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VMED 646: Animal Physiology II—A Peer Review of Teaching Project Benchmark Portfolio

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Peer Review of Teaching Project Portfolio

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Abstract

This Peer Review of Teaching Project portfolio focuses on the Animal Physiology II course which is required for first year veterinary medicine students. Weekly quizzes assess baseline knowledge and had been administered individually and in groups. I hypothesized the discontinuation of group quizzes would increase student effort when preparing for quizzes. Unit exams involve scenario-based questions and require students to apply information. I hypothesized the implementation of group exams would help under-performing students improve their ability to apply information they had learned. Exams were still taken individually prior to being taken in groups to encourage adequate preparation. Student impacts were assessed via surveys and assessment performance. Survey responses were positive regarding participation in both group quizzes and exams and the majority of students felt participation in group assessments helped improve their understanding of physiologic concepts. However, student agreement was significantly greater when asked if they would prefer to have group exams in future classes versus group quizzes. Students indicated they appreciated the opportunity to discuss ideas with classmates and the group format was similar to interactions they will have with future colleagues. However, the lack of equal participation of all group members during assessments caused frustration. Evaluation of quiz, exam, and post-test scores revealed the use of individual assessments improved retention of knowledge for low-performing students but assessment type had no impact on high-performing students. This study provides supportive evidence for the use of group assessments but only if modifications are made to limit the impacts seen with low-performing students.

Keywords: Physiology, veterinary, group, assessment, exam

Objectives – Peer Review of Teaching Project Portfolio

This portfolio will focus on VMED 646 Animal Physiology II. This course is the second course in a 2-semester series. I have been the instructor for the Animal Physiology I and II courses since 2014. My primary goal for participating in the Peer Review of Teaching Project is to document and reflect upon the learning objectives, teaching methods, assessments, and student learning for this course. Through this process, I hope to identify the strengths and weaknesses associated with my course design and then use this information to guide refinement of future iterations the course.

Description of Target Course

Animal Physiology II explores the physiology of cardiovascular, respiratory, renal, and digestive tissues at the systemic, cellular, and molecular levels. The primary focus is on domestic mammalian species (e.g. canine, feline, equine, bovine) but human physiology is presented at times to help expand upon limited available information in animals. In addition, the emphasis is on the normal physiologic state of animals. Alterations of the normal physiology, such as those which may occur with the presence of certain clinical disorders or following the administration of certain pharmacologic therapies, will be utilized to demonstrate the cascade of physiologic responses responsible for maintaining or restoring the "normal" state.

Enrollment in this course is limited to students who have been accepted to the Professional Program in Veterinary Medicine (PPVM) or the Graduate Studies Program. This course is required for all first-year PPVM students. Students are expected to have taken Cell Biology, Organismic Biology, Biochemistry, and Physiology either during their undergraduate education or as a graduate student. Students are also expected to have taken the first course of this 2 semester series, Animal Physiology I (VMED 645). Class enrollment averages 26-30 students.

There are 5 overall learning goals for this course that apply to all physiologic systems:
1. Describe the different methods of molecule transport across cell membranes and between/within cells.
2. List the basic components and characteristics of cell signaling pathways for each physiologic system, including ligands, receptors, and intracellular mediators.
3. For each physiologic system, explain how the different components (e.g. cells, tissues, organs) communicate and interact with one another.
4. For each physiologic system, explain how the different components (e.g. cells, tissues, organs) work together to maintain homeostasis.
5. Given a specific alteration in a system, identify how the normal physiologic processes will be impacted, how the alteration may be detected, and/or the best treatment to help reverse the alteration.

In addition, to these broad course goals, students will be expected to meet the following competencies after successful completion of this course:

1. Explain the functional importance of the blood (erythrocytes, thrombocytes, and plasma) as part of the cardiovascular system.
2. Describe the different steps of a cardiac action potential (in both slow and fast action potential cells) and the contraction/relaxation of cardiac muscle, including the involvement of ion channels and the direction of ion flow.
3. Describe the different components of a cardiac contraction cycle, including generation/propagation of action potentials, localization of diastole/systole, chamber contraction/relaxation, chamber filling/emptying, and valve closure/opening.
4. Explain how the heart rate and cardiac output are regulated by the different components of the cardiovascular system.
5. Explain how blood flow, blood volume, and blood pressure are regulated by different components of the cardiovascular system.
6. Compare and contrast the extrinsic and intrinsic regulation of vasoconstriction, vasodilation, and blood flow for the cardiac, cerebral, skeletal, pulmonary, cutaneous, splanchnic and fetal vasculature.
7. Explain how the flow of fluid and molecules across capillaries is regulated and how dysregulation can result in the formation of edema.
8. Describe the primary static lung characteristics and how they regulate lung volumes.
9. Describe the primary dynamic lung characteristics and how they regulate air flow.
10. Explain how oxygen and carbon dioxide are exchanged at the level of the alveoli, how they are transported throughout the circulation, and how they are exchanged at the tissue level.
11. Explain how ventilation is regulated, including different mechanisms to ensure that ventilation matches perfusion.
12. List the different lung functions that are not related to respiration/ventilation.
13. Describe glomerular filtration including the involved structures and the different mechanisms that are involved in tightly regulating the glomerular filtration rate.
14. Identify the renal tubule segments that participate in the reabsorption and/or secretion of water and solutes and the approximate percentage of filtered solutes that is typically reabsorbed or secreted in each segment...
15. Describe the specific mechanisms involved in the paracellular or transcellular reabsorption and/or secretion of water and solutes in the renal tubule.
16. Explain how the reabsorption and/or secretion of water and solutes in the renal tubule is regulated.
17. Describe how the different gastrointestinal hormones and nervous systems regulate digestive physiology.
18. Describe the secretory mechanisms associated with the salivary gland, stomach, pancreas, and liver/gall bladder.
19. Describe the different motility patterns and their regulation in the esophagus, stomach, small intestine, and large intestine.
20. Explain how carbohydrates, proteins, and fats are digested and absorbed throughout the gastrointestinal tract.
21. Describe the unique secretory, motility, digestive, and absorptive processes which occur in ruminant animals (versus monogastric animals).

