

Supporting student learning: improving performance on short-essay exams using realistic practice opportunities

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The present manuscript reports an attempt to support students in learning to apply knowledge from class to novel situations on course exams. Students took short-essay exams at the end of each unit. Students were offered two practice opportunities during each unit: answering practice questions and participating in a mock exam study session. On average, exam performance improved when students completed more practice questions accurately and when they took mock exams. The improved performance suggests that efforts to support student learning succeeded in helping them develop a deeper, application-based understanding of course materials.

Keywords: exam performance, practice exam, mock exam, developing understanding

I. Introduction.

Many undergraduates struggle with applying knowledge from lectures to novel exam situations. The students in the reported undergraduate behavior modification and therapy course faced that challenge every semester because all of the course exams contained primarily essay and short-essay questions which required them to apply class material to novel, application-based situations. In an effort to better support the students in successfully applying their knowledge on exams, we developed two realistic practice opportunities that the students could take advantage of: online practice questions and a mock exam study session. This manuscript reports the outcome of our inquiry into how successful those supports have been for our students.

The challenge of helping students learn to apply their knowledge is not new. We based our inquiry in the tradition of viewing application as a type of understanding; that a student who is able to use their knowledge to address a novel situation has a different understanding of the material than a student who simply memorizes the steps in some problem-solving procedure. This philosophy has been well-articulated in several places (McKeough, Lupart, and Marini, 1995; Wiggins and McTighe, 1998; Wiske, 1998), and views the ability of a student to use their knowledge in novel ways or in novel situations as one performance indicator that the student has achieved a deeper understanding of course material than just a basic knowledge of facts. As articulated by Perkins, evidence of understanding is found in performance, and understanding is a “flexible performance capability;” the ability of people to “think and act flexibly around what they know” (Perkins, 1998).

Such performance capabilities generally do not appear in the absence of instructional techniques, which encourage them, however, and we undertook this inquiry into our course design in an effort to recognize and tailor supports for students in order to achieve an

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application-based understanding of the course material. As recommended by Perkins, we saw the provision of opportunities for students to interact with course materials in a way which was challenging, engaging, active, and which required reflection on their performance as vitally important to helping them reach the level of understanding we desired for them (Perkins, 1998).

The desire for students to learn to use the knowledge gained in our course was also rooted in the deeper context of our field of study and practice: applied behavior analysis. A defining characteristic of applied behavior analysis is a focus on studying and intervening to solve applied, socially significant problems such as drug dependency and the education of people with developmental disabilities (Baer, Wolf, and Risley, 1968). Thus, a goal of our field is to produce socially meaningful change in the lives of people with whom we work. Producing desirable outcomes in diverse areas and under many different conditions in the community requires practitioners who can take a simple procedure or principle (say, that behavior which is reinforced happens more frequently in the future) and be able to apply that knowledge to different circumstances (e.g. providing praise to a child for engaging in desirable play behaviors or delivering a thank-you card to a teacher who made an extra effort to accommodate a student's needs on a difficult exam).

The course in which this inquiry was conducted is the first course students encounter in the major which asks them to address such important social issues by designing and describing actual interventions they might use. It requires them to develop an application-based understanding of the principles and procedures of behavior analysis to solve problems rather than just to become familiar with our approach to intervention. It is also often the first course students encounter which relies entirely on short-answer and essay-based evaluation of their knowledge. Students struggle with the unfamiliar format and performance requirements, and our goal has been to explore ways to facilitate their development of a deeper, application-based understanding.

We already conducted study sessions and offered optional practice exam questions in the course, so we began by looking to the literature for suggestions about how to make those two activities more effective. Given the ubiquitous presence of review activities on college campuses, we were surprised to find that few empirical studies had evaluated the effects of study sessions (Aamodt, 1982a; Aamodt, 1982b; Neef, Cihon, Kettering, Guld, Axe, Itoi, and DeBar, 2007; Rust, Price, and O'Donovan 2003) or practice exams (Balch, 1998; Bol and Hacker, 2001; Oliver and Williams, 2005; Simon, 2005) on student exam performance. Within the studies we found, however, there were some useful trends.

