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Nursing Diagnosis Accuracy in Nursing Education

Clinical Decision Support System Compared With Paper-Based Documentation—A Before and After Study

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Computer-based technologies have been widely used in nursing education, although the best educational modality to improve documentation and nursing diagnostic accuracy using electronic health records is still under investigation. It is important to address this gap and seek an effective way to address increased accuracy around nursing diagnoses identification. Nursing diagnoses are judgments that represent a synthesis of data collected by the nurse and used to guide interventions and to achieve desirable patients' outcomes. This current investigation is aimed at comparing the nursing diagnostic accuracy, satisfaction, and usability of a computerized system versus a traditional paper-based approach. A total of 66 nursing students solved three validated clinical scenarios using the NANDA-International terminologies traditional paper-based approach and then the computer-based Clinical Decision Support System. Study findings indicated a significantly higher nursing diagnostic accuracy ($P < .001$) in solving cancer and stroke clinical scenarios, whereas there was no significant difference in acute myocardial infarction scenario. The use of the electronic system increased the number of correct diagnostic indicators ($P < .05$); however, the level of students' satisfaction was similar. The usability scores highlighted the need to make the electronic documentation systems more user-friendly.

KEY WORDS: Clinical Decision Support System, Nursing education, Nursing informatics, Nursing students, Standardized nursing terminology

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Nursing documentation influences patient safety and affects the clarity of patient care outcomes. The lack of standardized nursing terminology use in nursing documentation can pose a risk to patients.[1] The use of terminologies and the identification of nursing diagnoses showed an impact on patient, organizational, and educational outcomes.[2–6] Within the nursing process, nursing diagnosis is defined as the nurse's clinical judgment about patient's response to health problems based on a comprehensive nursing assessment.[7]

Nursing diagnoses represent an outcome of clinical reasoning and decision-making on the part of the nurse or nursing student; the accuracy of nursing diagnoses informs interventions and impacts the effectiveness of measurable outcomes.[8] When diagnoses are generated with limited data, accuracy can be compromised, possibly affecting patient outcomes and the quality of nursing care.[8] Nursing diagnostic accuracy is defined as a rater's judgment of the degree to which a diagnostic statement matches the cues in a patient/clinic situation.[9,10] Nurses should be able to make highly accurate nursing diagnoses using problem solving, critical thinking, and decision-making skills that promote safe and effective nursing care. These skills can be learned, developed through teaching, and then applied in clinical practice.[11,12]

In many countries, efforts have been made by governments, health educators, and health managers to achieve high-quality education standards for skill transfer in clinical practice, fidelity to safety standards, and improvement of patient outcomes. Some governmental policies (eg, Spain, 2010; the Netherlands, 2015) have made implementation of standardized nursing terminologies in health records mandatory.[13,14]

In the field of information and communication technologies, electronic documentation systems are becoming crucial for quality healthcare delivery by nurses and for nursing education.[15]

Within electronic documentation systems or computer programs that store patient information related to healthcare,[16] a specific Nursing Process–Clinical Decision Support System (NP-CDSS) can be used to enhance clinical decision-making by encouraging use of a hypothetico-deductive approach for problem resolution. In addition, these systems have been shown to help nurses identify "high-accuracy" nursing diagnoses that reflect a patient's clinical condition.[1,17,18] A variety of electronic documentation systems (such as PROCEnf-USP, WiseNurse, Plataforma PEnsinar, and Nurse Diagnostician software) have been created to assess nursing students' diagnostic accuracy and have been found to strengthen nurses' clinical reasoning.[11,12,19–21] Peres and colleagues[21] examined the diagnostic accuracy of nursing students from a paper-based diagnostic approach compared with a CDSS diagnostic approach. Results from this study were inconclusive as the sample size was small, and only one clinical scenario was administered to students. Additional exploration of this technology was viewed as essential. The impact of using an NP-CDSS as educational electronic documentation methodology to improve diagnostic accuracy in nursing students needs to be fully explored.

