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THE IMPACT OF ON-LINE MULTI-CHOICE QUESTIONS ON UNDERGRADUATE STUDENT NURSES' LEARNING

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Abstract

This study investigates second year undergraduate student nurses' use of on-line Multi Choice Questions (MCQ) to support learning. Drawing on a sample of 42 second year undergraduate nursing students enrolled in a Bachelor of Nursing Degree, a descriptive survey was undertaken to provide a clearer picture of what students regard as helpful with on-line MCQ. The students' perceptions of this mode of learning were also explored using a qualitative approach. The survey revealed that all 42 students found the on-line MCQ helpful for their learning, though how the students approached learning varied. While the results indicated that the on-line MCQ supported the course design, learning and revision there is still room for improvement and consideration is given to the use of feedback.

Active learning for undergraduate nurses

Computer-based learning technologies are becoming increasingly popular with educators in nursing courses as a teaching tool for developing student learning. In conjunction with traditional teaching and assessment methods a computer-based learning tool was introduced into the pathophysiology course of an undergraduate-nursing programme. "Pathophysiology is generally perceived by students as one of the most difficult courses in the nursing curriculum" (Elberson, Vance, Stephenson, & Corbett, 2001, p. 259). Traditionally pathophysiology has been taught by means of didactic teaching methods and assessed using a written exam. Didactic teaching encourages passive learning and provides little opportunity for feedback (Teikmanis & Armstrong, 2001). According to Teikmanis and Armstrong, active learning is a necessary skill for students who are preparing for a professional role. Chickering and Gamson (1987) identified seven principles for good practice in undergraduate education to enhance student learning which included using active learning techniques. In 1996 Chickering and Ehrmann further reported that computer-based learning could provide a less intimidating way for implementing these principles in practice.

Undergraduate nursing education at the University of Auckland is new, having been offered through the School of Nursing, within the Faculty of Medical and Health Sciences since 2000. The Bachelor of Nursing degree is a three-year, full time programme that consists of both theory and clinical practice. The second year of the programme incorporates an integrated course titled Nursing 201, 'Nursing Clients with a Pathophysiological Problem' (Nursing 201). In this course there is an expectation by lecturers that students become active learners. The structure of the course includes inquiry-based learning, which encourages students to think for themselves and take responsibility for their own learning. Rather than being passive learners, students use critical thinking skills to solve problems. The students discover how to meet the health needs of clients with pathophysiological problems using case studies that apply to their practice. Bonwell and Eison (1991, cited in Teikmanis & Armstrong, 2001) suggest that case studies

can be an effective strategy for enhancing problem solving and critical thinking skills. Multi Choice Questions (MCQ) delivered on-line are used to reinforce and assess student learning of the case studies. Teikmanis and Armstrong (2001) maintain that if used appropriately computers are an effective teaching tool which can facilitate active learning.

There is also an external driver for using MCQ to assess learning in the course. The Nursing State Examination regulated by the Nursing Council of New Zealand is a multi-choice examination consisting of two papers each with 90 questions (Nursing Council of New Zealand, 2003). Candidates take the state examination at the successful completion of an approved three-year undergraduate nursing programme.

On-line MCQ

There are many well-developed computerised learning platforms in use today in higher education for promoting and assessing learning. Computerised assessment is used in many different contexts for both formative tests and summative exams and there are many user-friendly products available for creating on-line assessments (Thelwall, 2000). The platform utilised in the current study is a web-based computer-supported learning environment developed by the University of Auckland as a resource to support life-long learning. It has become a formal link between disseminating knowledge and assessment.

To reinforce and assess learning in the course, MCQ are delivered on-line within parameters that the teacher controls. In the course, only enrolled students have access to the on-line learning resources. The MCQ are available in sets of twenty questions related to each of the case studies. Thirty minutes is the maximum time allowed for the completion of each set which may be attempted three times. Only the highest score of the three attempts is recorded.

