Development of a web-based tool to evaluate competences of nursing students through the assessment of their clinical skills

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ABSTRACT

Background: Assessing the clinical ability of nursing students continues to be a fundamental challenge within the nursing degree. Designing innovative teaching strategies while ensuring an educational experience that results in safe nursing practices is an additional challenge for all educators.
Objectives: To design, develop and implement a tool to evaluate the clinical skills of nursing students.
Design: A two-phase study. In the second phase, a pre-experimental study was conducted.
Settings: Health Sciences Department of the University of Almería, Spain.
Participants: 250 Nursing students in the second year of their degree.
Methods: The study was divided into 2 phases: 1st) *Web-based tool design and development* and 2nd) *Usability testing.* In the second phase, a pre-experimental study was conducted both with an experimental group and a control group.
Results: In the first phase, a panel of 15 experts confirmed that the content and technical aspects of the tool were adequate (scores of 4–5/5). In the second phase, the participants of the experimental group showed higher final scores in the evaluated skills section, as well as shorter evaluation time and a greater number of observations and registered incidents than the participants in the control group. Finally, the students of the experimental group indicated a greater degree of satisfaction with the evaluation system used.
Conclusions: The web-based tool designed is an effective strategy to evaluate clinical skills. It is important to have strategies and instruments that allow us to demonstrate the development and acquisition of the skills required for future nursing professionals.

1. Introduction

Although the concept of nurse competence has been studied since 1980 (Smith, 2012), it is not yet universally defined (Cowan et al., 2005; Yanhua and Watson, 2017). Within countries and across international borders, there are different approaches to nurse competence. However, in recent decades a search for consensus has emerged to clarify the concept (O'Connor et al., 2017; Yanhua and Watson, 2017).

According to official bodies, nursing competence is defined as a combination of knowledge, skills, abilities and attitudes (American Nurses Association, 2010; Nursing and Midwifery Board of Australia, 2006; Nursing and Nursing and Midwifery Council, 2010). In the context of an increasingly complex provision of health services, nursing students must demonstrate competence and confidence in a wide range of clinical skills (Nursing and Midwifery Council, 2010). Evaluation is a fundamental part of the teaching and learning process. However, up to now there is no consensus on the best way to teach or evaluate clinical skills and this can be seen as a challenge for both professionals and educators (Bloomfield et al., 2010). Given the value of clinical competence, it is imperative to repeatedly reinforce and evaluate such a concept, especially among undergraduate nursing students, who are being prepared for their future role as nurses (Rebueno et al., 2017). Therefore, assessing clinical competence has become a fundamental aspect when evaluating health science students in general, as well as in the nursing degree specifically (Castro-Yuste et al., 2018).

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2. Background

For the nursing student, the evaluation of clinical competences is one of the aspects that creates the greatest expectations during their academic training (Lovric et al., 2017). Although many assessment methods have been developed in order to determine the progress among students in terms of competence (Kuh et al., 2014), consensus on the most appropriate evaluation method has not yet been reached. In addition, the method of assessing competence acquisition among nursing students has been affected by subjective aspects, which have presented several drawbacks such as variability in the evaluation method (Calman et al., 2002; Hsu and Hsieh, 2009; Hsu et al., 2013). These methods have not been sufficiently researched no have they been validated (Bartlett et al., 2009). Therefore, nursing educators demand more studies that evaluate the effectiveness of the learning assessment in nursing education programs (Annan et al., 2013).

The lack of instruments or tools is partly due to the time, organisation and resources that it requires; hence the importance of finding new alternatives to facilitate their evaluation, such as the use of new technology. The potential of new technology to improve both teaching and learning has become more than evident in recent decades. Specifically, strategies that incorporate new technology generate great interest and offer a potential scope for practical teaching, review and evaluation of clinical skills (Bloomfield et al., 2010).