METHODS

Aims

The main objective of this study was to compare the nursing diagnostic accuracy in third-year undergraduate nursing students using an NP-CDSS (Florence) versus a traditional paper-based approach to generate nursing diagnoses. Secondary objectives were developed to assess the number of correct nursing diagnoses labels and diagnostic indicators, the nursing students' satisfaction, and the usability of the NP-CDSS. The main research question that guided this study was as follows: (1) What is the difference in the nursing diagnostic accuracy of undergraduate students using an NP-CDSS compared with the diagnostic accuracy of those using a paper-based approach? Three additional secondary questions were as follows: (2) What is the difference in the number of correct nursing diagnoses labels and diagnostic indicators derived from the use of the NP-CDSS and the paper-based approach? (3) What is the difference in undergraduate nursing students' satisfaction using an NP-CDSS compared with their satisfaction using a paper-based approach? (4) Is NP-CDSS Florence found to be an easy-to-use software for undergraduate nursing students?

Design, Sample, and Setting

A before-after study design was carried out at an Italian university in a 6-month period between June and November 2021. Only those undergraduate nursing students enrolled in the third year who gave their informed consent to participate in the study were included. To prevent students feeling coerced to participate in the investigation, all students were assured that their privacy and anonymity would be respected, and they could withdraw from the study at any time without any repercussions on their academic career.

Operational Definitions

Traditional Approach

In the nursing curricula, the traditional method represents the current educational criterion standard found used to provide use application and communication of the nursing process nursing process and clinical decision-making. The "traditional approach" (or "paper-based") was defined as solving the clinical scenario by adopting the Advanced Nursing Process (ie, the nursing process with the standardized nursing terminologies) without using any electronic software.

Nursing Process–Clinical Decision Support System

Nursing Process–Clinical Decision Support System is defined as an electronic system used to support nurses' diagnostic reasoning using data from practice and documenting it in electronic health records. According to an internationally standard consensus, this system should contain 25 criteria grouped in eight main categories that include the following: (1) nursing process; (2) standardized nursing terminologies; (3) evidence-based nursing diagnoses and (4) evidence-based interventions; (5) standardized, knowledge-based outcome-indicators; (6) connections between measurement instrument results and nursing diagnoses, interventions and outcomes; (7) holistic nursing; and (8) coded, standardized concepts for data gathering and research.[17]

Florence

Florence is an Italian NP-CDSS, produced by i-CEA (Casa Editrice Ambrosiana, Rozzano, Italy), designed to support nurses and nursing students in the decision-making process regarding diagnoses, interventions, and outcomes. In addition, Florence allows the creation of simulated clinical cases with real patients, allowing students to improve their clinical reasoning skills following the phases of the nursing process.[22] This online educational platform is built in six phases according to the Advanced Nursing Process, with the combination of Gordon's Functional Health Pattern Assessment framework and the three American Nursing Association–recommended standardized nursing terminologies: NANDA-International diagnoses, NIC interventions, and NOC outcomes, known together as NNN.[23]

Clinical Scenarios Development

Three clinical scenarios were developed by two researchers starting from data related to three real clinical cases relating to (1) cancer in community setting, (2) acute myocardial infarction, and (3) stroke. Their content was assessed and revised by the research team according to current evidence and guidelines

for scenario script provided by the system provider. The script was also assessed for clarity (clear language and sentence structure), specificity, and nursing relevance. The cases underwent a preliminary test before the administration. Then, the scenarios were uploaded on the NP-CDSS by the information technology team.

Traditional Method (or Paper-Based Approach) Administration

Using the paper-based approach to evaluate knowledge, students were provided with a description of 3 clinical cases and asked to solve them by filling a structured grid provided by teacher, based on the nursing process, without using any software. Within the description of each clinical case, students were given a series of cues, or defining characteristics and related factors/associated conditions, useful to identify the patient's problem (nursing diagnosis), its etiology, signs and symptoms (PES format), and other components of the nursing process (eg, intervention, outcomes).

