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Original Article

Development and application of an online testing system for clinical nurses

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ABSTRACT

The online assessment is a new examination system which has a broad application in many research fields such as medical science and has been proved to be effective, reliable, and robust. The aim of this study was to establish an online testing system for clinical nurses and to assess its effectiveness compared with traditional paper-based tests in China. A randomized controlled trial was performed, a total of 1802 nurses were recruited and randomly assigned to take either the paper-formatted test or the online test. Then the paper quality, examinee's performance and nurses' assessments of online testing system were evaluated. The results shown that online assessment system for clinical nurses had a comparable examination effects with traditional paper-based format, and the nurse spoke highly of its effectiveness and efficiency. These data suggest that online nursing assessments should be considered a dependable replacement for paper test.

1. Introduction

The "digital healthcare" is a new healthcare management philosophy derived from "hospital information construction," which is based on high levels of integration, process optimization, and energy conservation [1,2]. Implementation of these practices will lead to optimized practices in nursing management. China currently has 2.8 million registered nurses. Traditional paper-based nurse assessment tests have been limited by their ineffectiveness and wastefulness in terms of manpower, material, and financial resources. The online assessment is a new examination system that has been shown to be effective, reliable, and robust [3–6]. The development and application of online assessment systems for nurses has attracted attention due to its high level of integration, standardization and paperless attribute of the "digital hospital." However, few studies have addressed potential weaknesses in the new online assessment system, such as imperfect programming, the quality of assessment questions, and inferior Internet platforms. Importantly, no comprehensive evaluation of its effectiveness has been performed in China. Our study attempts to develop a more reliable, science-based, and practical online assessment system for clinical nurses based on the traditional paper-based test formats. We then conducted an evaluation of its effectiveness.

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2. Materials and methods

2.1. Subjects

We recruited 1802 nurses who participated in the final theory examination in 2013. Participants were randomly assigned to either take the online assessment system or the traditional paper-based test. We ensured no significant difference between the two groups in terms of sex, age, educational background, years of working, or professional titles ($P > 0.05$).

2.2. Analysis of system requirements

System requirements were analysed by assessing the system framework, the basic functional modules, and technical points. The online assessment system was built on B/S (Browser/Server) model and operated on an MS platform following the principles of integrity, standardization, scalability, and security. The whole system was data compatible and expandable.

2.3. Construction of question bank

An expert group was put in place to regularly classify, proofread, and update all questions. The question bank covered a wide range of question on basic nursing, medical nursing, surgical nursing, obstetrics, gynaecological nursing, and paediatric nursing. Questions were formed as type A, type B, type X, multiple choice, true/false, fill-in-the-blank, short answer, essay, and one case study question.

2.4. Generation of tests

Three types of tests were assembled for this study:

1. Paper tests: We collected a random sampling of test questions, but specified question topics, difficulty, and question format. Three versions of paper tests were randomly distributed to the examinees. Each test version had identical content, but questions were in different orders.
2. Online tests: A testing centre was created in a way to prevent cheating. The online test system could track examinees' responses in real-time, track progress, compute current accuracy, and generate scores. The system was also configured with power failure backups, anti-crash technology, and an alert when five minutes were remaining.
3. Mock tests: The online system also provided mock tests for training purposes.

2.5. Management of tests

The testing systems required the following managerial upkeep:

1. Question bank management: Questions were organized categorically in a tree-like structure. The system could customize the question topic, format, and difficulty of questions. It could also accept bulk importing, error location, and similarity check.
2. Paper test management: The system was designed with the ability to print, reorganize, modify, review, and evaluate all paper tests.
3. Examination management: The system had the capability to set the examination environment, preventing cheating, security assurance, and enter simulation mode.
4. Score management: Qualified professionals assessed subjective questions, while objective scores were automatically marked correct or incorrect. Test scores were calculated by statistical functions. Results were exported and archived into 20 statistical reports for further utilization.
5. User management: The system could set, modify, and store users' information.

2.6. Examination methods

The experimental group was tested via the online assessment system. Prior to testing, a short training was carried out to ensure that participants knew how to take the exam. The control group was tested using paper tests. Questions included the standard examination syllabus from Basic Nursing (Version V). A total of 100 points were possible, with 30 points from single choice questions, 20 points from multiple choice questions, 20 points for true/false questions, and 30 points for a case analysis.

2.7. Test quality evaluations

Paper tests and online tests were evaluated by calculating difficulty coefficients, distinguishing coefficients, reliability, and validity. Difficulty coefficients (P) were expressed as the average score divided by the total score. Higher P-values indicated less difficulty. Ideal intervals were considered to be ~0.6–0.8. Distinguishing coefficients (D) were calculated by X_H-X_L/100 (X_H = the average score of the top 27% of scores; X_L = the average score of the lowest 27% of scores), $D \geq 0.3$ was considered to be a favourable value. Reliability, representing the consistency and stability, was calculated by Cronbach's α. Reliable values were set at 0.4–0.76. Validity, representing the accuracy and effectiveness of the paper test, was calculated by criterion-related validity. Scores were considered reliable between 0.4 and 0.7 [7]. The 2012 test results were also compared to the current results.

2.8. Performance evaluation

The average test scores of the two groups were evaluated to determine their comparability.

2.9. Nurses' assessments of online testing system

To get nurses' opinions on the online testing system, a questionnaire was given to the experimental group. The questionnaire included questions on satisfaction, fairness,