Preparing Students for Success on Examinations: Readiness Assurance Tests in a Graduate-Level Statistics Course

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Abstract

Background:

Formative feedback is one way to foster students' readiness for statistics examinations.

Method:

The use of Readiness Assurance Tests was examined as an educational intervention in which feedback was provided for both correct and incorrect responses in a graduate-level statistics course. Examination scores in the intervention group (n = 56) were compared with those in a control group (n = 42).

Results:

Intervention group examination scores significantly improved from 75.92 ± 14.52 on the Readiness Assurance Test to 90.06 ± 7.06, $p < .001$, on the midterm, and final examination scores improved from 78.23 ± 17.29 to 85.6 ± 6.98, $p = .002$. Intervention group midterm scores were significantly higher than those of the control group (90.06 ± 7.06 versus 79.7 ± 11.6, $p < .001$); however, no differences were found between the groups on the final examination (85.35 ± 9.46 versus 85.6 ± 6.98, $p = .91$).

Conclusion:

Use of Readiness Assurance Tests was an effective modality to increase student self-efficacy, learning experience, and, relative to a control group, midterm examination performance in statistics.

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Preparing Students for Success on Examinations: Readiness Assurance Tests in a Graduate-Level Statistics Course

Statistics courses, although important for nurses pursuing advanced degrees, tend to incite anxiety. Often, students view statistics courses as a major obstacle to their goals (Onwuegbuzie, Da Ros, & Ryan, 1997; Onwuegbuzie & Wilson, 2003). Anxiety often centers specifically around math and test taking (Bandalos, Yates, & Thorndike-Christ, 1995). Prior negative experiences, low math self-efficacy, and poor achievement are associated with statistics anxiety (Zeidner, 1991). Although it is necessary for students to have foundational understanding of some statistical calculations, ultimately they must translate statistical concepts to practice. This translation is especially important for evidence-based nursing practice. Given the combination of a nursing shortage and the need for more advanced practice nurses, faculty need to design student learning experiences that foster self-efficacy and application of course content in practice.

Statistics anxiety is defined as an emotional state of arousal experienced when individuals encounter statistics in any form and is preceded by negative attitudes toward statistics (Onwuegbuzie et al., 1997). Students who view themselves as not being a "math person," have low personal course expectations, or have low self-efficacy in general are more likely to experience statistics anxiety (Nie, Lau, & Liau, 2011; Onwuegbuzie, 2000; Onwuegbuzie & Wilson, 2003). Online courses and accelerated formats are associated with statistics anxiety (DeVaney, 2010). Examinations can also cause statistics anxiety, with timed tests and calculations serving as contributing factors (Onwuegbuzie & Seaman, 1995). More than 30% of nursing students experience general test anxiety (Shapiro, 2014), and a negative relationship has consistently been found between statistics anxiety and performance on statistics examinations (Chapell et al., 2005; Cheraghian, Fereidooni-Moghadam, Baraz-Pardejani, & Bavarsad, 2008; Iranfar et al., 2014; Onwuegbuzie & Seaman, 1995; Onwuegbuzie & Wilson, 2003).

Although anxiety has also been reported as a positive predictor of course performance, high levels of anxiety can lead to debilitation (Onwuegbuzie & Wilson, 2003). Students with statistics anxiety may procrastinate studying for examinations and completing assignments. Onwuegbuzie (2004) found that both fear of failure and task aversiveness were related to test anxiety and statistical interpretation anxiety.

One way to decrease anxiety in general and increase learning is to use formative assessment. This process allows learners to practice and gain feedback to foster content mastery. Upon receiving feedback, learners can decide the next steps needed to enhance learning outcomes. The theoretical framework of formative assessment combines constructs from social cognitive theory, including self-determinism, self-regulation, and self-efficacy (Black & Wiliam, 2009). By placing instructional decision making in the hands of the student through self-determinism and self-regulation, formative assessment increases the learner's self-efficacy.

In this article, use of Readiness Assurance Tests (RATs) is examined as a means to foster test-taking readiness through formative feedback in a graduate-level statistics course. Built on a formative assessment pedagogical framework, RATs were developed that consist of two low-stakes assessments that have formats and testing environments similar to the actual examinations. The RATs were given prior to the midterm and final examinations to (a) increase student familiarity with expectations by giving them early exposure to the testing environment and (b) serve as a study guide for content,

allowing students to identify their learning needs. The purpose of this project was to evaluate the effects of a RAT intervention on examination scores. The authors hypothesized that the RATs would help improve student self-efficacy and ultimately improve examination scores.