Selected MCQ are peer reviewed by the teaching team prior to use. To match the Nursing State Examination format a stem question and four distractors, or options for the correct answer, are provided. The shuffle setting is utilized to mix both the order of the questions and the distractors, making rote learning of answers less likely. Question sets are released in conjunction with a case study. Students have between one and three weeks to complete the MCQ and the time specified is dependent on whether students are on campus or off campus undertaking clinical practice. As the university platform is web-based students can complete the MCQ on any Internet enabled computer, either at home, in the library, or on-campus. Previous students of the course requested hardcopies of the MCQ as they considered them useful for directing their study. Copies of MCQ can also be downloaded as a document file in the event of the original being lost or damaged.

The delivery platform controls the time allowed for each test and also marks and records the grades for each student. Administratively this is easier than manual preparation and marking of a test and eliminates the class time required for administering the quiz. It is also possible for the teacher to monitor each student's attempts and achievements in the MCQ; also class grades and accumulative totals are then available.

Student's can self-pace their learning with the on-line MCQ as feedback is given electronically, immediately after an answer is selected. Students have the choice of repeating each MCQ set up to three times, and the teacher generated feedback aims to assist them to identify learning needs and guide further study. The feedback is positive for a correct answer ("well done", "you're right") and constructive for an incorrect answer, which directs the student to a specific chapter of their prescribed text. In this manner the student is encouraged to engage with their textbook. The MCQ can therefore be considered formative as they support ongoing learning, and summative as results of the best of five sets contribute five percent of the final grade of the course. In previous semesters it was found that most students achieved close to the possible five percent.

Although to date very little research has explored computerised testing in nursing education programmes in Aotearoa/New Zealand, there is understanding of the teaching design behind the use of the on-line

MCQ. However, the experience of students has not been evaluated. The current study specifically examines the strategies that students' use with on-line MCQ and to determine whether the strategies support learning in a pathophysiology course.

On-line assessment

A concern often raised about computerised summative assessment is whether it is effective in assessing higher cognitive skills, as the tests usually comprise of multi-choice questions, which have traditionally tested simple comprehension. It is argued that computer-based assessment cannot examine critical thinking skills such as developing a logical argument in an essay, or creative works. However research has shown other than testing facts, well written MCQ can test interpretation and understanding, and can be as reliable as traditional assessment methods. Using a framework for learning based on Bloom's taxonomy Cox and Clark (1998) described how to construct questions for formative quizzes to test all cognitive levels of learning. Thelwall (2000) described many advantages of using MCQ and maintained they are appropriate in higher education, though their scope is limited. Therefore MCQ should be used in conjunction with other assessment methods.

Overwhelmingly student reaction to computerised testing has been found to be positive, both within the nursing discipline and beyond (Bloom & Trice, 1997; Cunningham & Roche, 2001). However the use of an on-line learning environment requires students to use a more structured approach to answering questions. Anna (1998) found this negative aspect of the computer based testing process emerged due to the inability of students to move back and forward in the test to review previously answered questions and bypass more difficult questions.

Thelwall (2000) found computer access to practice tests when studying for an assessed test impacted on the students broader study habits as some students took home test printouts to use for revision. Thelwall found three dominant strategies in students studying methods:
- Students didn't practice at all
- Students practiced on the computer
- Students practiced on paper with test printouts.
The author noted that only a small proportion of students did not practice at all, those students also tended not to turn up for lectures or workshops, and 86% of students felt the practice test helped them to learn. Further, 65% of students felt that the test had motivated them to revise more.

Students appreciated the opportunity to take tests at a time that suited them (Bloom & Trice, 1997). Many students chose to take their tests at the latest possible moment, however this did not negatively affect the grades these students obtained. Similarly Anna (1998) reported 99% of students who undertook computerised tests supported the ability to choose the dates and times to take their computerised tests. On-line MCQ can be carried out when the student feels ready, thereby enabling self-paced learning. Other students may prefer group learning and as Cox and Clark (1998, p. 162) state, "Another outcome is the removal of time pressures on students to achieve an answer. They can take their time, discuss with others, look up text books and act in a way that professionals normally act when faced with questions."