Designing innovative teaching strategies and while simultaneously ensuring an educational experience that results in safe nursing practices is a challenge for all educators (Eymard et al., 2014). There is a notable shortage of literature related to the use of new technology for training assessment in the context of clinical skills education. Based on the aforementioned points, and along the same lines as the paradigm that promotes the European convergence process, the objective of this study was to design, develop and implement a tool to evaluate the clinical skills of nursing students.

3. Methods

The study was divided into 2 phases: 1st) *Web-based tool design and development* and 2nd) *Usability testing.*

3.1. First Phase: Web-based Tool Design and Development

The first phase consisted of the design and development of the web-based tool. The website was developed by nursing professors who were supervised by computer experts. The application of the website was scheduled within the evaluation of the Nursing for Adults subject, which is part of the 2nd year of the nursing degree. The tool was designed as a web page to facilitate teacher access and use from simulation laboratories. The professors responsible for the subject determined the clinical skills to be evaluated that were included in the course content. The content was developed following the guidelines established by nursing diagnoses (NANDA) (Herdman and Kamitsuru, 2014), Nursing Outcomes Classification (NOC) (Moorhead et al., 2013) and Nursing Interventions Classification (NIC) (Bulecheck et al., 2013).

The clinical skills to be evaluated were: venipuncture; oxygen therapy; administering intramuscular injection; administering intradermal injection; bladder catheterisation; administering subcutaneous injection; and preparing parenteral medication (Fig. 1). The tool allowed for the skill to be assigned randomly or manually, evaluate each of the items in the procedure, measure the execution time and include an observation section (Fig. 2). In addition, the tool allowed for the skills to be evaluated by pairs, creating a final document with the average scores of each evaluation.

The website was developed using HTML 5 language (HyperText Markup Language, version 5) and CSS 3 (Cascading Style Sheet, version 3). The code used was based on JQuery (multiplatform library of JavaScript) to streamline navigation and improve the user experience.

The database used a Firebase environment.

Before starting the use of the web-based tool, a group of 15 experts, comprised of nursing and computer science professors, evaluated the content of the tool as well as its technical adequacy. For this, the researchers developed a scale based on the results of previous studies (Goes et al., 2011; Freitas et al., 2012; Sousa et al., 2016). The scale contained 12 items divided into two dimensions: content of the tool and technical aspects. A Likert scale from 1 to 5 was used where 1 was totally inadequate and 5 completely adequate. All the evaluated items scored between the values of 4 and 5 (Table 1).

3.2. Second Phase: Usability Testing

The second phase consisted of applying the web-based tool.

3.3. Study Design

To implement the tool, a pre-experimental study was carried out with an experimental group and a control group.

3.4. Participants

A total of 250 students participated. The inclusion criteria were: 1) to be enrolled in the Nursing for Adults subject in the 2nd year of their Nursing Degree, and 2) not to be an exchange student. Participants were randomly placed in an experimental group and a control group.

3.5. Procedure

Prior to the data collection, the University's Institutional Review Board approved the study. The implementation of the tool and data collection was conducted from May 2017 to January 2018. First, the first phase previously described was completed. Once the tool was designed and developed, the pilot version was carried out for the evaluation of clinical skills within the specific subject. Before the evaluation, the researchers informed the participants of the purpose of study and requested their collaboration and participation. Once signed informed consent was obtained, the tool was implemented. The students previously completed a knowledge assessment test. Once the knowledge test was completed, the students were evaluated for clinical skills in the simulation laboratory. Participants were randomly placed in an experimental group (EG) and a control group (CG). The CG was evaluated traditionally, that is, through the observation of a single evaluator and using a paper record. In the EG each participant was evaluated by two observers using the web-based tool (Fig. 3). At the end of each evaluation, the participant was given the results of their procedure and a debriefing was carried out. Depending on the procedure, the high and low fidelity simulation was used. Finally, the participants completed a satisfaction questionnaire based on previous studies (O'Connor et al., 2017). The score method used was a Likert scale where the meanings were: 1 = totally disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = totally agree.