Conceptual Framework

Central to formative learning is the concept of feedback. Substantial evidence shows that feedback has a consistent positive effect on learning and markedly influences student achievement (Evans, 2013; Gikandi, Morrow, & Davis, 2011; Hattie, Biggs, & Purdie, 1996). When students are provided feedback and then provided an opportunity to apply that feedback to demonstrate mastery, they are more likely to retain and retrieve knowledge (Roediger & Butler, 2011). Learning interventions must show students what they know, do not know, and need to improve (Hattie & Jaeger, 1998). According to Wiliam (2011), assessment demonstrates examination standards, increases student confidence, and provides feedback on areas that need focused review. With enough feedback, the students know the actions they need to take. Good feedback facilitates self-assessment, encourages positive self-esteem, and helps students to close the gap between current and desired performance (Nichol & Macfarlane-Dick, 2006). Using those characteristics, the current authors developed the conceptual framework for the intervention (**Figure 1**). As depicted, formative assessment occurs in the preparation phase of learning. It prepares students for performance by providing them with goals, practice, and feedback. This process helps students to clarify their understanding of concepts and decreases their uncertainty about expected outcomes (i.e., examination results). As a result, summative assessment better indicates students' achievement, as formative assessment has better prepared them for it.

Method

Design

The current study was reviewed and approved through the institutional review process. A nonequivalent comparison group design was implemented to evaluate the effectiveness of the RATs on examination scores, using a convenience sample of students enrolled in two separate course sections (spring and fall 2014) of a graduate-level online statistics course. The control group consisted of graduate students taking this course in the spring semester of 2014. Both courses were identical in format and content, with the exception of the addition of the RATs to the fall 2014 course. A majority of the students in the intervention group receiving the RATs were accelerated baccalaureate (BSN) students. Although these students were technically considered to be prelicensure, they had completed at least one prior bachelor's-level undergraduate degree.

Measurement and Data Analysis is an online graduate-level statistics course. It is open to all graduate health science students and is required for the Master of Science in Nursing program at Indiana University. This course uses an electronic textbook and companion course-management site (Aplia™) for homework assignments. Students are allowed three attempts at homework questions, with formative feedback provided on submission. Timed midterm and final examinations assess the application of concepts.

Measures

Readiness Assurance Tests. The course faculty developed the RAT items using an existing test-item pool developed and reviewed by course faculty in the Indiana University School of Nursing. The first and

second authors (R.J.B.E., L.C-H.) independently reviewed and revised RAT items to align with course objectives. The authors reviewed each other's set of items to further promote construct validity. The course graduate teaching assistant (P.M.) provided item-level feedback. Estimated reliability using the Kuder–Richardson Formula 20 (KR-20) was adequate, with RAT #1 (administered prior to the midterm examination) KR-20 = .815, 43 items, and RAT #2 (administered prior to the final examination) KR-20 = .914, 46 items.

The RATs were computerized examinations, with built-in feedback for both incorrect and correct answer choices, using the characteristics of good feedback described by Wiliam (2011). Feedback was structured to explain why each correct response was correct and why each incorrect response was incorrect. The rationale for including feedback on correct items was to increase conceptual understanding as it relates to practical applicability. Textbook references for further explanation of the item were provided. The RATs were administered the week before the midterm examination and the week before the final examination via the online course management system. Students were allowed 3 hours to complete each RAT, which was consistent with the time limits for the examinations. Further, the online testing environment mirrored that of the examinations. The examinations contain different scenarios, but the format of the questions was consistent between the RATs and the examinations. The midterm examination accounted for 25% of the final course grade, and the final examination accounted for 35% of the final course grade.

Readiness Assurance Tests Student Satisfaction. Satisfaction with the RAT was assessed with an instructor-developed 4-point Likert survey questionnaire in which 4 = *strongly agree* and 1 = *strongly disagree*. The RAT Student Satisfaction Survey was administered via the online course management site.

Data Analysis

Data were analyzed using SPSS® version 21.0 software. Summary statistics were used to describe the overall distribution of scores for the RATs, midterm, and final examinations. Assumptions for parametric tests were met, and pairwise comparisons were made using independent *t* tests or dependent *t* tests, as appropriate. All analyses were performed using alpha = .05.