Bloom and Trice (1997) found that students who completed an on-line MCQ performed equally or better than those who took the traditional paper version. Difficulty does surround the evaluation of on-line tests as a method of teaching in comparison to paper versions. A common occurrence with computer-based tests in which students are provided with the answers and an explanation immediately subsequent to the test is in a reduced level of students requesting feedback from staff (Anna, 1998; Bloom & Trice, 1997). Indications were that the computer explanations were sufficient for students.

Advantages for on-line MCQ for the teacher include the administration and marking of MCQ, plus the feedback given to students can all occur electronically. The time to develop the tests remains, but the management time is reduced (Anna, 1998; Sheridan, 1997).

Little research was found that reported on the use of on-line MCQ in nursing education. This is despite the fact that the American National Council Licensing Examination for Registered Nurses (NCLEX-RN) is computerised (Bloom & Trice, 1997).

Method

To try to understand if and how MCQ help undergraduate nursing students learn during their pathophysiology course a survey was distributed to students who had completed the course the previous semester. The survey method was chosen because of the convenience and anonymity. As students were used to questionnaires for evaluating courses it was anticipated this method of data collection would result in a high response rate. The questionnaire was developed and went through a process of internal review and editing. The questionnaire allows both a quantitative and qualitative approach. A free text section in the survey instrument was provided for students' comments on the impact of on-line MCQ on their learning. The University of Auckland Human Ethics Committee approved the study and gave permission to invite students to participate. The student's participation was voluntary and responses anonymous. An independent person was used to explain, distribute and collect the questionnaire, as both authors were lecturers involved with the course. The questionnaire took approximately 20 minutes to complete and students were informed they had the right to refuse to answer any question.
A computer software package (SPSS version 10) was used to analyse quantitative data using descriptive statistical methods. Qualitative data were analysed using content analysis.

Results

A 100% response rate was achieved with 42 questionnaires distributed and returned. In the first section students were asked to rate statements on their helpfulness or importance. Overall the on-line MCQ were considered helpful for learning. The availability of hardcopy in conjunction with the on-line MCQ was found to be helpful or most helpful by all students (100%). The majority of students (95%) found the association of on-line MCQ to the case studies within the course beneficial. The timing of feedback was found to be valuable by 93% of students, while the type of feedback was considered as helpful by only 76%. Marks allocated to the MCQ, as part of the summative assessment, were found to be a motivating factor for some students (76%). The statements and the responses are shown in Table 1.

	Not Helpful (%)	Sometimes Helpful (%)	Helpful (%)	Most Helpful (%)
The MCQ are helpful for my general learning	0	7	48	45
The MCQ are helpful for directing my learning using the prescribed text	0	10	38	52
The MCQ feedback straight away is helpful for my learning	2	5	29	64
The MCQ type of feedback is helpful for my learning	5	19	26	50
The MCQ in hardcopy as well as on-line is helpful for my learning	0	0	19	81
The MCQ are helpful for my learning around the case studies	0	5	45	50
	Not Important	Somewhat Important	Important	Most Important
The marks for the MCQ are important to me	2	21	50	26

Table 1: Statements and student responses

Students were then asked to indicate their approaches to learning with on-line MCQ. Options were provided and students could tick all that applied. The ranked options are shown in Table 2. Approaches other than those offered could be indicated, but none were. The most favoured (81%) approach to on-line MCQ was to use it as a revision tool. Thereafter a variety of approaches were found, such as pre-reading before attempting on-line MCQ (64%), completing the MCQ using only the hardcopy first (64%) or using the hardcopy to direct reading before going on-line to complete the MCQ (62%). Other less popular approaches were attempting the on-line MCQ after the student felt they had completed all the study they needed (31%) and undertaking the on-line MCQ straight away (21%). A group approach was preferred by only 20% of students; while 12% indicated they got the answers anyway they could just to get the MCQ completed.