After reading the clinical case in depth and by using their clinical reasoning skills, students organized the data available into Gordon's Functional Health Patterns framework, highlighting all the critical data provided. Then, supporting using the NANDA-International handbook,[7] they completed the grid provided by the teacher, reporting nursing diagnosis, nursing outcomes, nursing interventions, and the evaluation of the nursing outcomes before submitting it for final revision by the supervising teacher.

Nursing Process–Clinical Decision Support System (or Electronic Approach) Administration

Florence was used to solve the same clinical scenarios previously described to identify the components of the nursing process as well as nursing diagnoses using the PES format (problem–etiology–signs and symptoms). After login, students selected a clinical scenario and read the case description. After completing the assessment, students then selected one or more nursing diagnoses and then proceeded to the selection of nursing outcomes, nursing interventions, nursing activities, and the evaluation of the nursing outcomes. The student then generated a nursing process report.

Data Collection Procedure

After being contacted and provided with information about the study aims, the third-year nursing students received instructions about data collection to input all the data in a Web-based survey. The study consisted of three stages:

1. Phase 1: Traditional approach (T_0): After obtaining the informed consent, demographic and academic characteristics (ie, age, biological sex, academic status, last grade in the internship examination, examination grades mean) were collected using an online questionnaire. Then, participants were required to solve three clinical cases reporting in a grid provided by teachers the problem labels (nursing diagnoses), the related factors (etiology), and the signs/symptoms (defining characteristics). Students were allowed to use the Handbook of Nursing Diagnoses NANDA-International classification 2021-2023.[7]
2. Phase 2: Afterward (2 weeks apart), students received, together with the system's credentials, an online training about the use of the platform with a PowerPoint-based (Microsoft Inc., Redmond, WA, USA) toolkit explaining in a detailed and illustrated manner how to use the NP-CDSS. This training had the goal to prevent major confounding factors such as the lack of digital literacy and difficulties to access to computers. An investigator trained about the system was made available to reply to any questions raised by the students about the software.
3. Phase 3: NP-CDSS (T_1): Thirty days apart, the three clinical scenarios were presented to the same group of students who had to identify the nursing diagnoses, the related factors, and the defining characteristics using the NP-CDSS. Finally, the students had to self-evaluate their overall satisfaction and the usability of the system filling the second online questionnaire.Each student was required to select up to three nursing diagnoses for each clinical scenario in phases 1 and 3. The study procedure is graphically depicted in the study flow chart (Supplemental Figure 1, http://links.lww.com/CIN/A291).

Instrumentation, Analysis, and Data Interpretation

Three main instruments were used for measuring, respectively, nursing diagnostic accuracy, overall satisfaction, and system usability. They were the (1) Ordinal Scale for Degrees of Accuracy,[9] (2) Italian Version of the 10-item System Usability Scale,[24,25] (3) and the Total System Usability Scale

Nursing diagnostic accuracy has been measured using the Ordinal Scale for Degrees of Accuracy[9] adapted by the authors according to the aims of the study; the overall score is the sum, according to the PES format, of the scores of the three correctly inserted components: (1) nursing diagnoses labels (problem), (2) related factors/associated conditions (etiology), and (3) defining characteristics (signs and symptoms) identified by the students for each clinical scenario. The assessment of the overall score as well of the three components was performed independently by two raters, and any disagreement among the assessors was solved by discussion with a third author until 100% agreement was reached. This scale was previously piloted by five nursing experts of the field; then, the scale underwent reliability analysis showing an acceptable level of internal consistency (Cronbach's $\alpha = .790$).[26] The score of the instrument ranged from 0 to 3 for each diagnosis (0 = poor accuracy, 3 = maximum accuracy). Considering that

for each clinical scenario a maximum of three correct diagnoses were possible, the overall score ranged from 0 to 9 (0 = poor accuracy, 9 = maximum accuracy).