3.6. Data Analysis

The statistical program SPSS version 23 was used for the data analysis. First, a descriptive analysis was conducted, calculating quantitative variables, such as means and standard deviations, while frequencies and percentages were used for the categorical variables. The nonparametric Mann Whitney U test was used to compare the qualitative and quantitative variables. A $p < 0.05$ was considered significant.
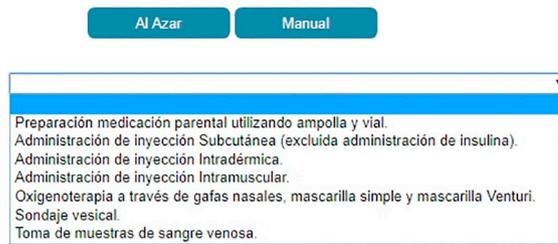
Fig. 1. Selecting the procedure to be evaluated.

4. Results

4.1. Sociodemographic Characteristics of Participants

Of the total number of participants ($N = 250$), 78% ($n = 195$) were women and 22% ($n = 55$) were men. The average age of the participants was 22.18 (SD = 5.16). The distribution of participants by group can be seen in Table 2.

4.2. Results of the Clinical Skills Evaluation

Prior to the evaluation of clinical skills, the participants took a knowledge test, showing no statistically significant differences ($U = 2442.5$, $z = -1.136$, $p = 0.256$).

In the evaluation of clinical skills, the most evaluated procedures for the EG were the administration of intramuscular injection ($n = 20$, 8%), intradermal injection (n = 20, 8%) and bladder catheterisation (n = 20, 8%); while in the CG it was the administration of intradermal injection ($n = 25$, 10%) and the preparation of parenteral medication

($n = 36$, 14.4%). Globally, the results of the evaluation in the EG was of 1.53 (SD = 0.47), while in the CG it was of 1.37 (SD = 0.50) considering a score on 2 possible points, showing statistically significant differences ($U = 1936.0$; $Z = -2.998$; $p = 0.003$).

In the EG, the skills with the highest scores were the administration of subcutaneous injection (1.78 ± 0.98), administration of intradermal injection (1.71 ± 1.45) and oxygen therapy (1.70 ± 1.30), while the one with the lowest score was administration of intramuscular injection (1.56 ± 3.75). On the other hand, in the CG, the skill with the highest score was administration of intramuscular injection (1.72 ± 0.88), while bladder catheterisation obtained the lowest score (1.20 ± 1.04).

Regarding the observations, a greater number of incidents was recorded in the EG (5.01 ± 2.89) than in the CG (4 ± 2.66), showing statistically significant differences ($U = 1693.0$; $Z = -2.304$; $p = 0.019$).

Finally, with regards to time, the average time used to evaluate the skills in the EG was 11.51 (SD = 1.68) and 12.17 (SD = 1.46) in the CG, showing statistically significant differences ($U = 1693.0$; $Z = -2.304$; $p = 0.003$).

Fig. 2. Evaluation of the venipuncture.

Table 1
Expert scores of tool content and technical aspects.

Items	M*	SD**
Content		
1. The purpose of the tool is consistent with the training of a nursing student.	4.80	0.41
2. The tool facilitates the assessment of clinical skills.	4.87	0.35
3. The content of the tool corresponds with the proposed objective.	4.87	0.35
4. The tool content coincides with the content of the subject.	5	–
5. The information presented in the tool is correct.	5	–
6. The information presented in the tool is well structured.	4.73	0.45
Technical aspects		
7. Ergonomics.	4.80	0.41
8. The user can change from one screen to the next easily.	4.87	0.35
9. The style used is appropriate.	4.93	0.25
10. The controls and commands can be distinguished easily.	4.80	0.41
11. Functionality.	5	–
12. The tool is easy to use.	4.93	0.25

* M: Mean.
** SD: Standard Deviation.

4.3. Student Satisfaction Results

At the end of the evaluation procedure, the participants completed a satisfaction questionnaire, with the average EG score being 4.30 (SD = 0.38) and the CG score being 3.94 (SD = 0.49). Statistically significant differences were found when comparing the mean satisfaction score with the groups (U = 4449.0; Z = −5.900; p = 0.000).