Approach	Response (%)
Use it as a revision tool after study is completed	81
Pre-read before trying MCQ on-line	64
Complete MCQ using hardcopy alone first	64
Use hardcopy to direct reading, then go to do the MCQ on-line	62
Do MCQ on -line to test knowledge to direct study before trying again	52
Do MCQ on-line after completing all the study you think you need	31
Go on-line and try it straight away	21
Complete MCQ using hardcopy with a group first	19
Get the answers any way I can and just get it done.	12

Table 2: How Students approach learning with on-line MCQ

Finally students were asked to share any qualitative comments regarding the impact of on-line MCQ on their learning. Thirty-one students made a comment and content analysis indicated three key issues.

MCQ supports learning

Overall the responses indicated that students felt on-line MCQ supported their learning. It was apparent that students also found the MCQ encouraged them to read their text more thoroughly. Students specifically commented that using the on-line MCQ provided "active" learning that continued throughout the semester. They also considered that having the MCQ in hardcopy and on-line directed their study. Specifically they commented that they could improve their knowledge base with the marks providing a guide to the level of their achievement. The MCQ were considered a "great" revision tool as they supported students' study for examinations. Students were positive of the way the MCQ built on their knowledge of the case studies and the overall learning they could achieve.

Specific feedback preferred

The computerised feedback received mixed comments. The timeliness of feedback received positive comments only. However, the type of feedback produced varied responses. Students appreciated the "friendly" tone of the feedback while some indicated they would prefer to have more directed feedback for an incorrect answer. Students suggested a specific page, rather than the chapter of their text would be more helpful, especially when it was difficult to discriminate between distractors.

On-line learning is convenient

The on-line platform used to deliver the MCQ was considered useful because it was convenient, self-explanatory and accessible from home. However, a small number of students commented that the speed of their Internet connection was frustrating, with the platform being slow to access and to download from. The availability of a hardcopy to download if their original was lost was noted favourably and others found the independence of being able to test their own learning constructive.

Most students identified no aspects of on-line MCQ hindered their learning. Negative comments tended to relate to the on-line environment and remembering to complete the MCQ within the time frames.

Discussion

The principles for good practice in undergraduate education (Chickering & Gamson, 1987) were further developed because of advancements in communication and information technology and their use as resources for teaching and learning. The more recent work (Chickering & Ehrmann, 1996) based on the seven principles for good practice with the addition of technology as lever, forms the framework for the following section.

1. Good practice encourages contacts between students and teachers:

Contact was minimal between students and teachers as students take their on-line MCQ independently. Teachers were available for further clarification but only a few students sought teacher input and this seems to not be uncommon (Anna, 1998; Bloom & Trice, 1997). Some students prepared for doing the MCQ on-line and after a first or second attempt (out of three) came to the teacher to seek clarification on a difficult question. Teachers then encouraged discussion around underlying principles and further reading. The questions from students and discussion would often link back to their experience in clinical practice.

2. Good practice develops reciprocity and cooperation among students:

As each student completes on-line MCQs independently it was thought there would be little opportunity for students to work together. However, cooperation was evident amongst a small percentage of students (19%) who worked in groups to complete the MCQ. This links to principle seven which concerns students' diversity and ways of learning (Chickering & Ehrmann, 1996) as students organised themselves into groups, presumably to suit their preferred learning style.

3. Good practice uses active learning techniques:

The on-line MCQ encouraged active learning that related to students inquiry-based case studies and their textbook. As Chickering and Ehrmann (1996, p. 3) state, "learning is not a spectator sport", so methods that encourage students to engage with the learning resources are particularly helpful for promoting learning. For undergraduate student nurses the on-line MCQ required further consideration and reflection on the case studies. The case studies are presented as client scenarios, which are realistic and authentic. The course includes both theory and clinical practice, and the case studies link to clinical practice and the students' developing knowledge and clinical skills.