Findings

Forty-two students comprised the control group and 56 students comprised the intervention group. Both groups completed the midterm and final examinations, with the intervention group completing two RATs. To determine whether being a prelicensure student had an effect on examination outcomes, two groups were created. One group consisted of the accelerated BSN students and the other consisted of graduate students, ignoring whether participants were in the control or intervention group. These groups were then compared based on their first examination score, whether it was the RAT examination or the midterm examination. No difference was noted between undergraduate (75.58 ± 15.3) and graduate (79.27 ± 11.4) students' performance on this first examination (t[82.79] = 1.34, p = .183).

Midterm Examination. Students who took RAT #1 significantly improved their midterm scores (90.06 ± 7.06), compared with their RAT #1 scores (75.92 ± 14.52, t[55] = 6.95, p < .0001). The midterm scores for the intervention group were significantly greater than the midterm scores for the control group (79.7 ± 11.61, t[63.26] = 5.12, p < .001); equal variances were not assumed. These results are displayed in **Figure 2**.

Final Examination. The final examination scores for the RAT intervention group were not significantly different from the control group's final examination scores, $t(96) = .13$, $p = .90$. However, comparisons between the control group's final examination scores (85.35 ± 9.46) and the intervention group's RAT scores (78.23 ± 17.29) were significantly different, with the control group having higher scores ($t[88.71] = 2.6$, $p = .01$), when equal variance is not assumed. Students in the RAT intervention group significantly improved their final examination scores after taking the RAT intervention examination ($t[55] = 3.23$, $p = .002$).

Readiness Assurance Tests Student Satisfaction. In the intervention group, 45% ($n = 25$) of the students completed the RAT Student Satisfaction Survey. All students agreed or strongly agreed that the RAT helped to anticipate expectations related to the midterm and final examinations. Helping students anticipate what to expect on the examination was associated with significantly less worry about it.

Discussion

The use of RATs significantly increased students' midterm examination scores relative to both their RAT #1 scores and the scores of a control group. Although students in the intervention group improved their final examination scores, compared with their second RAT scores, the final examination scores were no different from the control group's final examination scores. The differences observed between the two groups at midterm were not evident with the final examination. It is possible that after experiencing the first RAT, students knew what to expect and may have had a false sense of security going into the second RAT and final examination. The authors observed students' tendency to ask more questions prior to the midterm examination compared with the final examination. In addition, more students reported not studying prior to taking the final examination after completing the RAT. This may have been related to students experiencing the RAT previously and viewing it as a substitute for studying. Black and Wiliam (2009) described how formative assessment may reassure students and decrease motivation for further study.

As with any study, the current study was not without limitations. The intervention group was composed primarily of accelerated BSN students. When accelerated BSN scores were compared with graduate student scores, no difference was found; therefore, the authors felt confident there is no difference in scores due to the type of student. On the basis of college educational experience, the BSN and graduate students were similar, except for the lack of a nursing license. However, lower scores on the second RAT may have been associated with fatigue and pressures related to an accelerated prelicensure BSN program. Further study should focus on program characteristics that may influence study outcomes.

A strength of the RATs was that it allowed students to anticipate what to expect on the examinations, which helped them to prepare for the examinations. Although the authors did not use an externally validated measure of statistical anxiety, they did assess students' perceptions of worry and found that, overall, the RATs helped to reduce students' worry about their examinations.

Students did not have an incentive to complete the satisfaction survey; therefore, the response rate was low. Future studies should examine statistical anxiety using a measure with evidence of reliability and validity. The current study used an instructor-developed satisfaction questionnaire that included items about worry but not specifically a measure of anxiety. The authors also found that the RATs (a) clarified faculty expectations for students with regard to the examinations, especially given that the structure of the examination varied from that of the homework assignments; (b) helped students to master a large

amount of statistics material; and (c) fostered self-efficacy in statistics for nursing students, helping to focus study efforts for maximum impact.

Conclusion

Statistics is a critical component of nursing; however, statistics courses can cause disproportional levels of anxiety and become a barrier to student success. Using RATs helps to prepare students for examinations and enhances the learning experience. The RATs helped students to focus on conceptual understanding, making the content in this statistics course more applicable for practice. Future research is needed with homogeneous samples to fully evaluate the intervention.

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