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Cumulative Quizzes in a Nursing Research Course for Nursing Doctoral Students

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Abstract

Background—The purpose of this quality improvement project was to examine the association between regular cumulative quizzes and knowledge retention in nursing doctorate students.

Method—Sixteen students in a large Midwestern university enrolled in a hybrid Nursing Research course were assessed with weekly online cumulative quizzes.

Results—The mean score on the cumulative weekly quizzes was 94% ($SD = 3\%$). The mean score on the cumulative final was 97% ($SD = 3\%$). Fifteen students who completed an average of 12 out of 14 (86%) cumulative weekly quizzes as scheduled passed the course.

Conclusion—The cumulative final scores were higher than the cumulative weekly quizzes and completing more of the cumulative weekly quizzes as scheduled was associated with higher cumulative final scores and passing the course, suggesting improved knowledge retention and ability to use that knowledge in other assignments throughout the course.

Cumulative learning is when an assignment requires students to draw on information they learned earlier in the semester (Lang, 2016). For example, a cumulative final covers material from the entire semester. Students who are evaluated with a cumulative final retain more information than students who are evaluated with a noncumulative final (Khanna, Brack, & Finken, 2013), such as an exam that only covers material from the latter part of the semester. Students who have assessments throughout the semester retain more information on a cumulative final than students who do not have assessments throughout the semester and are solely assessed with a single cumulative final (Domenech, Blazquez, de la Poza, & Muñoz-Miquel, 2015). This may be because cumulative assessments throughout the semester encourage students to distribute their learning activities over the course, instead of postponing preparation until the final is imminent (Kerdijk, Cohen-Schotanus, Mulder, Muntinghe, & Tio, 2015). In addition, students who have cumulative assessments throughout the semester, such as weekly quizzes that cover all content in the course up to that point, retain more information than students who have noncumulative assessments throughout the semester (Lawrence et al., 2013), such as weekly quizzes that only cover content from that week. This may be because noncumulative assessments throughout the semester do not adequately prepare students for a cumulative final. Thus, current research on cumulative

assessments suggests that students retain more information by completing cumulative assessments throughout the semester in preparation for a cumulative final.

An important distinction should be made between cumulative assessments throughout the semester which are a type of formative assessment, and a cumulative final which is a type of summative assessment. Weekly cumulative assessments are formative assessment that occur during the learning process and offer immediate feedback to both students and instructors, such as frequent quizzes and opportunities for recalling or retrieving information from memory where the stakes are low, allowing students a safe opportunity to test their current understanding (Dirks, Wenderoth, & Withers, 2014, p. 4). A cumulative final is a summative assessment which usually occurs at the end of the semester to evaluate what students have learned (Dirks et al., 2014, p. 4).

Cumulative assessments throughout the semester have been examined in undergraduate students from various disciplines, including psychology (Khanna et al., 2013; Landrum, 2007; Lawrence, 2013), math (Beagley & Capaldi, 2016), business (Domenech et al., 2015) and medicine (Kerdijk et al., 2015). However, the effects of cumulative assessments throughout the semester have not been examined in the nursing discipline. With the exception of medical students (Kerdijk et al., 2015), few studies have examined the effects of cumulative assessments throughout the semester on graduate students. Finally, the effects of cumulative assessments throughout the semester have been examined in face-to-face courses (Domenech et al., 2015; Kerdijk et al., 2015; Landrum, 2007) or courses that appear to be face-to-face (Beagley & Capaldi, 2016; Khanna et al., 2013; Lawrence, 2013), but not hybrid courses.

In the current quality improvement project, cumulative assessments were assigned throughout the semester in a hybrid doctoral-level Nursing Research course. This quality improvement project aimed to answer two questions:

1. Is completing cumulative weekly quizzes associated with improved knowledge retention as indicated by higher scores on the final cumulative quiz which served as a final exam? The a priori hypothesis was that the average scores on the final exam would be higher than the average scores on the cumulative weekly quizzes.
2. Is completing cumulative weekly quizzes *as scheduled* associated with improved knowledge retention as indicated by higher scores on the final cumulative quiz which served as a final exam? The a priori hypothesis was that the average scores on the final exam would be higher in those completing more of the cumulative weekly quizzes as scheduled than those completing fewer cumulative weekly quizzes as scheduled.

Method

Sixteen participants included students admitted into the DNP and PhD programs in a large university in the Midwest who were enrolled in Nursing Research, a 16-week hybrid course in which students met face-to-face for three hours once a month (four sessions) with the rest of the course online. This course was required in the DNP program and fulfills the American

Association of Colleges of Nursing (2006) Essentials of Doctoral Education for Advanced Nursing Practice: Clinical Scholarship and Analytical Methods for Evidence-Based Practice. The course examined quantitative and qualitative research methods; the interrelationships among theory, research and practice; the research process; critical evaluation of research findings; and applying ethical criteria for the protection of human subjects in research. The prerequisites were graduate standing or consent of the instructor. The course was taught by a PhD-prepared nurse with an active program of research. Prior to the start of the course, the university's Educational IRB reviewed this project and exempted it, as this was considered a quality improvement project. Students were informed at the beginning of the semester that the weekly cumulative quizzes were part of a quality improvement project and could speak with the professor of the course or the local IRB if they had concerns.