These goals and competencies have been designed to highlight key physiologic principles, as well as concepts related to the cardiovascular, respiratory, renal, and digestive systems that are relevant to current and future veterinary medical coursework. Current and future coursework for students enrolled in this class includes but is not limited to Veterinary General, Cellular, and Molecular Pathology; Veterinary Systemic Pathology, Clinical Pathology, Pharmacology, Small Animal Surgery and Anesthesiology, Foundations of Veterinary Medicine, Disturbances of Reproduction, Equine Medicine, Pharmacology and Therapeutics, Small Animal Internal Medicine, Small Animal Medicine, Large Animal Clinical Medicine, and Veterinary Toxicology.

The vast majority of students in the Animal Physiology II course are first year veterinary medicine students and their educational program is mostly prescribed. A cohort of students that matriculate into the program at the same time will take the same courses together for the first 6 semesters. The only exceptions are elective courses that can be taken in addition to the core curriculum. Over 90 percent of program graduates will be employed in a type of clinical practice (e.g. small animal veterinarian, food animal veterinarian, equine veterinarian, shelter veterinarian). Therefore, a primary goal of this course is to prepare students for future coursework and ultimately help develop competent clinical veterinarians.

Teaching Methods & Course Materials

The primary focus of my teaching in terms of content is physiology and veterinary medicine. My courses explore the physiology of neurocrine, muscular, endocrine, reproductive, cardiovascular, respiratory, renal, and digestive tissues at the systemic, cellular, and molecular levels. These courses are structured to provide fundamental background information which will help prepare veterinary medicine students for future coursework. This is essential since physiology is a foundational course within the veterinary medicine curriculum and a certain number of concepts need to be presented to help prepare students for courses such as pathology, pharmacology, and medicine.

Appropriate schema development when learning physiology will assist in the learning process for future courses that build upon physiologic concepts and help reduce the cognitive load placed on the learner. Physiology courses in veterinary school typically cover a large amount of information in a relatively short period of time. In addition, physiology and its associated biologic systems are complex with a high level of element interactivity. Both the large quantity of information to be learned and the high element interactivity results in a high cognitive load.

Lectures are a viable strategy to provide an overview of a large number of topics but the passive nature of lecture-based learning benefits from the supplementation of active-learning activities. Therefore, my classes also involve case-based learning exercises. These exercises are centered on patient cases and physiologic concepts are integrated with normal and abnormal clinical conditions. Case-based learning has been proposed to increase student understanding of physiology while also providing clinical relevance. Therefore, these activities are believed to promote the acquisition of clinically-related schema. Furthermore, several studies have reported that patient cases motivate students and engage them in the learning process.

The case-based exercises utilized in my classes involve a written clinical scenario which includes patient signalment, history, clinical signs, diagnostic test results, and/or therapeutics relevant to a specific physiologic system. To facilitate exploration and discussion of the underlying physiology, students are randomly assigned to small groups and each group needs to answer questions focused on key concepts within each case, including how a disorder disrupts the normal physiology of the animal, comparing and contrasting physiologic differences between disorders, and how certain treatments can help restore the physiologic balance. When working on these questions, students are allowed to refer to specific journal articles, textbooks, and lecture notes, as well as ask clarifying questions of the instructor.

These case-based activities are designed in a direct format, meaning they are content-driven to facilitate the mastery of specific concepts. Therefore, the case studies are not open-ended and a specific answer is expected for each question. The intent behind directed case studies is to guide student application of knowledge and prevent frustration for students that have limited experience applying knowledge to clinical-based scenarios (e.g. first year veterinary medicine students). In addition, students are required to review, relearn, and apply information they have received.

I feel that implementation of new teaching strategies should occur as a result of research-based evidence and not simply anecdotal evidence or instructor/student preference. Therefore, I strive to stay current on research applicable to veterinary medical education. In addition, I have conducted a research study in my physiology classes to evaluate the implementation of case-based learning activities. In this study, student surveys revealed that students enjoyed the case-based activities and believed these exercises improved their understanding of physiology concepts. Students also appreciated the opportunity to apply things they learned in lecture and felt that working in groups and being able to ask questions of the instructor while working on the assignments benefited their learning. Furthermore, participation in case-based activities resulted in improved knowledge retention versus participation in lecture alone. The evidence obtained in this study supported the increased implementation of case-based exercises in my classes.