Student performance on exams improved more when review activities more closely resembled the actual exam in form (e.g. it asked questions in the same style, such as multiple choice) and content (e.g. the review activity contained materials which would be on the exam and did not contain materials which would not be on the exam) than when the review opportunities did not resemble the actual exam (Balch, 1998; Bol and Hacker, 2001; Oliver and Williams, 2005; Simon, 2005). For example, Balch (1998) compared student performance on multiple-choice exams in an introductory psychology course across two groups: students completing a practice exam during a review session, and students who only reviewed the same course material. Students who completed the practice exam (formatted like the actual exam, and covering the same material) scored higher on the actual exam than the students who only reviewed the material with the instructor.

Additionally, study sessions that included a review of performance expectations and realistic practice were the most effective, followed by the sessions involving only a review of

performance expectations (Aamodt, 1982a, 1982b; Balch, 1998; Rust, Price, and O'Donovan, 2003). Study sessions that included only question and answer opportunities (Aamodt, 1982b) or less realistic practice opportunities (Neef, et al., 2007) did not produce large improvements in exam performance. For example, Aamodt (1982b) conducted a study comparing the effects of two different study sessions: one involving a review of key course material and performance expectations for the exam guided by a course teaching assistant and another where no review was given, but students had the opportunity to ask the teaching assistant questions about the exam. Both sessions were held a couple of days before a comprehensive final exam in the course. Not surprisingly, students attending the study session with the active review of material and performance expectations scored higher on the final exam than students attending the question and answer only session.

Of most interest to us was a study by Rust and colleagues (2003) reporting the results of a study session designed to improve the application ability of business students on an essay-based final exam. Across two years of a large-enrollment, first-year, undergraduate business course, the authors offered a 90-minute study session. Four weeks before the final, open-ended assessments were turned in by students, every student in the course received a set of grading criteria and two sets of sample answers to the assessment questions they would be completing at the end of the course. One week later the instructors offered a 90-minute study session. Students attending the session were asked to evaluate the sample answers according to the grading criteria and bring the completed evaluations to the optional study session. Once at the session, students worked in small groups to discuss their grading, shared their grading with the larger group, listened to an instructor/grader describe how the question would be graded, discussed their grading again in light of that description, and then finally viewed and discussed the instructor/grader's specific evaluation of the same sample answer.

A baseline measure of student ability was established by looking at the performance of all students participating in the study in a course taken prior to the business module in which the study session was offered. There were no significant differences between the two groups of students (those attending and those not attending the study session) on the baseline measure, suggesting there were not differences in ability and motivation between the two groups even though they were self-selected. Following the study session, however, there were significant differences in course performance between the two groups, with those attending the study session scoring higher in the business course than those who did not attend the study session. Those differences in performance persisted in a third business course students took a year later, with students who had attended the study sessions in the second course scoring higher on average than those who did not attend the session.

We modeled our review sessions (described in more detail below) on the study sessions conducted by Rust and colleagues (2003) because we felt our goals were similar, we had capabilities to offer similar opportunities, and because the results were compelling. We also wanted to see if already existing practice opportunities in our course were comparable in effect.

The overarching goal of our inquiry was to identify ways to better support students in meeting the course performance expectations; to help them, as Perkins (1998) conceived, "put their understanding to work" in solving difficult and novel problems. The purpose of this specific inquiry was to examine the effectiveness of two realistic review opportunities (practice questions and a mock exam study session) at improving performance on short-essay exams requiring the students to apply knowledge learned in class to novel situations. Both review activities involved offering students multiple opportunities to engage with and apply course materials during

activities and settings designed to be similar to what they would see when they took actual unit exams.

II. Method of Inquiry.

A. Background of Course and Participants.

We conducted our inquiry within a course entitled Principles and Procedures of Behavior Modification and Therapy. The course introduces students to many of the guiding ideas, philosophies, and methods of the field of Behavior Analysis, and it is a required course within the department curriculum. It is a prerequisite course for most other upper-division courses, including the required, year-long senior practicum for majors. Most students take the course during their sophomore or junior years as part of either a major or minor in Applied Behavioral Science. All students enrolled in the course during two semesters (182 students: 90 in spring, 92 in fall) participated in the investigation.

