Hussey, P. A., & Kennedy, M. A. (2016). Instantiating informatics in nursing practice for integrated patient centred holistic models of care: A discussion paper. *Journal of Advanced Nursing*, *72*(5), 1030–1041. https://doi.org/10.1111/jan.12927

Inoue-Smith, Y. (2016). College-based case studies in using PowerPoint effectively. *Cogent Education*, *3* (1), 1127745-15. https://doi.org/10.1080/2331186X.2015.1127745

Jenkins, P. D., Lahr, H. E., Fink, J., & Ganga, E. C. (2018). *What We are learning about guided pathways*. Columbia University Community College Research Center.

Kennedy, S., & Yaldren, J. (2017). A look at digital literacy in health and social care. *British Journal of Cardiac Nursing*, *12*(9), 428–432. https://doi.org/10.12968/bjca.2017.12.9.428

Kirchhoff, J. W., Marks, A., Helgesen, A. K., Andersen, K. L., Andreassen, H. M., & Grøndahl, V. A. (2021). The impact of information and communication technology on doctors' and registered nurses' working conditions and clinical work – A cross-sectional study in a Norwegian hospital. *Journal of Multidisciplinary Healthcare*, *14*, 2941–2949. https://doi.org/10.2147/JMDH.S327669

Kleib, M., Chauvette, A., Furlong, K., Nagle, L., Slater, L., & McCloskey, R. (2021). Approaches for defining and assessing nursing informatics competencies: A scoping review. *JBI Evidence Synthesis*, *19*(4), 794–841. https://doi.org/10.11124/JBIES-20-00100

Kleib, M., & Nagle, L. (2018). Factors associated with Canadian nurses' informatics competency. *CIN: Computers, Informatics, Nursing*, *36*(8), 406–415. https://doi.org/10.1097/CIN.0000000000000434

Kustijono, R., & Zuhri, F. (2018). The use of Facebook and WhatsApp application in learning process of physics to train students' critical thinking skills. *IOP Conference Series: Materials Science and Engineering*, *296*(200120258), 1–7. https://doi.org/10.1088/1757-899X/296/1/012025

Laukka, E., Hammarén, M., Pölkki, T., & Kanste, O. (2023). Hospital nurse leaders' experiences with digital technologies: A qualitative descriptive study. *Journal of Advanced Nursing*, *79*(1), 297–308. https://doi.org/10.1111/jan.15481

Lee, J. J., Carson, M. N., Clarke, C. L., Yang, S. C., & Nam, S. J. (2019). Nursing students' learning dynamics with clinical information and communication technology: A constructive grounded theory approach. *Nurse Education Today*, *73*, 41–47. https://doi.org/10.1016/j.nedt.2018.11.007

Männistö, M., Mikkonen, K., Kuivila, H. M., Virtanen, M., Kyngäs, H., & Kääriäinen, M. (2020). Digital collaborative learning in nursing education: a systematic review. *Scandinavian Journal of Caring Sciences*, *34*(2), 280–292. https://doi.org/10.1111/scs.12743

Mather, C., Douglas, T., & Jacques, A. (2018). Health literacy of undergraduate health profession students in Australia: A comparison of the island state of Tasmania and other Australian universities. *Kontakt*, *20* (4), e386–e393. https://doi.org/10.1016/j.kontakt.2018.08.008

McCarthy, B., Fitzgerald, S., O'Shea, M., Condon, C., Hartnett-Collins, G., Clancy, M., Sheehy, A., Denieffe, S., Bergin, M., & Savage, E. (2019). Electronic nursing documentation interventions to promote or improve patient safety and quality care: A systematic review. *Journal of Nursing Management*, *27*(3), 491–501. https://doi.org/10.1111/jonm.12727

McDonald, R. P., & Ho, M.-H. R. (2002). Principles and practice in reporting structural equation analyses. *Psychological Methods*, *7*(1), 64. https://doi.org/10.1037/1082-989X.7.1.64

McKagan, S., Sayre, E., & Madsen, A. (2017). Normalised gain: What is it and when and how should I use it? PhysPort. https://www.physport.org/recommendations/Entry.cfm?ID=93334.

McNally, S., Azzopardi, T., Hatcher, D., O'Reilly, R., & Keedle, H. (2019). Student perceptions, experiences and support within their current Bachelor of Nursing. *Nurse Education Today*, *76*, 56–61. https://doi.org/10.1016/j.nedt.2019.01.032

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of Cardiac Anaesthesia*, *22*(1), 67. https://doi.org/10.4103/aca.ACA_157_18

Nagle, L. M., Crosby, K., Frisch, N., Borycki, E. M., Donelle, L., Hannah, K. J., Harris, A., Jetté, S., & Shaben, T. (2014). Developing entry-to-practice nursing informatics competencies for registered nurses. *Nursing Informatics*, *2014*, 356–363. https://doi.org/10.3233/978-1-61499-415-2-356

Nes, A. A. G., Steindal, S. A., Larsen, M. H., Heer, H. C., Lærum-Onsager, E., & Gjevjon, E. R. (2021). Technological literacy in nursing education: A scoping review. *Journal of Professional Nursing*, *37*(2), 320–334. https://doi.org/10.1016/j.profnurs.2021.01.008

Nsouli, R., & Vlachopoulos, D. (2021). Attitudes of nursing faculty members toward technology and e-learning in Lebanon. *BMC Nursing*, *20*(1), 1–15. https://doi.org/10.1186/s12912-021-00638-8

Nuuyoma, V., Lauliso, S. S., & Chihururu, L. (2023). Perspectives of nursing students on challenges of e-learning during early stages of the COVID-19 pandemic. *Curationis*, *46*(1), e1–e10. https://doi.org/10.4102/curationis.v46i1.2358