In addition to group assignments, assessments for my courses include unit exams and weekly quizzes. Section exams are the summative assessments for each physiologic system. In contrast, weekly quizzes are formative assessments intended to monitor student understanding throughout each unit and encourage students to stay current with their studying. Students also have the opportunity to earn extra credit points by submitting sample quiz questions addressing new content presented each week. Not only does this activity further encourage students to stay current with the course material but these questions are also reviewed for accuracy and then made available to the class for use as a self-assessment prior to quizzes and exams.

Weekly quizzes are taken individually and in groups. After each student completes their individual quiz, students retake the quiz in randomly-assigned groups. Not surprisingly, performance on the group portion of the quiz is superior to individual performances. However, the primary reason for using this format is to facilitate discussion and peer-assisted teaching during the group component of the quiz. In order to reach a group consensus on quiz answers, students must explain and defend the reasoning behind their answer selection. Active discussion

and collaborative learning between students is believed to improve understanding, regardless of the individual student's role in the discussion.

An important aspect of my assessments is the post-administration review of questions and a willingness to revise questions or desired responses. For paper-based assessments, all questions are reviewed based on the overall correct response rate. For assessments administered via Blackboard, questions are also reviewed based on discrimination value. Questions with relatively low correct response rates or discrimination values are carefully reviewed to help determine if questions, distractors, or answer keys need to be revised. If questions do not appear flawed, this suggests instruction of the related concepts needs revision to improve student understanding.

Formal teaching strategies and assessments are only a portion of my teaching role. Despite extensive planning, there will always be students that can benefit from additional explanations or assistance. This is one of the reasons I reserve 2-3 hours of class time each week for lecture review and completion of assignments. For students that feel uncomfortable asking questions in front of other students or have questions that arise while studying, I am also available during office hours and via email for consultation. These one-on-one student consultations can also provide valuable feedback regarding my teaching style and methodology. This feedback is especially beneficial because it can be acted upon more rapidly than feedback received via end-of-the-semester course evaluations to help improve my teaching.

Objectives for Spring 2017

Goal #1: Encourage students to become more active participants in the learning process and avoid last-minute cramming for exams.

> *Course Activities*: Weekly quizzes are designed to assess baseline knowledge and questions are lower-order (e.g. remember, recall). Currently, quizzes are taken individually and in groups. I believe students are overly leveraging their groups on these quizzes because they "don't have time to study." I hope that the discontinuation of group quizzes and the implementation of individual-only quizzes will increase student effort when preparing for these assessments. Preparatory activities for weekly quizzes include lecture notes, lecture recordings, student learning objectives, online practice quizzes, and student-written practice quiz questions.

> *How will I assess this?* Quantitative and qualitative student surveys will be used to assess how individual versus group quizzes impacted study habits and student learning. Quantitative data from quizzes and from end-of-semester post-tests will be used to evaluate how individual versus group quizzes impacted student performance and retention of   knowledge.

> *How will I use this assessment to enhance student learning?* Quiz format for future semesters will be based on the quantitative and qualitative data received. I may return to the group format, continue using the individual format, or even consider replacing

quizzes with another activity if the evidence suggests quizzes are minimally beneficial or not beneficial.

Goal #2: Increase critical-thinking and application of knowledge in my students.

Course Activities: Unit exams require students to apply information presented in class. Questions are typically scenario-based and are of a higher-order (e.g. understand, apply) compared to quiz questions. Currently, exams scores vary widely (e.g. 40-100%). I am hoping that the implementation of group exams and the associated peer-led teaching will help under-performing students improve their ability to apply the information they have learned to unique scenarios. Exams will be taken individually prior to being taken in groups which will encourage everyone to adequately prepare for exams. Introducing group exams will also increase the points assigned to the exams (group exams will be worth the same number of points as individual exams). Currently, I believe the point value for exams are too low, limiting the amount of time students spend studying. Preparatory activities for unit exams include lecture notes, lecture recordings, student learning objectives, and case-based homework assignments.

How will I assess this? Quantitative and qualitative student surveys will be used to assess how individual versus group exams impact study habits and student learning. Quantitative data from exams and from end-of-semester post-tests will be used to evaluate how individual versus group exams impacted student performance and retention of knowledge.

How will I use this assessment to enhance student learning? Exam format for future semesters will be based on the quantitative and qualitative data received. I may return to the individual format or continue using the group format if the evidence suggests group exams are beneficial.

Implementation of New Teaching Methods

The goal of this spring 2017 project is to evaluate and document the benefits of group assessments in the Animal Physiology I and II courses. If one type of group assessment provides significantly greater benefits, increased use of this assessment format will be implemented in future semesters. If minimal to no benefits are identified, different strategies will be explored.

Prior to the group portion of each assessment, all students completed the quiz or exam individually. Students were then randomly assigned to groups of 3 students and these student groups completed the exact same quiz or exam. During the fall semester (Animal Physiology I), students completed weekly quizzes individually and then took the quizzes in assigned groups. During the spring semester (Animal Physiology II), students completed all unit exams individually and then took the exams in assigned groups. Assessments were administered online via the Blackboard Learning Management System.