4. Good practice gives prompt feedback:

The timing of the feedback was found to be more helpful to students than the type of feedback they received. Immediate feedback, as provided on-line, directly after each question, was found to be most helpful or helpful for 93% of students. According to Sly (1999), appropriately timed feedback can be expected to be beneficial to learning. Anna (1998) comments that the provision of immediate feedback is one of the strengths of on-line testing, as students are informed of their progress, which reinforces learning. An advantage for students is that feedback on screen eliminates the delay of knowing how well they have performed in a test, as they get feedback for each question and a mark for the test. The qualitative comments were congruent with the data from students who found the type of feedback to be either not helpful or only sometimes helpful (24%). More specific feedback to direct them to the correct page, instead of the chapter was requested. Interestingly students did not ask for feedback that told them why each distractor was wrong although others (Cox & Clark, 1998) have found detailed feedback for each distractor to be helpful. Consideration has been given to the learning impact of providing feedback to the exact page of the text. Directing students to a specific page may narrow their reading and focus their attention on only finding the correct answer. Going to the chapter gives a broader area for reading and requires a more critical and analytical approach to discern the important information and consider the rationale that makes one distractor more correct than another (Cox & Clark, 1998).

5. Good practice emphasises time on task:

MCQ make up a proportion of the course mid semester test, end of semester examination, and are the only kind of questions used in the Nursing State Examination which students take after the three years

of their Bachelor of Nursing programme. Practice and proficiency with answering MCQ is therefore important. Yet students are enrolled in a course that also includes practice in clinical placements. Having the MCQ on-line allows students to take the test wherever they can use a computer with Internet access. Taking the MCQ can therefore fit around their different shifts, part-time work, and other commitments, which promotes effective use of their time.

6. Good practice communicates high expectations:
Students are informed that multiple attempts are possible with the on-line MCQ to foster their learning and that full marks can be achieved by them all. While the on-line MCQ are used for improvement implying formative assessment, marks are also awarded to contribute, in a minor way, to summative assessment. The students completed a total of seven MCQ sets over the semester and the best five are calculated and contribute five percent of the final grade. Of interest was that while 76% of students thought the marks were important or most important, a further 24% thought marks were either not or only somewhat important. Assessment drives learning (Cox & Clark, 1998). Given that students could attempt just five sets of MCQ and achieve the full marks, it was interesting to note that 87% of students completed more than five. The average grade achieved by students was 95% (weighted 5%). Across the seven MCQ sets the class average for correct answers was between 18.83 and 19.51 out of a possible 20 questions. Despite 12% of students who indicated that they get the answers any way they can just to complete the MCQ, a clear majority of students demonstrate they value the MCQ by their pattern of usage.

7. Good practice respects diverse talents and ways of learning:
The current study showed students used a variety of approaches to complete the on-line MCQ, which probably reflects their individual learning styles. Clearly most students (81%) found the MCQ useful for revision of learning and some students commented that it was helpful in preparing for the mid semester test and end of semester examination. This is congruent with the findings of Thelwall (2000) who found that testing facilitated revision and broader study habits. While Thelwall (2000) found three dominant strategies, the current study indicates four strategies that were more commonly used (used by more than 50% of the students). These were
- Pre-read prior to attempting on-line MCQ
- Attempt MCQ using hardcopy first
- Use hardcopy to direct study before attempting on-line MCQ
- Attempt on-line MCQ to assess knowledge and to direct study

The results indicated that a minority (12%) adopted the approach of "Get the answers any way I can and just get it done", which also was consistent with the findings of Thelwall's (2000) study. The findings show that while students use the hardcopy in different ways for their learning, they all appreciate it, as 100% found the hardcopy either helpful or most helpful.

Overall it was heartening to find the MCQ augmented the inquiry-based course design around case studies, which in turn integrated student's learning and experience in clinical practice. The positive response reflects that MCQ strongly support student learning. Consideration is now being given to extending the use of MCQ to other courses within the Bachelor of Nursing programme. Further study, of a longitudinal nature, following a cohort through would determine whether MCQ better prepares nursing students for the external MCQ based Nursing State Examination.

Conclusions

The overall purpose of this study was to explore the benefits of on-line MCQ for undergraduate nursing students learning. It was anticipated that providing specific information about students' pattern of use and their perceptions of the impact of MCQ on their learning may enable refinement of the current use of MCQ within the course and ultimately extend this further throughout the Bachelor of Nursing programme. This study has gathered evidence to support expansion of the use of on-line MCQ to other courses. It is clear from the responses in this study that students value the on-line MCQ and that this mode of assessment supports their learning.

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