5. Discussion

The objective of this study was to design, develop and implement a tool for the evaluation of clinical skills among nursing students.

Table 2
Demographics characteristics and skills evaluated.

Item	Experimental group (n = 125)		Control group (n = 125)	
	n	%	n	%
Sex				
Man	25	20	30	24
Woman	100	80	95	76
Procedure				
Venous blood collection	18	7.2	12	4.8
Oxygen therapy	18	7.2	10	4
Intramuscular injection	20	8	13	5.2
Intradermal injection	20	8	25	10
Bladder catheterisation	20	8	14	5.6
Subcutaneous injection	15	6	15	6
Preparing parenteral medication	14	5.6	36	14.4
Age	21.93*	4.91**	22.43*	5.41**

* Mean.
** Standard Deviation.

Education professionals are responsible for creating teaching innovation strategies that allow for the optimisation of time and resources. Because of this, the nursing faculty must adopt more innovative teaching methods to peak students' interest and motivation in learning the content, as well as to strive for excellence in their teaching and in students' learning experiences (Cho et al., 2018; Papathanasiou et al., 2014; Wolf et al., 2004). A fair and consistent assessment of nursing students' acquisition of clinical skills by nursing students remains an important challenge for nursing educators (Eymard et al., 2014).

The design and implementation of this web-based tool is in accordance with the search for excellence in methods for student learning and assessment. Authors such as Wood and Su (2017) and Cho et al.
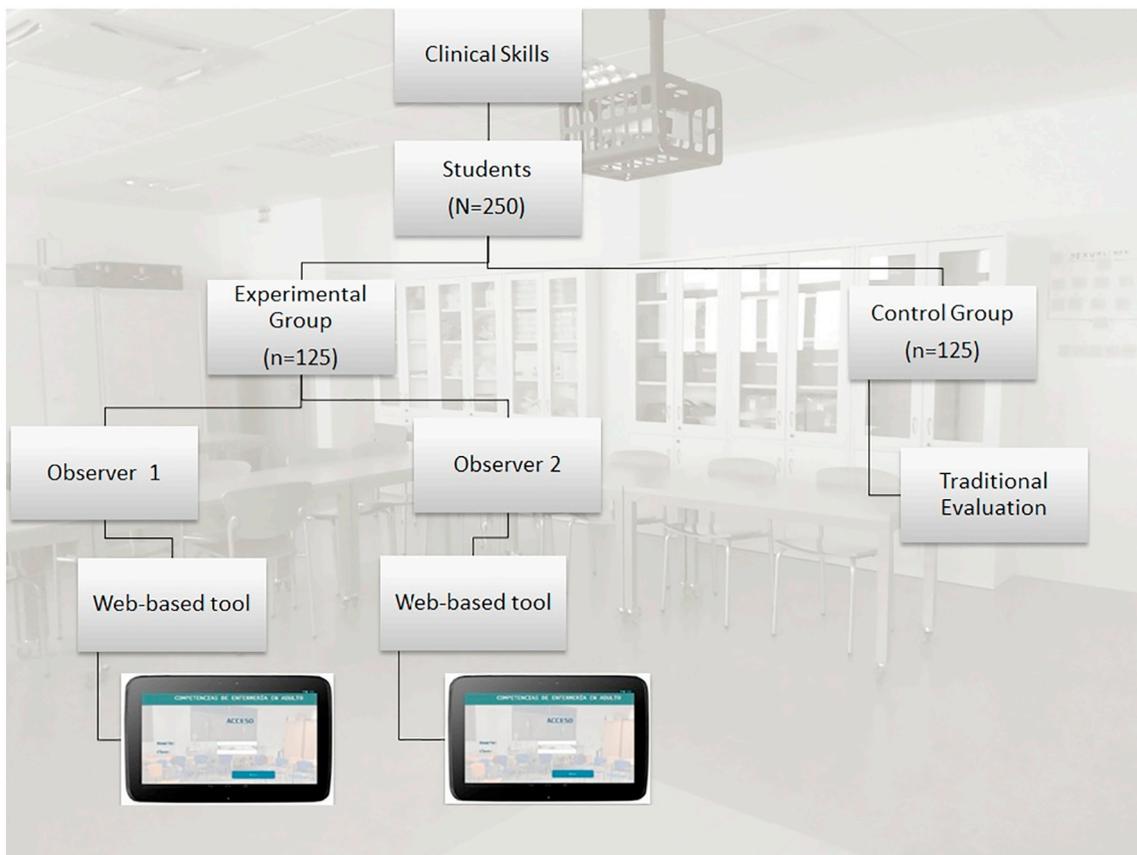