B. Structure of Course.

The course contained five units, each exploring a facet of solving applied problems, such as: defining and measuring behaviors of interest, teaching new behaviors, reducing problem behaviors, writing behavioral contracts to help families in need, designing token economies, and addressing legal and ethical issues in the treatment of people with disabilities. At the beginning of each, an outline of the content of the unit was made available to students online. At the end of each unit, students took an exam over the material covered in the preceding unit. Unit exams were worth thirty points apiece (150 total points in the course) and consisted of essay and short-answer questions. The majority of questions (80-90%) required students to apply the principles of behavior and the techniques described in the textbook (Martin and Pear, 2007) and discussed in lectures to address novel applied problems which they had not seen before. For example, a man with disabilities might be described, and students asked to explain how they would teach him a self-care behavior. Short-answer questions from the textbook and lectures accounted for 10-20% of the questions on each exam.

C. Identifying Areas of Difficulty and Developing Supports.

In considering how to support the students in the present course, the first step was identifying what the students should be able to do as a result of taking the course. At the most basic level, we wanted students to become critical consumers of behavioral interventions and to develop a foundational set of skills in the design and use of relatively simple behavioral techniques and procedures. Table 1 presents a representative sample of both general performance goals and also some specific examples of more detailed performance targets within each goal for several units of the course. In addition, Table 1 also contains information about how student performance was assessed on unit exams.

Table 1. Examples of General Course Expectations and Specific Goals within Each.

Expectations	How assessed
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Unit 1:

Students will label, define, and measure behavior. Students will also describe basic experimental designs and social validity measures

Specific expectation:

Students will accurately describe how to use a frequency recording system to measure the amount of some behavior

Short-essay question on exam which describes a situation and asks students to identify behaviors of concern and then describe how those behaviors and interventions designed to address them should be measured and evaluated

Unit 2:

Students will describe how to teach Both non-verbal and verbal behaviors

Specific expectation:

Students will accurately describe how they will shape a new behavior including identifying specific steps in the shaping process

Short-essay question on exam which describes a client who is both non-verbal and who lacks basic self-care skills and asks students to describe the teaching procedures they would use to address the deficits of the client

Unit 5:

Students will describe how to design a token economy for a population of dependent people

Specific expectation:

Students will accurately describe how they will assign values to backup reinforcers used in the token economy

Short-essay question on exam which describes a group of people who are served in some group setting such as a classroom or residential care facility and who have behavior problems. Students asked to address concerns related to setting up a token economy to provide reinforcement and support for the clients

We also wanted to address the common difficulties students encountered when taking exams. There were both organizational difficulties (i.e., struggles with writing clear and organized answers, misunderstanding grading criteria), and application-based difficulties (i.e., failing to identify relevant details from exam questions, engaging in rote memorization of sample answers to practice situations rather than learning how to use a procedure) for students. These difficulties became the targets for support and for additional practice opportunities. Because an informal, TA-led study session already occurred before each exam and optional practice questions for students to answer throughout the semester were an established part of the course, a modification of those review activities became the means of providing the additional support students needed.

Practice Questions. For each unit of the course, there was a practice exam that was posted online on the first day of the unit. It contained a description of one or more clinical

situations and a set of questions. Each question required students to use the information presented in the unit to develop behavioral solutions to the clinical situations described.

The questions asked on the practice exams and the actual exams were similar in structure and format. Both the practice exam and actual exam questions requires students to apply the course material to a novel situation. What was different between the practice exams and the actual exams were the situations to which the unit materials needed to be applied. For example, a question on both exams in the third unit was, “Describe how to use extinction to reduce the client’s problem behavior.” The client described in the practice exam might be a child who tantrumed whenever his parents did not pay attention to him, while on the actual exam, the client might be a junior-high student who became aggressive when asked to work. Students had to apply what they had learned about extinction to the different situations. For the first case, a correct answer involved not paying any attention to the child when he tantrumed. For the second, a correct answer involved continuing to present requests to work even if the student became aggressive.

Questions from the practice exam were assigned 4-6 times during each unit, and students could turn in written answers online on specified dates prior to the unit exam. Students who submitted answers received feedback (a copy of the grading key for those questions with their score for each answer submitted) within a week, and could earn up to three extra-credit points for each unit of the course for answering the questions. Extra credit points counted toward the final course grade, and the amount of extra credit earned depended on the correctness of the answers submitted. Thus, a student who turned in all of the assignments and was 50% correct received 1.5 extra credit points for the unit. A student who turned in all of the assignments and was 100% correct earned 3 extra credit points for the unit. Because course grades were assigned based on the percentage of 150 points the students earned, the students could earn up to 10% additional credit on their final grade (15 points) by completing the practice questions accurately and on time.