Overview of quizzes & exams for the fall and spring semesters:

Fall semester – Animal Physiology I
- -Cell-Neuronal-Muscular, Endocrine, and Reproductive Physiology
- -Weekly quizzes: 10 points individual, 10 points group, 4 or 5 quizzes per unit
- -Unit exams – 40 or 50 points each, only taken individually
- -Total individual assessments = 260 points
- -Total group assessments = 130 points
- -Individual quiz time = 13 * 30 = 390 minutes
- -Group quiz time = 13 * 15 = 195 minutes
- -Exam time = 3 * 120 = 360 minutes

Spring semester – Animal Physiology II
- -Cardiovascular, Respiratory, Renal, and Digestive Physiology
- -Weekly quizzes – 10 points each, only taken individually, 3 or 4 quizzes per unit
- -Unit exams – 30 or 40 points individual, 30 or 40 points group
- -Total individual assessments = 260 points
- -Total group assessments = 130 points
- -Quiz time = 13 * 30 = 390 minutes
- -Individual exam time = 4 * 90 = 360 minutes
- -Group exam time = 4 * 45 = 180 minutes

Three differences in assessment administration occurred in the spring semester versus the fall semester. For the group quizzes in the fall semester, student groups were assigned randomly with no specific consideration for group formation and student groups were posted at the beginning of the semester. For the group exams in the spring semester, student groups were still assigned randomly but randomization occurred until all student groups had a mean quiz/exam score less than 1 percentage point away for the overall class mean quiz/exam score. Students were only notified of their group assignment after they had submitted their individual exam. In addition, quiz groups in the fall only submitted 1 set of answers for the entire group. In contrast, exam groups in the spring submitted a set of answers for each student so individual students could submit different answers if the group was unable to reach a consensus.

At the end of each semester, quiz and exam questions were evaluated in terms of difficulty and discrimination value. Questions in which 60-99% of students responded correctly and were determined to have a discrimination value of greater than 0.1 (greater than 0.1 is considered fair, greater than 0.3 is considered good) were considered for inclusion in the end-of-semester post-test. Selection of questions was also done to ensure that the mean percentage of correct responses was not significantly different for questions taken from fall quizzes (group), fall exams (individual), spring quizzes (individual), and spring exams (group). A total of 42 questions was selected for the fall semester and 49 questions were selected for the spring semester. Post-tests were also administered via Blackboard and were taken individually.

Students were not informed of the post-test in advance to prevent them from studying to prepare. However, students had the ability to earn bonus points based on their performance to help encourage maximal effort. The score each student obtained when answering the questions on the original weekly quiz or unit exam was compared with the score each student obtained when answering the same questions on the post-test. The top one-third of students with the smallest

difference in scores received 2 bonus points, the middle one-third of students received 1 bonus point, and the lowest one-third of students with the greatest difference in scores did not receive any bonus points. Bonus points were awarded separately for the fall and spring post-tests.

A survey was administered at the end of the spring semester to evaluate student perceptions of the advantages and disadvantages of the group testing format for both the quizzes and the exams. These surveys were also designed to determine if there is a student preference for group quizzes versus group exams. Surveys were administered via Blackboard and completed anonymously by students outside of class. Students that completed the survey received 4 bonus points. The response rate for the surveys was 100 percent.

Evaluation of New Teaching Methods – Surveys

Quantitative survey responses were overwhelming positive regarding participation in both group quizzes and group exams. The majority of students felt participation in group assessments helped improve quiz or exam grades, as well as student understanding of physiologic concepts. In addition, students believed group quizzes and exams were a valuable use of class time and they would prefer to have group assessments in future classes. Student perceptions of the impact on quiz/exam grades and the understanding of physiologic concepts did not differ between group quizzes and exams. In contrast, survey responses were more favorable for group exams compared to group quizzes when students were asked if group assessments were a valuable use of class time and if they would prefer to have group assessments in future classes (*Table 1*). This suggests there was a slight preference for group exams compared to group quizzes.

When students were queried about student participation in the group assessments, a variety of participation patterns occurred throughout the year. The 2 most common types of participation were equal participation of all 3 group members and equal contribution between 2 group members (including the survey respondent) with only minimal contribution from the third group member. Approximately one-third of respondents indicated that equal participation of all 3 group members was the most common type of group member participation. In addition, roughly one-quarter to one-third of respondents indicated that equal participation of all 3 group members never occurred during either the fall or spring semesters (*Table 2*). This provides evidence that at least one group member did not contribute or only minimally contributed to the group discussion in many of the assigned student groups for both quizzes and exams.

Qualitatively, there were numerous favorable student comments regarding the positive effect group assessments had on the understanding of physiologic concepts. These benefits appeared to be the result of the opportunity to discuss ideas with fellow students and peer-assisted teaching. In addition, students felt the group format was similar to interactions they will have with colleagues when they are practicing clinicians.

> *It provides an opportunity for people to share and talk through problems. Others may understand one concept better than others allowing a comprehensive understanding of the material.*

It was easier to understand an error when another student explained it.

I believe they provide an environment that is more similar to what we will experience when we are working in veterinary clinics or even our clinical rotations. There were many times where I was confused about a certain topic alone, but being able to talk through a process in a group really helped to clarify things.

The major benefit to group exams and quizzes is that you can talk the concepts through with your classmates which can help you gain a better insight on the material. If you had one minor detail wrong in your head, your classmate could be there to help you out and help you think it through. I also think it's a benefit to work together because these will be my future colleagues and building those teamwork skills is a necessary aspect of this profession. Overall, I wish more professor incorporated group exams or quizzes in their classes because I felt like I learned more after taking a group exam.