The overall students' satisfaction after using both approaches was evaluated with a national instrument, routinely used by Italian universities, constituted by a 5-point Likert scale considering the following question: "Overall, are you satisfied with the educational experience?" where higher numbers on the scale corresponded to higher satisfaction scores ranging from 1 (poor) to 5 (excellent).[27,28]

In phase 3, the Italian Version of the 10-item System Usability Scale[24,25] was utilized to measure the usability of NP-CDSS. Each item ranges from "strongly disagree" (0) to "strongly agree" (4). For odd-numbered items, the score contribution is the scale position minus 1, whereas for even items the contribution is 5 minus the scale position. The total score was calculated by summing the score contribution for each item, multiplied by 2.5. Total System Usability Scale score ranges from 0 to 100, with scores greater than 68 identified an acceptable usability.[24,25]

Data Analysis

Continuous variables were described by central tendency (mean, median) and dispersion measures such as SD, interquartile range, and range (minimum-maximum). Categorical variables were described as numbers (n) and percentages (%). The normality in distribution of continuous variables was visually assessed using histograms, boxplots, Q-Q plots, and verified using Kolmogorov-Smirnov test. For categorical variables, the comparisons between groups were performed using the χ^2 test.

Differences of students' characteristics by biological sex and the difference in magnitude of outcomes (nursing diagnostic accuracy, satisfaction) were explored respectively using the Mann-Whitney *U* test and the Wilcoxon signed-rank test because a nonnormal distribution was revealed. The interrater agreement of nursing diagnostic accuracy was expressed using Cohen's *k*.

Linear mixed-effects modeling was used to control for demographic and academic variables while exploring the change in the accuracy of nursing diagnoses between phase 1 and phase 3.[29] The significance was fixed at $P < .05$. All data were analyzed using IBM SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki. Approval was obtained from the internal review board of the University of L'Aquila (approved on May 25, 2021, no. 23/2021). The written informed consent was obtained. Students who refused to provide their consent were not forced to change their mind and were assured of no consequences on their academic program. Confidentiality of data was guaranteed in accordance with the Italian law. The Florence publisher has authorized the use of the electronic system for research purposes.

RESULTS

Demographics

A total of 113 third-year students agreed to participate to the study. Ninety students (79.65%) completed phase 1 (T_0), and 66 of them concluded phase 3 (T_1) (73.30%). Twenty-three students did not participate because they did not fill the questionnaire at T_0, whereas 24 dropped out and did not solve the clinical cases using NP-CDSS at T_1 (Supplemental Figure 1, http://links.lww.com/CIN/A291).

The students' mean age was 25 ± 3.5 years (median, 24.00 years; interquartile range, 3 years; minimum-maximum, 22-39 years), with a slightly higher age for males (25.57 vs 24.85 years). Most of them were female (78.80%) and "in progress" with the course (92.42%). Of 31 possible points, the average grade of the students was 27.13 ± 1.15 (median, 27.09; interquartile range, 1.42, minimum-maximum, 24.30-29.50), whereas the grade in the last internship examination was 29.24 ± 1.60 (median, 30.00; interquartile range, 2; minimum-maximum, 21-31). Compared with male colleagues, female students had higher average grade (27.26 vs 26.63) and last internship examination grade (29.25 vs 29.21) (Table 1).