Mock Exams. During each unit, students could also participate in a mock exam study session led by the course graduate teaching assistant (GTA). Each mock exam session lasted two to three hours and was usually held two days before the unit exam. The mock exam sessions took place in a classroom on campus –often the same classroom in which students attended the course meetings. Students earned no extra credit for participating in mock exam sessions.

Mock exam sessions contained three parts: an introduction, the administration of the mock exam, and the grading and discussion of answers. During the introduction, a general description of the session was given. Next, students were given a copy of the mock exam, and were asked to complete it within 45 minutes under “test-like” conditions (without notes and working independently). The mock exam included the same situations and questions as posted online in the practice exam, but the document was re-formatted to resemble the actual exam by spacing out questions on the pages to give students room to write on the document and rewording and shortening some questions so students could more likely finish the mock exam in the allotted time. Finally, the GTA handed out a grading key and discussed the grading criteria question by question. Students were asked to evaluate their answers and were also encouraged to volunteer answers for discussion and analysis. After discussion of answers for each question, the GTA briefly displayed a correct sample answer to clarify the expectations for that question. This lasted 60-90 min, and the students were allowed to take their answers and grading criteria home. The discussion portion of the mock exam study session was designed to promote a deeper

understanding of both the grading criteria and of issues to be addressed when applying procedures across different situations.

D. Evaluation Measures.

The primary measure in this analysis was student performance on the unit exams. Student attendance at mock exam sessions and completion of practice questions were also recorded to determine whether they were correlated with exam performance. At the end of the semester, students were also given a brief survey about the two review activities.

III. Results.

Overall, both review activities were associated with improved performance on unit exams. The mock exam study sessions appeared to have the biggest impact on student performance. Additionally, students preferred attending the mock exam study sessions to completing the practice questions.

Average scores on the section exams during the spring and fall semesters of 2006 are shown in Figures 1 and 2. These scores do not include any extra credit students earned. As shown in Figure 1, across all exams ($N=874$), students who attended the mock exam study sessions scored higher on the actual exam than students who did not attend the mock exam study sessions for the same unit. A two-tailed t-test confirmed that the differences between groups were significant, with $t(2) = 8.558, p = 0.013$.

Students also scored higher, on average, on unit exams as they earned more extra credit for the same unit. A correlation analysis of extra credit earned and exam score indicated a highly significant positive correlation between the two: $r = 0.41, p = <0.0001$. Figure 2 shows that for both students who did and did not attend the mock exam study sessions, as they earned more extra credit, their average exam score also increased (divided into 4 groups to allow easier visual analysis). The effect was most pronounced for students not attending the mock exam study sessions. Figure 2 also shows that even when matched for the amount of extra credit earned, students performed better on the actual exam if they attended the mock exam study session. The effect of attending the mock exam study session on test performance was the most pronounced for those students who earned the least amount of extra credit on the practice questions. The students who performed the best on exams, however, were those who both attended the mock exam study session and also earned at least 75% of the available extra credit for the unit.

A four-question survey handed out during both semesters asked students to indicate if they participated in each review activity, and if they did participate, to rate the helpfulness of the activity on a scale of 1-5 (1= waste of time, 5=vital). Nearly all of the students who completed the survey participated in at least one type of review activity. Students rated both the practice questions (mean: 3.85) and the mock exam study sessions (mean: 4.70) as being helpful, with the mock exams receiving the higher rating.