It allows students to discuss the questions to explain their train of thought as to why a particular answer is right or wrong. This allows for different viewpoints to be brought up that not everyone may have thought of. It helps everyone to understand the reasoning behind each answer instead of just missing a question and never actually understanding why. The discussion also forms a base for us to be able to intelligently discuss physiological concepts with others, like colleagues and clients.

Although quantitative survey results indicated that group quizzes were a beneficial use of class time, some students indicated that the amount of class time required was a detriment to the process.

The only drawback is that extra class time had to be utilized for both individual and group exams/quizzes and that once finished with the individual you had to wait until everyone was finished to start the group exam/quiz.

While some students mentioned the benefits of group discussions, other students indicated group discussions could create confusion; being able to talk things through with classmates didn't always improve student understanding.

If everyone has a different answer it can be difficult and confusing to figure out who is correct.

It's possible for your group to influence your thought process to be incorrect.

There were times when discussion led to changing of answers that had been previously answered correctly on individual quizzes and exams.

Also, with the quizzes, sometimes members didn't agree with the answer that was chosen but had no way to submit their own answer. This was fixed with the group exams as each member submitted their own group exam.

Sometimes I did worse on the group exam because I was talked out of something that I knew. I guess I wasn't that confident or else I would have stuck with my answer. I like that we still put in our own answers so if there was a disagreement we could put different answers.

Furthermore, some students were uncomfortable when they believed their group members had a better understanding of the material. Other students were frustrated because they didn't feel all group members contributed equally.

Sometimes you felt dumb when the other people in the group knew the correct answer without any hesitation and you struggled with it.

The fact that individual performance is only half of the grade may cause some students to lessen how much effort they put into studying or understanding concepts.

People have the opportunity to slack and still get a good grade.

One drawback was that sometimes group members did not contribute equally.

If you were in a group with someone that may not have studied as much as you or your partner, they would just sit back and be quiet and copy the answers the other two group members had and would not contribute to the conversation about possible answers, but yet possibly still get the same group exam score.

During rough weeks (multiple exams or quizzes), we depended on one person from the group to get the correct answers.

I think the individual (assessments) push you to study the material more, since you don't have any classmates to rely on.

Although quantitative survey results favored group exams versus group quizzes for inclusion in future classes, different students had different preferences.

The group quizzes helped me to understand more basic concepts of physiology, while the group exams were more centered around applying the concepts to clinical cases, which I think in the long run, really improved my understanding

I enjoyed the group quizzes because it cleared up concepts I was unclear of before I got to the exam.

While both were beneficial, I feel that the quizzes were more helpful for me. Taking group quizzes gave opportunities to discuss concepts with classmates before taking the exam, while taking group exams only allowed you to discuss concepts after you had already taken the individual exam.

> *I thought the group exams were not as beneficial because it made for a very long exam and was harder to focus. I also felt that I continually was confused by material preceding exams, whereas when group quizzes were used I was better able to build up an understanding of the material as the class went forward.*

Student opinions of the formulation of groups varied. Some students would prefer a strictly random generation of groups while others thought it would be beneficial to distribute students into groups by class performance. In addition, knowledge of group assignment prior to an assessment may influence the amount of effort put into studying for that assessment.

> *I don't know how groups were formed but it would be helpful if better students were spread out into different groups.*

> *Regarding group exams, I wonder if the groups were composed by random or by GPA distribution. I'd much prefer a random composition.*

> *If groups were to be created based on grades (to even out group performance), this would lower the incentive for studying. In addition, if students know who is in their group, there is less incentive to study because they can split up material or slack off because they know someone else will pull their weight.*

Evaluation of New Teaching Methods – Assessments

The impact of group assessments on student performance was evaluated by comparing the individual student score and the group score for the different assessments. Mean group scores were higher than mean individual scores for all unit exams. However, the difference between group and individual exam scores was greater for low performing students (defined as students with an overall course grade of B-, C+, or C; n = 8) compared to high performing students (defined as students with an overall course grade of A+, A, or A-; n = 8). The difference between group and individual exam scores for middle performing students (defined as students with an overall course grade of B+ or B; n = 10) was greater than that for high performing students for 3 of the 4 unit exams and less than that for low performing students for 1 of the 4 unit exams. For individual exams, high performing students scored higher than low performing students for all exams. In addition, high performing students scored higher than middle performing students for 3 of the 4 exams and middle performing students scored higher than low performing students for 2 of the 4 exams. For group exams, there was no difference between high, middle, and low performing students except for 1 of the 4 exams where middle performing students received lower group scores than both high and low performing students (*Table 3*).

Mean group scores were higher than mean individual scores for all quizzes. However, the difference between group and individual quiz scores was greater for low performing students compared to high performing students. The difference between group and individual quiz scores for middle performing students was greater than that for high performing students and less than that for low performing students for 2 of the 3 units. For individual quizzes, high performing students scored higher than middle and low performing students and middle performing students

scored higher than low performing students for all units. For group quizzes, there was no difference between high, middle, and low performing students except for 1 unit where low performing students received lower group scores than both high and middle performing students (*Table 3*).