The Impact of the Nursing Process–Clinical Decision Support System on Nursing Diagnostic Accuracy

The interrater reliability between the two raters of nursing diagnostic accuracy was strong (Cohen's $k = 0.86$, $P < .001$) before full agreement was reached. In all three clinical scenarios, the nursing diagnostic accuracy was higher using NP-CDSS in comparison to the paper-based method, although it was statistically significantly higher only for cancer in community setting ($\Delta = +1.15 \pm 1.76$; 95% confidence interval [CI], 0.720-1.583; $P < .001$) and stroke ($\Delta = +0.96 \pm 1.83$; 95% CI, −0.51, 1.40; $P < .001$) scenarios and not in the acute myocardial infarction scenario ($\Delta = +0.35$; 95% CI, −0.09, 0.79; $P = 1.000$). Scores of nursing diagnostic accuracy at T_0 and T_1 are shown in Table 2.

After using linear mixed-effects modeling to control for demographic and academic variables (biological sex, age, average grade, grade internship, status, previous use of standardized nursing terminologies during internship), the accuracy of phase 1 was still significantly lower than the phase 3 score in both cancer in community setting ($\beta = -1.15 \pm 0.22$; $t = -5.327$; 95% CI, −1.583 to −0.719; $P < .001$) and stroke ($\beta = -0.95 \pm 0.22$; $t = -4.246$; 95% CI, −1.404 to −0.506; $P < .001$) scenarios; controlling for the same variables, there was no significant difference in the accuracy between the phase 1 and phase 3 scores for acute myocardial infarction scenario ($\beta = -0.35 \pm 0.22$; $t = -1.587$; 95% CI, −0.787 to 0.090; $P = .117$) (Table 3).

Table 1. Demographic and Academic Characteristics Compared by Biological Sex (No. of Nursing Students = 66)

Variables	Total	Women	Men	P[a]
	Mean ± SD n (%)	Mean ± SD n (%)	Mean ± SD n (%)	
n	66 (100.00)	52 (78.80)	14 (21.20)	
Age, y	25.00 ± 3.50	24.85 ± 3.59	25.57 ± 3.23	0.100
Average grade	27.13 ± 1.15	27.26 ± 1.16	26.63 ± 1.01	0.040
Last internship exam grade	29.24 ± 1.60	29.25 ± 1.71	29.21 ± 1.12	0.540
Students' status				
In progress	61 (92.42)	48 (78.70)	13 (21.30)	1.000
Out of course	5 (7.58)	4 (80.00)	1 (20.00)	
Utilizing SNTs				
Yes	56 (84.85)	45 (80.40)	11 (19.60)	0.431
No	10 (15.15)	7 (70.00)	3 (30.00)	

Abbreviation: SNTs, standardized nursing terminologies.

[a]Mann-Whitney *U* test or Fisher exact test.

The Impact of the Nursing Process–Clinical Decision Support System on Correct Nursing Diagnoses Labels and Diagnostic Indicators

Within the 970 total nursing diagnoses identified by students in the three scenarios (477: T_0, 493: T_1), a total of 324 correct diagnoses labels were identified (152: T_0, 172: T_1). The average number of correct nursing diagnoses labels was significantly higher using NP-CDSS in the stroke scenarios (Δ = +0.30 ± 0.82; 95% CI, −0.505 to 2.994; $P < .01$), whereas it was not significant for acute myocardial infarction and for cancer in community setting. The correctly inserted diagnostic indicators (defining characteristics, related factors/associated conditions) supporting the NANDA-International nursing diagnoses were significantly higher using the NP-CDSS than the paper-based approach in all three clinical scenarios ($P < .05$; Table 2).

Table 2. Comparison Between Phase 1 (T_0) and Phase 3 (T_1) for Diagnostic Accuracy, Diagnostic Indicators, and Correct Nursing Diagnoses Labels (No. of Nursing Students = 66)