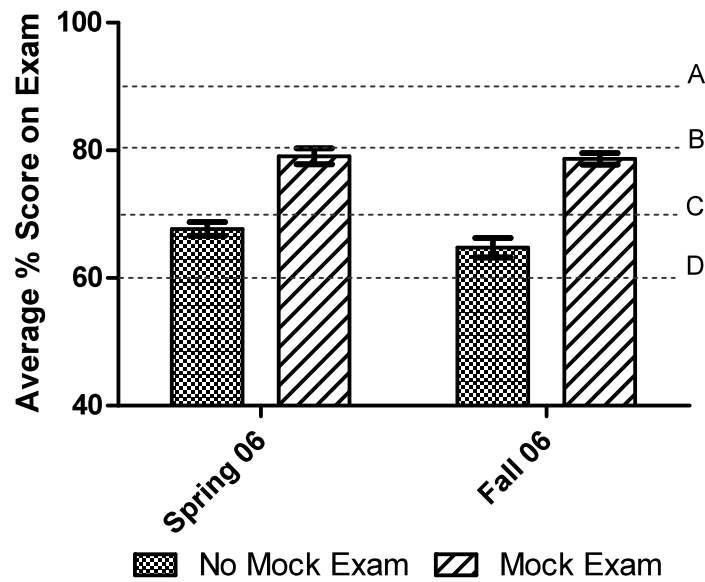


Figure 1. Average performance on section exams of students who did and did not take the mock exam for that section. Exam score does not include any extra credit points, and error bars represent standard error.

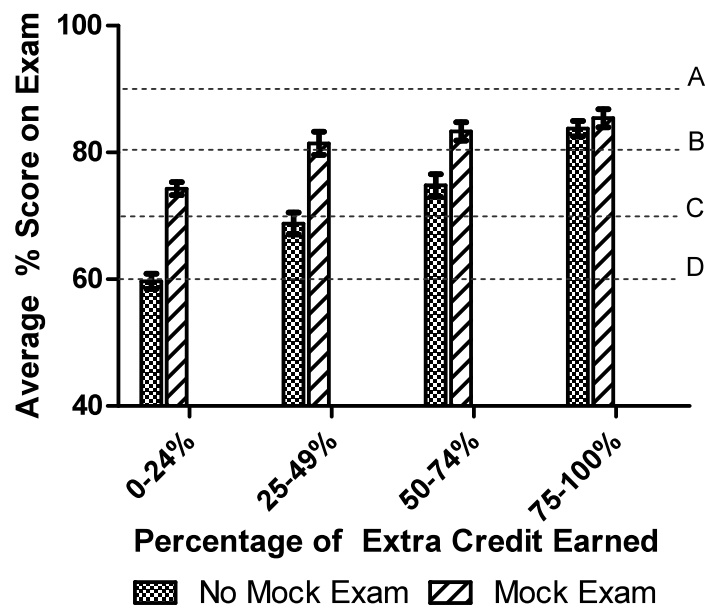


Figure 2. Average performance on section exams of students across both semesters by the amount of extra credit they earned. (Extra credit based on accurate completion of practice questions) and by attendance or non-attendance at the mock exam session. Exam score does not include any extra credit points, and error bars represent standard error.

Student attendance at mock exam study sessions also suggested student preference for, and perceived helpfulness of, the mock exam study session. Figure 3 shows the percentage of

students who participated in each review activity across both semesters. The percentage of students earning at least 50% of the available extra credit for each of the five units across both semesters of the course shows no clear trend, but the number of students doing so decreased in the fall semester compared to the spring and was markedly lower than the percentage of students attending the mock exam study sessions.

An increasing percentage of students participated in the mock exam sessions across both semesters. With no contingency on attendance such as extra credit points, it was assumed students came because they found the sessions helpful. Also, as student attendance at the mock exam study sessions increased across the two semesters (see figure 3) so too did the overall GPA of the students finishing the course. Table 2 presents the cumulative GPA (earned in the course) of the students for each semester.

Table 2. Cumulative Class GPA Across Semesters.

	FL 05	SP 06	FL 06
Cumulative final GPA of each class	2.06	2.13	2.21

IV. Discussion.

The results from this investigation indicate that both completion of practice questions and participation in a mock exam study session were associated with positive effects on student performance on section exams in our course. Students who answered more practice questions correctly scored higher on unit exams than students who answered fewer or none. Students who participated in the mock exam for a unit scored, on average, 12% higher on the unit exam than those who did not. The students who performed the best on the exams were those who earned at least 75% of the extra credit points and also attended the mock exam for the unit. The students who performed worst were the ones who neither completed practice questions nor attended the mock exam session. Additionally, the overall performance of students in the course improved as more students attended the mock exam study sessions. These results suggest that both of the review activities provided the additional support students needed in order to demonstrate a deeper understanding of the course material by writing better answers to essay and short-essay questions requiring application of knowledge to novel situations.