Nwozichi, C. U., Marcial, D. E., Farotimi, A. A., Escabarte, A. B. S., & Madu, A. M. (2019). Integration of information and communication technology in nursing education in Southeast Asia: A systematic literature review. *Journal of Education and Health Promotion*, *8*(141), 141–147. https://doi.org/10.4103/jehp.jehp_240_18

Padayachee, K. (2017). A snapshot survey of ICT integration in South African schools. *South African Computer Journal*, *29*(2), 36–65. https://doi.org/10.18489/sacj.v29i2.463

Pentecost, T. C., & Barbera, J. (2013). Measuring learning gains in chemical education: A comparison of two methods. *Journal of Chemical Education*, *90*(7), 839–845. https://doi.org/10.1021/ed400018v

Portnoy, J., Waller, M., & Elliott, T. (2020). Telemedicine in the era of COVID-19. *The Journal of Allergy and Clinical Immunology: In Practice*, *8*(5), 1489–1491. https://doi.org/10.1016/j.jaip.2020.03.008

Reid, L., Button, D., & Brommeyer, M. (2023). Challenging the myth of the digital native: A narrative review. *Nursing Reports*, *13*(2), 573–600. https://doi.org/10.3390/nursrep13020052

Røsvik, K., & Haukedal, T. A. (2017). Wikis as digital learning resources in nursingeducation. *Nordic Journal of Digital Literacy*, *12*(1-2), 31–46. https://doi.org/10.18261/issn.1891-943x-2017-01-02-04

Shruti, M., Prashanthi, K., Myron Anthony, G., Nachiket, G., Anil, J., & Oommen, J. (2023). Digital health innovations for non-communicable disease management during the COVID-19 pandemic: A rapid scoping review. *BMJ Innovations*, *9*(1), 3–18. https://doi.org/10.1136/bmjinnov-2021-000903

Singh, F., & Masango, T. (2020). Information technology in nursing education: perspectives of student nurses. *The Open Nursing Journal*, *14*(1), https://doi.org/10.2174/1874434602014010018

Skiba, D. J. (2017). Nursing informatics education: From automation to connected care. *Studies in Health Technology and Informatics*, *232*, 9–19. https://doi.org/10.3233/978-1-61499-738-2-9

Soni, N. K., Gupta, K. K., & Shrivastava, J. (2018). Awareness and usage of electronic resources among LIS scholars of Jiwaji University, Gwalior: A survey. *DESIDOC Journal of Library & Information Technology*, *38*(1), 56–62. https://doi.org/10.14429/djlit.38.1.11524

Staddon, R. V. (2020). Bringing technology to the mature classroom: Age differences in use and attitudes. *International Journal of Educational Technology in Higher Education*, *17*(1), 1–20. https://doi.org/10.1186/s41239-020-00184-4

Swaminathan, N., Ravichandran, L., Ramachandran, S., Milanese, S., Singaravelu, R., & Govindaraj, P. (2021). Entry level nursing graduate students' perception and readiness toward online component of blended learning: A mixed method study. *Journal of Education and Health Promotion*, *10*(163), 1–7. https://doi.org/10.4103/jehp.jehp_771_20

Swan, B. A., Haas, S., & Jessie, A. T. (2019). Care coordination: Roles of registered nurses across the care continuum. *Nursing Economics*, *37*(6), 317–323.

Sykes, C., Urquhart, C., & Foster, A. (2014). Role of the practice education facilitator (PEF): The Cambridgeshire model underpinned by a literature review of educational facilitator roles. *Nurse Education Today*, *34*(11), 1395–1397. https://doi.org/10.1016/j.nedt.2014.03.014

Tebeje, T. H., & Klein, J. (2021). Applications of e-Health to support person-centered health care at the time of COVID-19 pandemic. *Telemedicine and e-Health*, *27*(2), 150–158. https://doi.org/10.1089/tmj.2020.0201

Terkes, N., Celik, F., & Bektas, H. (2019). Determination of nursing students' attitudes towards the use of technology. *Japan Journal of Nursing Science*, *16*(1), 17–24. https://doi.org/10.1111/jjns.12207

Ting, D. S. W., Carin, L., Dzau, V., & Wong, T. Y. (2020). Digital technology and COVID-19. *Nature Medicine*, *26*(4), 459–461. https://doi.org/10.1038/s41591-020-0824-5

Veikkolainen, P., Tuovinen, T., Jarva, E., Tuomikoski, A.-M., Männistö, M., Pääkkönen, J., Pihlajasalo, T., & Reponen, J. (2023). eHealth competence building for future doctors and nurses – Attitudes and capabilities. *International Journal of Medical Informatics*, *169*, 104912-8. https://doi.org/10.1016/j.ijmedinf.2022.104912

WHO. (2020). *Digital education for building health workforce capacity*. World Health Organisation.

Yang, K.-H., Jiang, Z.-X., Chavez, F., Wang, L.-H., & Yuan, C.-R. (2019). Effectiveness of a training program based on maker education for baccalaureate nursing students: A quasi-experimental

study. *International Journal of Nursing Sciences*, *6*(1), 24–30. https://doi.org/10.1016/j.ijnss.2018.11.006

Zhou, X., Snoswell, C. L., Harding, L. E., Bambling, M., Edirippulige, S., Bai, X., & Smith, A. C. (2020). The role of telehealth in reducing the mental health burden from COVID-19. *Telemedicine and e-Health*, *26*(4), 377–379. https://doi.org/10.1089/tmj.2020.0068