Variable (Range)	Clinical Scenarios	Traditional Method (T_0)	Nursing Process-CDSS (T_1)	Z[a] P[b]
		Mean ± SD n (%)	Mean ± SD n (%)	
Nursing diagnostic accuracy (0-9)	Scenario 1: Cancer in community setting	2.32 ± 1.08	3.47 ± 1.79	4.435 $P < .001$
	Scenario 2: Acute myocardial infarction	0.86 ± 1.28	1.21 ± 1.44	1.644 $P = 1.000$
	Scenario 3: Stroke	0.33 ± 0.75	1.29 ± 1.69	4.246 $P < .001$
Nursing diagnostic indicators (0-6)	Scenario 1: Cancer in community setting	0.82 ± 0.82	2.03 ± 1.14	5.456 $P < .001$
	Scenario 2: Acute myocardial infarction	0.33 ± 0.75	0.63 ± 0.78	2.312 $P = .021$
	Scenario 3: Stroke	0.06 ± 0.39	0.71 ± 0.99	4.347 $P < .001$
Correct nursing diagnoses labels (0-3)	Scenario 1: Cancer in community setting	1.50 ± 0.75 99 (51.03)	1.44 ± 0.73 95 (48.97)	0.651 $P = .515$
	Scenario 2: Acute myocardial infarction	0.53 ± 0.66 35 (47.30)	0.58 ± 0.68 38 (52.70)	0.461 $P = .645$
	Scenario 3: Stroke	0.27 ± 0.48 18 (32.14)	0.58 ± 0.73 38 (67.86)	2.805 $P = .005$
	No. of correct nursing diagnoses	152 (46.91)	172 (53.09)	

[a]Z score (Wilcoxon signed-rank test).

[b]Significant at .05.

Table 3. Linear Mixed-Model Analysis to Control for Demographic and Academic Variables the Increased Diagnostic Accuracy in Phase 3 (No. of Nursing Students = 66)

Scenario	Variables	β (SE)	*df*	*t*	95% CI	*P*
Scenario 1: Cancer in community setting	Intercept	2.63 ± 3.87	59.09	0.679	−5.114 to 10.370	0.500
	Phase 1 (relative to phase 3)	−1.15 ± 0.22[a]	65.00	−5.327	−1.583 to −0.719	<0.001
	Men (relative to women)	0.04 ± 0.36	59.00	0.106	−0.683 to 0.760	0.916
	In course (relative to out of course)	−1.26 ± 0.59[b]	59.00	−2.144	−2.430 to −0.084	0.036
	Not used SNTs (relative to SNTs used)	0.61 ± 0.42	59.00	1.458	−0.226 to 1.439	0.150
	Age, y	0.04 ± 0.04	59.00	0.860	−0.050 to 0.126	0.393
	Average grade (0-31)	−0.13 ± 0.14	59.00	−0.925	−0.415 to 0.153	0.359
	Grade in the internship (0-31)	0.14 ± 0.10	59.00	1.398	−0.060 to 0.340	0.167
Scenario 2: Acute myocardial infarction	Intercept	−4.79 ± 3.35	59.127	−1.430	−11.491 to 1.913	0.158
	Phase 1 (relative to phase 3)	−0.35 ± 0.22	65.00	−1.587	−0.787 to 0.090	0.117
	Men (relative to women)	0.04 ± 0.31	59.00	0.126	−0.585 to 0.664	0.900
	In course (relative to out of course)	−0.77 ± 0.51	59.00	−1.518	−1.785 to 0.245	0.134
	Not used SNTs (relative to SNTs used)	0.57 ± 0.36	59.00	1.575	−0.154 to 1.288	0.121
	Age, y	0.03 ± 0.04	59.00	0.699	−0.050 to 0.103	0.488
	Average grade (0-31)	0.08 ± 0.12	59.00	0.682	−0.162 to 0.329	0.498
	Grade in the internship (0-31)	0.11 ± 0.09	59.00	1.296	−0.061 to 0.285	0.200
Scenario 3: Stroke	Intercept	−1.05 ± 3.14	59.127	−0.335	−7.347 to 5.237	0.739
	Phase 1 (relative to phase 3)	−0.95 ± 0.22[a]	65.00	−4.246	−1.404 to −0.506	<0.001
	Men (relative to women)	0.52 ± 0.29	59.00	1.788	−0.062 to 1.110	0.079
	In course (relative to out of course)	−0.51 ± 0.48	59.00	−1.073	−1.464 to 0.442	0.287
	Not used SNTs (relative to SNTs used)	−0.13 ± 0.34	59.00	−0.386	−0.807 to 0.546	0.701
	Age, y	−0.04 ± 0.04	59.00	−1.216	−0.115 to 0.028	0.229
	Average grade (0-31)	0.05 ± 0.12	59.00	0.404	−0.184 to 0.277	0.688
	Grade in the internship (0-31)	0.09 ± 0.08	59.00	1.110	−0.072 to 0.253	0.271