One of the most exciting aspects of the results for us involves the effects of attending the mock exam sessions for students who did not complete any practice questions. Those students have historically been at the highest risk of failing our course (over 60% of students who complete no practice questions earn an F on exams), and are often the students who struggle the most with the material. We were encouraged to see that if those students attended the mock exam session, then their exam performance, and presumably their understanding of the course material, was dramatically improved (less than 10% of students who earned no extra credit, but attended a mock exam, earned an F on the exam). The mock exam sessions appeared to be most helpful for the group of students who needed it the most. The attendance figures also show that more of those students attended mock exam sessions across the two semesters. These results are in contrast to the results reported by Balch (1998) and Aamodt (1982a), who found that students

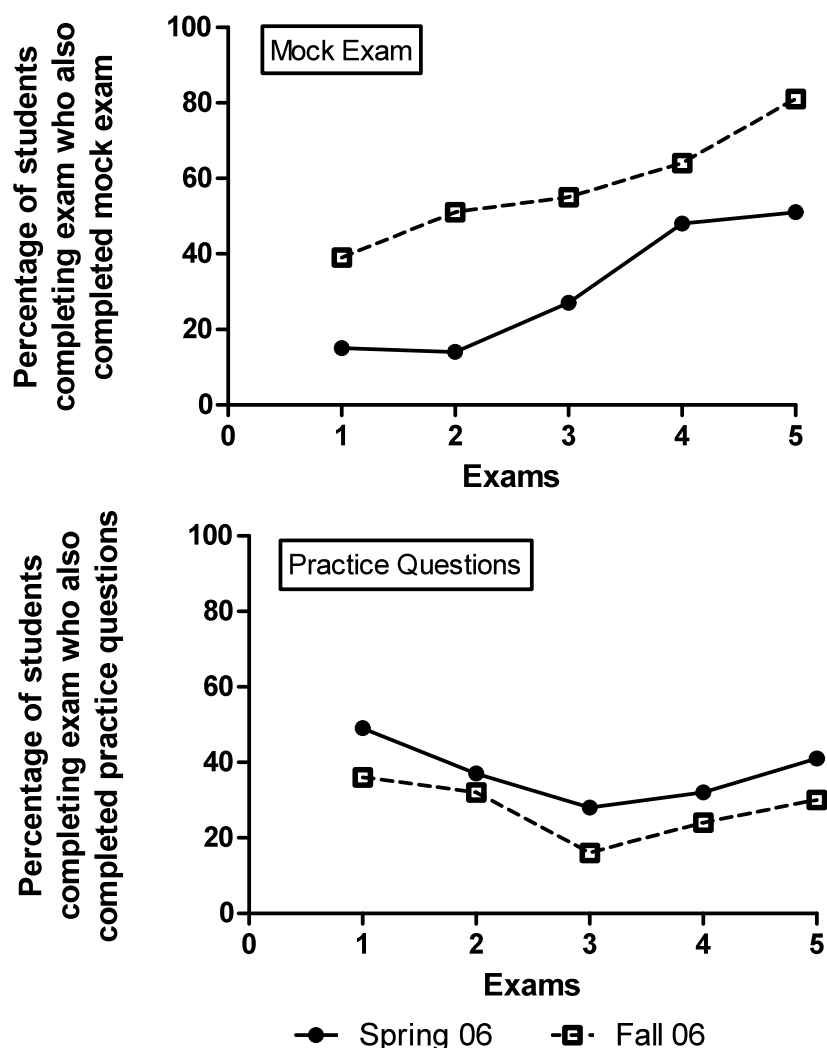


Figure 3. Percentage of students completing practice activities (attending mock exam or earning at least 50% of available extra credit) for each section of the course across both semesters.

with higher GPA's entering the course were helped more by the review activities than students with lower entering GPAs. We did not measure our students' entering GPA in this course, but we plan to in future semesters in order to more carefully determine if the effect of the mock exam sessions is more pronounced for the weaker students entering the course. If future research confirms that the mock exam does improve the learning of students entering the course with lower GPAs, then it has implications for how to design effective supports in other application-based courses across disciplines that have historically high failure rates (e.g. physics, laboratory-based biological sciences).