The quizzes were administered online outside of class at a time and location convenient to students. Students were allowed to use their notes and book during the quizzes but were instructed to only take their own quiz, not share answers with their peers prior to their peers taking the quizzes, not help another student while they were taking the quiz, and not receive help from another student while taking the quiz. Although the quizzes had no time limit, once a quiz was started, it had to be completed during that session and could only be attempted once. Each quiz was made available at the beginning of the week and due by the end of the week. If a quiz was not taken by the due date, the quiz was marked late but could still be taken at any time during the semester prior to the last day in the course with no reduction in points, as suggested by Landrum (2007). The first week was a practice quiz, which was not worth any points. The final cumulative quiz which served as the final exam was 100% cumulative, meaning there were questions from every chapter. All of the quizzes combined (including the final exam) were worth 10% of the final grade in the course.

The content for the quizzes came from 1–2 assigned chapters per week. Every quiz had about one question from each chapter, with the length of the quizzes increasing each week from two questions on the quiz from the first week to twenty-five questions on the final quiz at the end of the semester. None of the questions were repeated in a subsequent quiz. All questions came from the test bank of the required text book for the course, which were used over the previous three years in non-cumulative weekly quizzes with over 100 graduate nursing students in the same course at the same institution. All questions were multiple-choice with a stem, four options and one correct answer. The questions were mostly at the *remembering* level of Anderson's revision of Bloom's Taxonomy (Bloom, 1956), with an occasional question at the *understanding* level (Krathwohl, 2002). Students completed other assignments in the course which were at the *applying*, *analyzing*, *evaluating* and *creating* levels of Anderson's Taxonomy (Krathwohl, 2002). Descriptive statistics were conducted to analyze the results.

Results

The sample for this project was comprised of 16 students enrolled in the Nursing Research course fall offered annually in the fall. Fourteen of the students were in the DNP program and two were in the PhD program. All students completed the course. Table 1 describes the results of the cumulative weekly quizzes.

The first question this project aimed to answer was if completing cumulative weekly quizzes was associated with improved knowledge retention as indicated by higher scores on the final cumulative quiz which served as the final exam. The mean score on the cumulative weekly quizzes was 94% (SD = 3%); the lowest was 86% in week 11 while the highest was 100% in week 2 with a range of 14% and mode of 100% across the semester. The mean score on the final exam was 97% (SD = 3%); the lowest score was 93% while the highest score was 100% with a range of 7% and modes of 96 and 100% on the final exam.

The second question that this project aimed to answer was if completing cumulative weekly quizzes *as scheduled* was associated with improved knowledge retention as indicated by higher scores on the final cumulative quiz which served as the final exam. The five students who earned 100% on the final exam completed an average of 13 out of 14 (93%) cumulative weekly quizzes as scheduled. The seven students who earned 96% on the final exam completed an average of 11 out of 14 (79%) cumulative weekly quizzes as scheduled. The four students who earned 93% on the final exam completed an average of 9 out of 14 (64%) cumulative weekly quizzes as scheduled.

Discussion

This quality improvement project aimed to answer two questions. The first question was if completing cumulative weekly quizzes was associated with improved knowledge retention as indicated by higher scores on the final cumulative quiz which served as the final exam. Results showed that the average scores on the final exam were higher than the average scores of the cumulative weekly quizzes. Scores improved from an average of 94% across the cumulative weekly quizzes to 97% on the final exam. This coincides with previous literature that found students who are assessed with cumulative finals retain more information (Khanna et al., 2013), perhaps by encouraging students to distribute their learning activities throughout the course (Kerdijk et al., 2015). The current results also coincide with studies that found students who complete cumulative assessments throughout the semester have improved knowledge retention as indicated by higher scores on a cumulative final than students who have noncumulative assessments throughout the semester (Lawrence et al., 2013).

The second question this quality improvement project aimed to answer was if completing cumulative weekly quizzes *as scheduled* was associated with improved knowledge retention as indicated by higher scores on the final cumulative quiz which served as the final exam. Results showed that completing more of the cumulative weekly quizzes as scheduled was associated with improved knowledge retention as indicated by higher average scores on the final exam than completing fewer cumulative weekly quizzes as scheduled. Students who earned 100% on the final exam completed the most quizzes on schedule (93%), while students who earned the lowest score on the final exam completed the fewest quizzes on schedule (64%).

Cumulative quizzes were added to the course as a method to address the issue that students struggled with other components of the course, especially towards the end of the semester, because they forgot what they learned earlier in the semester. Post hoc analyses were

conducted to determine if completing more of the cumulative weekly quizzes as scheduled was associated with the use of higher cognitive functioning on other assignments in the course that required applying, analyzing, evaluating and creating (Anderson, 2001). Post hoc analysis found completing more of the cumulative weekly quizzes as scheduled was further associated with more knowledge retention as indicated by a higher average grade in the course than completing fewer cumulative weekly quizzes as scheduled.