Abbreviations: *df*, degrees of freedom; SNTs, standardized nursing terminologies.

[a]$P < .001$.

[b]$P < .05$.

Satisfaction and Usability

The satisfaction of nursing students was higher using the NP-CDSS in comparison to the traditional approach (3.24 ± 0.99 vs 2.97 ± 1.11, respectively), but the difference was not statically significant (Δ = +0.27 ± 1.55; 95% CI, −0.107 to 0.652; $P = .515$).

Of 100 possible points, the total usability score was 41.94 ± 17.98 indicating a level of usability below the average of the scale's score acceptability range (cutoff = 68).

DISCUSSION

The primary aim of this study was to compare nursing diagnostic accuracy between traditional paper-based approach and the NP-CDSS. Adopting multiple clinical scenarios, the use of the NP-CDSS improved the accuracy of nursing diagnoses developed in comparison to the traditional approach, thus reinforcing the body of literature on how technology using electronic documentation systems can help students to learn, to use, and to refine clinical reasoning skills needed for nursing practice.[1,11,12,19–21]

The improvements in accuracy of nursing diagnoses that persisted for scenarios 1 (cancer) and 3 (stroke) even after controlling for demographic and academic factors suggest that Florence increased nursing diagnostic accuracy. The reason of this improvement was due to the beneficial characteristic of the NP-CDSS to "guide" nursing students through the nursing process stages, starting from the identification of the correct diagnostic indicators (as highlighted by the significant results obtained, as shown in Table 2), which are crucial elements to provide the final correct nursing diagnoses.

Using these support platforms in nursing education represents the first step for the transition from the paper-based approach to nursing information systems in daily clinical practice.[22] Despite this consideration, the diagnostic accuracy levels for both phase 1 and phase 3 in all three clinical scenarios were low, confirming literature that described nursing students experiencing difficulties in the clinical reasoning process and the identification of correct diagnostic indicators and accurate nursing diagnoses.[11,19] These findings have important implications for education throughout the curriculum, particularly regarding mentoring and evaluation to

increase the accuracy of students in the nursing diagnoses. The number of correct nursing diagnoses labels between the two approaches, traditional and Florence, was similar even if it was higher using the NP-CDSS. Analyzing the diagnosis formulation according to the PES format suggested that the better diagnostic accuracy in NP-CDSS was strongly influenced by the diagnostic indicators. These findings suggest the pivotal role of the PES format in improving the ability of nursing students to formulate accurate nursing diagnoses, in particular in relation to the diagnostic indicators.[30] These latter are the key components of nursing assessment[31] that represents the foundation of the nursing process because selecting the correct etiology for the diagnosis guides caretakers to select nursing interventions that impact care outcomes.[7] Because Gordon's Functional Health Patterns are incorporated within Florence as an approach to nursing assessment, students were guided through a nurse-centric, systematic method to assessment; using the traditional paper-based approach, the students could sometimes neglect this critical part, choosing the diagnosis before having collected all the necessary information. From the literature, the use of Gordon's Functional Health Patterns as a framework for nursing assessment demonstrated enhanced patient, organizational, and students' learning outcomes.[32,33]