Fig. 3. Participant distribution.

(2018) state that excellent teachers are those who are able to motivate students, establish a safe learning environment, influence students' desire to learn with appropriate disciplinary knowledge and approaches, and have a supportive relationship with students. This search for excellence must be focused on the aspects that concern the student's education the most. Along the lines of what has just been mentioned, certain authors establish that the evaluation of clinical faculties is the most important aspect for the student (Lovric et al., 2014, 2017).

The experts who participated in the evaluation of the tool indicated high levels of adequacy, which establishes that the tool was well designed with regards to the objective established. That is, it allowed to measure the acquisition of clinical skills in nursing students, which will affect the provision of quality care for the patient (Navabi et al., 2016).

Although the objective of this tool does not directly affect learning, statistically significant differences were found in the final results between the EG and the CG. This could be due to the fact that significant improvements were observed with regards to the time of evaluation, recording of incidents, more objective evaluations and greater satisfaction of the student, which consequently affects the student's learning and motivation. In this sense, this evaluation system should be considered as an element to identify weaknesses and strengths, as well as opportunities to improve clinical skills as indicated in other studies (Pazargadi et al., 2013).

Additionally, the web-based tool allows the establishment of structured, clear and more objective content, within a scope that has sometimes been called unclear, inconsistent and subjective (Eymard et al., 2014). On the other hand, it also allows having a greater control of time and making more dynamic observations. For example, previous studies have already shown the importance of establishing timestamps during the evaluation (Bloomfield et al., 2010) as well as the efficiency of time with this type of resource (Jawaid et al., 2014).

The tool designed allowed for the collection of more incidents and observations to debate during the debriefing. Constructive feedback is essential in any clinical evaluation to allow the student to integrate the knowledge and skills required to gain competence and confidence (Ali and Musallam, 2018; Bloomfield et al., 2010), so this should be considered an integral component of the computer tool. Finally, the EG participants showed a higher level of satisfaction with the methodology used to evaluate their clinical skills than the CG participants, which could imply that the tool is well accepted by the students. This would be in accordance with what was expressed by the panel of experts.

5.1. Limitations

The results of the present study should be considered taking into account a series of limitations. First of all, the sample was selected through convenience sampling, and in a single institution, which limits the generalisation of the results. On the other hand, there is a possibility of social desirability bias; the participants could have modified their performance during the evaluation by feeling observed. In theory, a pre-post test methodology was not considered since the main objective was the development and implementation of the web-based tool. In future research projects, an initial and final analysis should be considered. In addition, it is necessary to bear in mind that the application of this type of new methodologies requires adaptation time for the faculty and the student (Nickitas et al., 2010), so the implementation of the tool should be applied gradually. Finally, the absence of related literature on the subject makes it difficult to discuss the results since there are few technological tools designed to assess the clinical skills of nursing students, so the impact of this type of tool on the student's learning and evaluation process should be studied in depth. Future research projects should incorporate new clinical skills to evaluate, as well as the possibility of adding new elements to the evaluation method.

6. Conclusions

The tool designed is an effective strategy to evaluate clinical skills. Typically, conceptual competence is measured through knowledge assessment methods. However, the attitudinal and procedural competence developed in the practical part of the subject is not measured objectively in most cases. Therefore, we are faced with the need to have strategies and instruments that allow us to demonstrate the development and acquisition of the skills required for the future nursing professional.

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