Grades in the course seemed to reflect how and when the cumulative weekly tests were taken. The average course grade was 95% (SD = 5%); the lowest grade was 79.2% while the highest grade was 98.2% with a range of 19% and no mode. All of the students completed all of the cumulative weekly quizzes. The twelve students who demonstrated the highest knowledge retention as indicated by an “A” in the course completed an average of 12 out of 14 cumulative weekly quizzes as scheduled. The three students who demonstrated the next highest knowledge retention as indicated by an “AB” in the course completed an average of 13 out of 14 cumulative weekly quizzes as scheduled. The one student who demonstrated the lowest knowledge retention as indicated by an earned a “C” in the course, which was a failing grade, completed only 1 out of 14 cumulative weekly quizzes as scheduled, even though no points were deducted for late completions. Whatever prevented the student from completing the quizzes as scheduled could also be the cause of the student failing the course. For example, time management may have been an issue. The quizzes probably indicate short-term surface learning as the quizzes were untimed, open book and mostly at the *remembering* level of Anderson’s (2001) Taxonomy. Since the student was having difficulty meeting the timely requirements for assignments at the remembering level of Anderson’s Taxonomy that was worth 10% of their grade in the course, it follows that the same student may have trouble meeting the timely requirements of assignments at higher levels of Anderson’s (2001) Taxonomy that were worth 90% of their grade in the course.

Limitations to findings include the small number of nursing doctoral students enrolled in one course, in one semester, at one institution with no control group. Since there is literature showing the advantage of cumulative assessments throughout the semester over a single final exam (Domenech et al., 2015) or non-cumulative exams throughout the semester (Beagley & Capaldi, 2016; Lawrence et al., 2013), it is questionably ethical to have a control group. Finally, this project focused on multiple-choice questions. Some articles on cumulative assessments comprised multiple-choice questions (Khanna et al., 2013; Kerdijk et al., 2015; Landrum, 2007; Lawrence, 2013), some had both multiple-choice and essay questions (Domenech et al., 2015), and one had short-answer questions (Beagley & Capaldi, 2016). Although the literature suggests assessments that require producing information result in greater benefits than assessments involving recognition of a correct answer among alternatives, both produce positive effects on later knowledge retention (Roediger & Karpicke, 2006). As there were other assignments in this course that focused on producing information, the current results focus on multiple-choice questions.

There are several strengths to this quality improvement project, as the current results extend the literature in multiple ways. Although previous research included timed (Domenech et al., 2015) and untimed (Khanna et al., 2013) assessments, most research did not mention whether the cumulative assessments were timed or untimed (Beagley & Capaldi, 2016;

Kerdijk et al., 2015; Landrum, 2007; Lawrence, 2013). No previous research mentioned if the assessments were open-book or not. Finally, previous literature focused on face-to-face courses (Beagley & Capaldi, 2016; Domenech et al., 2015; Kerdijk et al., 2015; Khanna et al., 2013; Landrum, 2007; Lawrence, 2013). The current results extend the literature by examining knowledge retention through cumulative, untimed, open-book multiple-choice online assessments throughout the semester in a doctoral level hybrid nursing research course.

Conclusion

In conclusion, in this sample of 16 students, the cumulative final exam scores were higher than the cumulative weekly assessments, suggesting improved knowledge retention. Completing more of the cumulative weekly assessments as scheduled was associated with higher cumulative final exam scores and passing the course, suggesting improved knowledge retention and ability to use that knowledge in other assignments throughout the course. This project should be replicated with an item analysis for multiple-choice questions, in courses with a larger number of students, perhaps by examining the same course across multiple semesters and institutions if possible; in students at different levels such as those in an Associate, Bachelor, and Master of Science in Nursing programs; and in different course formats such as completely online.

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Table 1

Description of cumulative weekly quizzes

Week #	Quiz #	# of questions	Points (%)	Mean Score (%)	SD Score (%)	Mode Score (%)	completed the quiz as scheduled (%)
1	1	2	-	96.6	12.5	100	62.5
2	2	4	0.2	100.0	0.0	100	81.2
3	3	6	0.3	92.7	10.5	100	87.5
4	4	8	0.4	95.3	6.3	100	87.5
5	5	10	0.5	91.9	10.5	100	81.2
6	6	12	0.6	94.8	7.4	100	85.7
7	7	14	0.7	92.4	7.6	100	68.7
8	8	16	0.8	93.4	5.8	100, 94	75.0
9	9	17	0.85	94.9	3.6	94	87.5
10	No quiz						
11	10	19	0.95	86.2	10.1	89	93.7
12	11	21	1.05	89.6	8.6	100, 86	93.7
13	12	23	1.15	90.6	6.2	88, 83	81.2
14	13	25	1.25	94.8	5.6	100	81.2
15	No quiz						
16	14	25	1.25	96.7	2.8	100, 96	87.5
Total		10					