Retention of student learning was evaluated with the use of end-of-semester post-tests since students were not informed of the post-test in advance to prevent them from studying to prepare. High performing students scored higher than middle and low performing students and middle performing students scored higher than low performing students on post-test questions when they were originally administered as part of weekly quizzes and unit exams. High performing students also scored higher than middle and low performing students on post-test questions when they were administered as part of end-of-semester post-tests. Middle performing students scored higher than low performing students on the spring end-of-semester post-test questions but not the fall. The difference between end-of-semester post-test and original scores was smallest for high performing students and lowest for middle performing students. The difference between post-test and original scores was not different between low performing students and both high and middle performing students (*Table 3*).

Post-test questions were used to determine the impact group assessments had on learning retention. Scores were determined for students when they answered the questions as part of a weekly quiz or unit exam. These scores were then compared with those for when students answered the same questions as part of an end-of-semester post-test. Post-test questions were classified in 2 different ways: exam (administered on a unit exam) versus quiz (administered on a weekly quiz) and individual (administered on a quiz/exam not administered in a group format) versus group (administered on a quiz/exam administered in a group format).

Performance on questions was compared between the original scores students received on the questions and the end-of-semester scores. Scores were significantly lower on post-tests versus original assessments for questions administered on individual exams, group exams, individual quizzes, and group quizzes (*Figure 1A*). These differences were also seen when scores were evaluated for just the top performing students and the middle performing students (*Figure 1B* and *Figure 1C*). For these cohorts of students, retention was not impacted by the use of group assessments. For low performing students, scores were significantly lower on the post-test for questions administered on group exams or quizzes but significant differences were not seen for questions administered on individual exams or quizzes (*Figure 1D*). For this student group, the use of individual assessments improved retention of physiologic knowledge.

Performance on post-test questions was also compared between the scores students received on questions administered during individual assessments and group assessments. There was no difference in scores for original exam questions, post-test exam questions, and original quiz questions. However, scores were significantly lower for group quiz questions versus individual quiz questions when administered on an end-of-semester post-test (*Figure 2A*). This same effect was seen with middle performing students but there was no significant difference in scores for any of the question groupings for high performing students (*Figure 2B* and *Figure 2C*). For low performing students, scores were significantly lower for group quiz questions versus individual quiz questions and for group exam questions versus individual quiz questions when administered

on an end-of-semester post-test (*Figure 2D*). This provides further evidence that use of individual assessments improved knowledge retention in low performing students. Use of individual assessments may also improve knowledge retention in middle performing students.

Lastly, post-test question performance was compared between exam questions and quiz questions. There was no difference in scores for original individual questions, post-test individual questions, original group questions, and post-test group questions (*Figure 3A*). No differences were identified when the same analysis was conducted for just high, middle, and low performing students (*Figure 3B, Figure 3C,* and *Figure 3D*, respectively). This suggests that question type (quiz = remember; exam = understand, apply) did not have an impact on the use of group assessments or post-tests.

Plans for Future Courses

Students believed that group assessments helped improve their understanding of physiologic concepts; however, evaluation of quizzes, exams, and post-tests did not reveal any evidence of improved academic performance or retention of learning. In fact, learning retention for low performing students appeared to be impaired with the use of group assessments even though this group of students received the greatest score improvement from participation in group assessments. Despite the lack of performance evidence to support increased learning, the positive survey responses suggest that group assessments may a role in physiology courses and I would like to repeat a similar study during the fall semester of 2017.

It would be beneficial to conduct group assessments with a different cohort of students to determine if comparable effects would be evident on quizzes, exams, and post-tests. In addition, different students may have unique perceptions of the associated benefits and drawbacks of group assessments. Conducting group quizzes and group exams in a single semester would also prevent differences in course content from influencing student perceptions or performance.

For the fall 2016 and spring 2017 semesters, the individual portion of assessments was worth one-half of the total value while the group portion comprised the other half of the assessment value. For fall 2017, I would like to administer both group quizzes and exams but group assessments would no longer be equal in value to individual assessments. Instead, group assessments could be used to add points to the individual assessment but the addition of points would be limited to 5-10% of the total assessment value. For example, students would have the opportunity to raise their individual assessment score by 0.5 to 1 point on a 10 point quiz. A student that earned 6 out of 10 points on the individual quiz could raise their score to 7 out of 10 points while a student that earned 9 out of 10 points on the individual quiz could raise their score to 10 out of 10 points.

For the fall 2016 semester, high, middle, and low performing students had a score difference of 3.1-6.8%, 14.5-14.8%, and 19.7-25.8%, respectively, between group and individual quizzes. For the spring 2017 semester, high, middle, and low performing students had a score difference of -2.7-4.1%, 13.3-15.3%, and 21.4-38.3%, respectively, between group and individual exams. Allowing participation in group assessments to improve student assessment scores by a

maximum of 5-10% would be similar to the score improvement experienced by high performing students but less than the score improvement experienced by middle and low performing students.

Reducing the weight of group assessments in the overall assessment score should increase the level of fairness for this process as low and middle performing students should not experience a greater increase in their course grade compared to high performing students. In addition, limiting the amount of points a student could earn from a group assessment would hopefully reduce the occurrence of students studying less than they would for an individual assessment because they plan to rely on their group members to substantially increase their score.