These results also replicate and extend the results of earlier studies on review activities. First, it replicates the positive effects previously reported for realistic practice (e.g. Balch, 1998; Rust, et al., 2003) and review of performance expectations (e.g., Aamodt, 1982b; Rust, et al.

2003). Second, this study extends the literature on review activities to application-based essay exams in a behavioral psychology course. It will be important for future research to continue to evaluate methods to support students in mastering more advanced, application-based demonstrations of their understanding, and this study represents an early step in empirically evaluating procedures designed to do so.

There were several aspects of the practice questions and the mock exam study sessions which might have accounted for the results. One is the active nature of the activities. In the mock exam study sessions students wrote answers to questions, offered answers to the group for discussion, and received feedback on their answers both from a provided grading key and from discussions with peers and the facilitating graduate teaching assistant. Students completing practice questions wrote answers to novel situations and also received feedback and a grading key online. Such discussion and feedback might have facilitated more effective reflection by the students by helping them realize what course information they had not mastered, thus helping them focus their studying on those areas.

Another aspect of the review activities, which may have accounted for the large effect were the permanent products students received which might have guided further study. Students were able to take both their completed mock exams and the provided grading keys home with them for further study at the conclusion of the mock exam study sessions, and for each practice question assignment students could access their completed grading key at any time. Such products provided concrete records of the important information they needed to know and how well they knew it which could be referred to in future, independent study sessions. It may also be that the mock exam study sessions and practice questions allowed students to prepare in more productive ways by offering them the chance to interact with review materials in the same way they would have to interact with actual exam questions. Students may also have studied and prepared more knowing they had to write answers in the mock exam session.

Another interesting finding of the present study was the different rates of student participation in answering practice questions and attending mock exam study sessions. Neef and colleagues (2007) suggest that students might participate in study sessions more if they are more effective. Both the practice questions and the mock exam study sessions appeared to have beneficial effects on exam performance, and yet more students attended mock exam sessions as the two semesters progressed, while the number of students writing answers to practice questions dropped across semesters. It may be that the mock exams, while intense, were seen by students as easier because all they had to do was show up for a single session, while answering practice questions required students to spend time preparing and submitting answers on multiple occasions throughout the unit to receive the highest benefit from the activity. Since even beneficial review activities do not positively influence students' grades if the students do not complete them, it is important that future research identify what characteristics of such activities (such as proximity in time to the exam and the effort required to attend) make it more likely that students will participate.

A potential limitation of this approach to supporting student learning relates to the amount of time required to conduct review activities. Conducting five mock exam sessions of two and a half hours each and grading 15-20 practice question assignments across a semester requires a large investment of time that some instructors may feel they do not have. While the up-front time requirements are large, anecdotally, the timesavings in grading more than offset this concern within the reported course. With increased participation, especially in mock exam sessions, more students wrote more well-organized and correct answers. Since it took less time to

grade correct and clearly written answers, the GTA spent much less time overall grading each set of unit exams.

In a further effort to make the review activities more efficient, ongoing work in the same course has involved efforts to identify which specific components of the review activities might be most responsible for improvements in student learning. We want to explore questions about which components are needed or redundant. For example, perhaps requiring students to write answers and requiring them to evaluate and correct sample answers are both helpful, but do not produce summative improvements in exam performance. It may only be necessary to do one or the other in a session and still see a positive effect on exam performance. Future studies will report the results of these additional component analyses. Also, the effect of the review activities, and especially the mock exams, have led to the incorporation of aspects of the review sessions into the daily course activities; for example, by spending time in class asking students to work in small groups to answer applied questions at several points during a lecture in an effort to increase engagement during a class period.

This investigation was undertaken to identify ways in which students could be better supported in learning to apply course materials to novel situations by revising existing practice opportunities. The two review activities appeared to do so. The results suggest that both completing practice questions and attending mock exam study sessions improved student understanding of the course material, as indicated by performance on short-essay exams and also in the course overall. This improved performance suggests that students write better answers on exams when they take advantage of course activities designed to support their learning by offering realistic, engaging, practice opportunities which have been aligned with the expectations and assessments of the course.

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