The satisfaction levels of nursing students using the NP-CDSS were greater in comparison to the traditional approach even if the difference was not statistically significant. This is not necessarily a negative result considering that the main aim of the study was not to improve the student satisfaction but to sustain their learning. In the future, satisfaction levels may be enhanced by working on the usability of the platform. This study provided the score of the usability of the platform by all enrolled students, whereas a smaller portion of participants was usually considered in the literature.[19,34] From the analysis of the System Usability Scale individual scores, students expressed a need for additional technical support to be more confident in their use of the system. This result could be linked to the fact that students did not have the time to achieve an adequate level of experience in the use of the system. However, the aim of this study was to evaluate the impact of using the NP-CDSS, and more reliable results could only be obtained by enrolling students who did not have previous experiences with the system, like the population recruited in this study.

Other standardized nursing languages could be included in educational platforms to allow educators to quickly and automatically compare and test larger international nursing student populations. Some of the potentialities of these platforms could provide automatic feedback to students using machine learning and artificial intelligence techniques and could be integrated with physical mannequins (eg, high-fidelity simulators) to provide a fuller immersion using standardized terminologies. Because these technologies are expanding, and policies are also pushing toward using electronic health records,[12] the education of future care providers on electronic documentation represents a current challenge. Future studies should involve other cohorts of nursing students (eg, first and second year), using different clinical scenarios and data collection timing as well as compare educational platforms with other educational strategies.

Finally, nursing curriculum designers should ensure that NP-CDSS and documentation process can be applied to the real-life electronic health records in patient-centered care; to achieve this goal, it should be essential to evaluate how realistic it is to use these technologies compared with the real-world systems and how these systems are reflective of the nursing workflows.

Strengths, Limitations, and Future Perspective

User-friendliness of electronic health records represents an issue for nurses in clinical practice, and using this platform could improve their skills for their future workplaces.[14] Considering the study findings, Florence was found to be a useful and positive learning experience for students. A strength of this study is that the improvement of accuracy from phase 1 to phase 3 was maintained after controlling for possible demographic confounders using linear mixed-effects modeling. Study limitations included the small sample size, the absence of a control group and randomization, the testing only on third-year students, and the lack of students' familiarity with the platform. Findings call for caution in generalizing the results to other educational settings.

Nursing Process–Clinical Decision Support System using standardized nursing terminologies should be taken in consideration by policymakers and academic managers as a valid educational strategy to be utilized as a complementary approach to traditional teaching. Nursing programs should include electronic documentation system courses in the nursing curriculum to prepare future nurses to use them in a safe learning environment and to improve the quality of their clinical reasoning.

Nursing Process–Clinical Decision Support System as Florence can be valuable for nursing documentation because through these systems, nurses can use data to improve the quality and safety of patient care and research. Using the NP-CDSS within educational settings allows nursing academic leaders the opportunity to provide students with time to familiarize themselves with electronic information systems for use in clinical practice and enhancing student learning. In addition, students have the opportunity to access a large amount of data that can be analyzed to enhance evidence-based clinical practice and clinical decision-making.

CONCLUSIONS

This study demonstrated the impact of using an NP-CDSS in nursing education as a pedagogical strategy to improve

clinical reasoning skills adopting standardized nursing terminologies. This NP-CDSS improved the nursing diagnostic accuracy and provided additional data about the international debate on the effects of these systems on the learning outcomes of nursing students.

Nursing faculties should recommend exposing nursing students to these systems supporting the clinical decision-making process, integrating them in their curriculum, and linking these technologies to real-life nursing practice. Nursing curriculum designers could develop best-practice guidelines to standardize the use of these systems to facilitate the transition from educational environment to clinical practice.

The study results highlight the potential of electronic documentation system as an effective pedagogical strategy to build a positive and safe educational virtual environment. Further studies with a larger sample size using experimental designs are required to confirm the tendency highlighted in this research experience.

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