Based on student feedback, I think there are 3 other factors that should be implemented for future semesters in which group assessments are used. I do not think students should be notified of their group assignment in advance. If a student is aware that they have been grouped with a high performing student, this may discourage them from putting forth the necessary effort when studying for the assessment because they are confident the high performing student will help earn them a high grade on the group portion of the assessment. Furthermore, taking prior quiz/exam performance into consideration when forming student groups may not be fair to high performing students. High performing students should have the same chance of being placed in a group with a high performing student as a middle and low performing student. Lastly, allowing students to submit separate answers for group assessments will reduce some dissatisfaction with the process when group members cannot come to a consensus on correct answers.

Tables

Table 1

Survey Item[1]	Mean[1]			% Agree[2]		
	Quizzes	**Exams**	*P* value	**Quizzes**	**Exams**	*P* value
Participation in group quizzes/exams improved my overall quiz/exam grades.	4.54	4.70	0.1392	92.3%	92.6%	0.9687
Participation in group quizzes/exams helped improve my understanding of physiologic concepts.	4.12	4.22	0.4083	83.0%	85.2%	0.6686
Participation in group quizzes/exams was a valuable use of class time.	4.42	4.67	0.0957‡	92.3%	92.6%	0.9687
I would prefer to have group quizzes/exams in future classes.	3.85	4.52	0.0153*	77.4%	85.2%	0.1653

[1]Items were scored 5, 4, 3, 2, and 1, respectively, for the responses Agree, Somewhat Agree, Neutral, Somewhat Disagree, and Disagree.

[2]Agree and Somewhat Agree were considered responses in agreement for each item while Neutral, Somewhat Disagree, and Disagree were not.

$*P < 0.05$ $‡P < 0.1$

TABLE 1 Student perceptions as reported on end-of-course surveys (response rate = 100%). Means are presented but the nonparametric data were statistically analyzed via rank sums. Statistically significant differences ($P < 0.05$) in rank sums between group quizzes and group exams were determined by Wilcoxon/Kruskal-Wallis tests and are represented by asterisks (*). Percent agreement data were statistically analyzed via Pearson's chi-squared tests; no significant differences were identified.

Table 2

Survey Item	Quizzes	Exams
Indicate the *most common* level of participation which occurred during the group quizzes/exams.[1]		
All three group members were equal contributors to the decision-making process.	34.6%	34.6%
Two group members (including yourself) were equal contributors to the decision-making process; the other group member was only a minor contributor.	53.8%	30.8%
Two group members (not including yourself) were equal contributors to the decision-making process; you were only a minor contributor.	3.9%	11.5%
You were the primary contributor to the decision-making process; the other 2 group members were only minor contributors.	3.9%	7.7%
One of your group members was the primary contributor to the decision-making process; the other 2 group members (including yourself) were only minor contributors.	3.9%	15.4%
Indicate the levels of participation that occurred during ANY of the group quizzes/exams.[2]		
All three group members were equal contributors to the decision-making process.	76.9%	61.5%
Two group members (including yourself) were equal contributors to the decision-making process; the other group member was only a minor contributor.	84.6%	80.8%
Two group members (not including yourself) were equal contributors to the decision-making process; you were only a minor contributor.	53.9%	42.3%
You were the primary contributor to the decision-making process; the other 2 group members were only minor contributors.	53.9%	42.3%
One of your group members was the primary contributor to the decision-making process; the other 2 group members (including yourself) were only minor contributors.	38.5%	50.0%

[1]Percent of total responses, n = 26. Students were only able to select 1 response.

[2]Percent of total respondents, n = 26. Students were able to select multiple responses. Total responses for quizzes = 80. Total responses for exams = 72.

TABLE 2 Student perceptions as reported on end-of-course surveys (response rate = 100%). Percent agreement data were statistically analyzed via Pearson's chi-squared tests; no significant differences were identified.

Table 3

Assessment	Mean[1]			P value
	High	Middle	Low	
Individual Exam Score				
Cardiovascular	89.3%[a]	74.5%[b]	67.7%[b]	0.0001
Respiratory	84.4%[a]	74.2%[ab]	65.1%[b]	0.0013
Renal	91.4%[a]	72.4%[b]	57.0%[c]	0.0001
Digestive	91.4%[a]	73.2%[b]	63.5%[c]	0.0001
Group Exam Score				
Cardiovascular	90.8%[a]	88.5%[a]	89.1%[a]	0.6854
Respiratory	88.4%[a]	88.7%[a]	90.8%[a]	0.7788
Renal	94.6%[a]	87.7%[b]	95.3%[a]	0.0140
Digestive	88.6%[a]	86.4%[a]	88.1%[a]	0.3769
Exam Score Difference (Group minus Individual)				
Cardiovascular	1.5%[a]	14.0%[b]	21.4%[b]	0.0028
Respiratory	4.1%[a]	14.5%[ab]	25.7%[b]	0.0007
Renal	3.2%[a]	15.3%[b]	38.3%[b]	0.0001
Digestive	-2.7%[a]	13.3%[b]	24.6%[c]	0.0001
Individual Quiz Score				
Cell-Neuronal-Muscular	90.6%[a]	76.6%[b]	64.9%[c]	0.0001
Endocrine	91.1%[a]	78.2%[b]	65.8%[c]	0.0001
Reproductive	88.5%[a]	77.5%[b]	65.1%[c]	0.0001
Group Quiz Score				
Cell-Neuronal-Muscular	93.7%[a]	91.1%[a]	89.9%[a]	0.2790
Endocrine	96.0%[a]	92.9%[a]	85.5%[b]	0.0002
Reproductive	95.3%[a]	92.0%[a]	90.8%[a]	0.0706
Quiz Score Difference (Group minus Individual)				
Cell-Neuronal-Muscular	3.1%[a]	14.5%[b]	24.9%[c]	0.0001
Endocrine	4.9%[a]	14.8%[b]	19.7%[b]	0.0001
Reproductive	6.8%[a]	14.5%[a]	25.8%[b]	0.0004
Post-test Questions - Original Score				
Cell-Neuronal-Muscular, Endocrine & Reproductive	96.7%[a]	85.2%[b]	76.8%[c]	0.0001
Cardiovascular, Respiratory, Renal & Digestive	95.4%[a]	80.5%[b]	64.4%[c]	0.0001
Post-test Questions - End-of-semester Score				
Cell-Neuronal-Muscular, Endocrine & Reproductive	82.7%[a]	61.9%[b]	56.9%[b]	0.0001
Cardiovascular, Respiratory, Renal & Digestive	82.9%[a]	59.2%[b]	50.4%[c]	0.0001
Post-test Score Difference (End-of-semester minus Original)				
Cell-Neuronal-Muscular, Endocrine & Reproductive	-14.0%[a]	-23.3%[b]	-19.9%[ab]	0.0478
Cardiovascular, Respiratory, Renal & Digestive	-12.5%[a]	-21.3%[b]	-14.0%[ab]	0.0404

[1]Superscript letters represent values that are significantly different between students classified as high-performing (course grade = A+, A, A-), middle-performing (course grade = B+, B), or low-performing (course grade = B-, C+, C). $P < 0.05$

TABLE 3 The mean percentage of correct answers on questions from unit exams and weekly quizzes administered in an individual format versus a group format. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Statistically significant differences ($P < 0.05$) in means between high, middle, and low performing students were determined using Tukey-Kramer HSD.
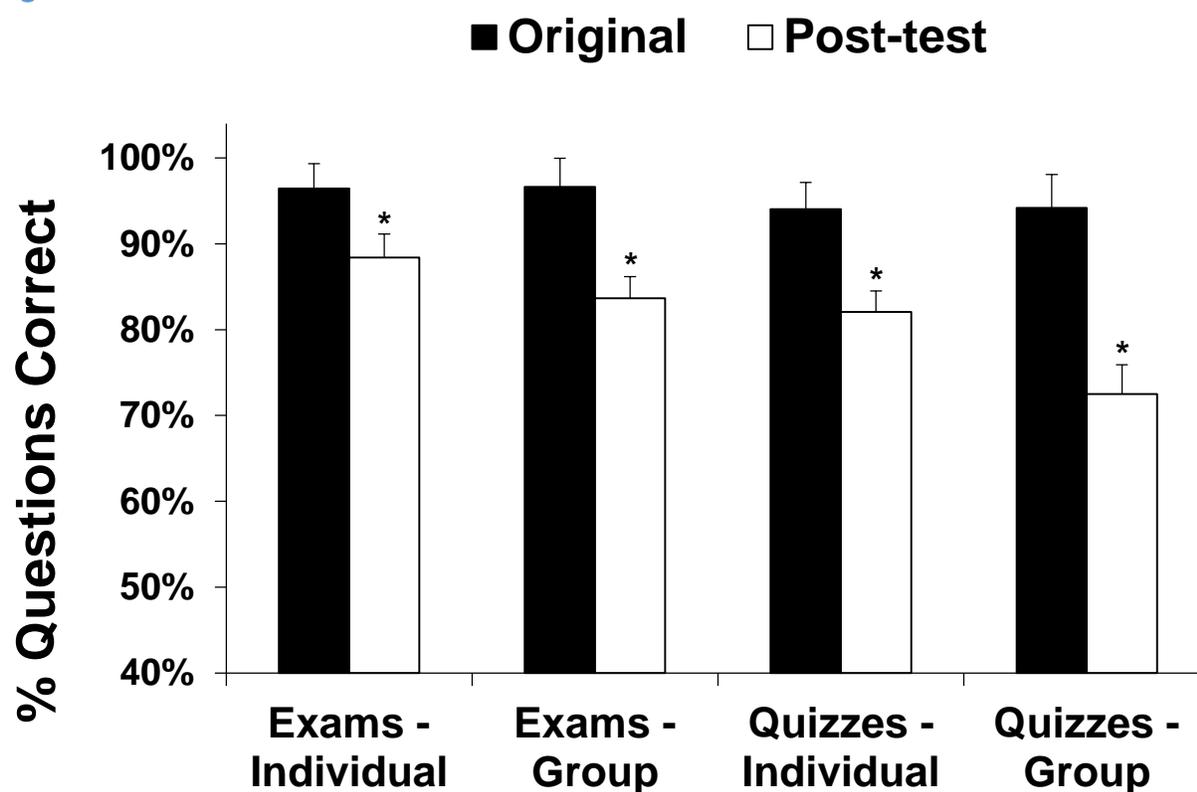
Figures

Figure 1A

■ Original   □ Post-test
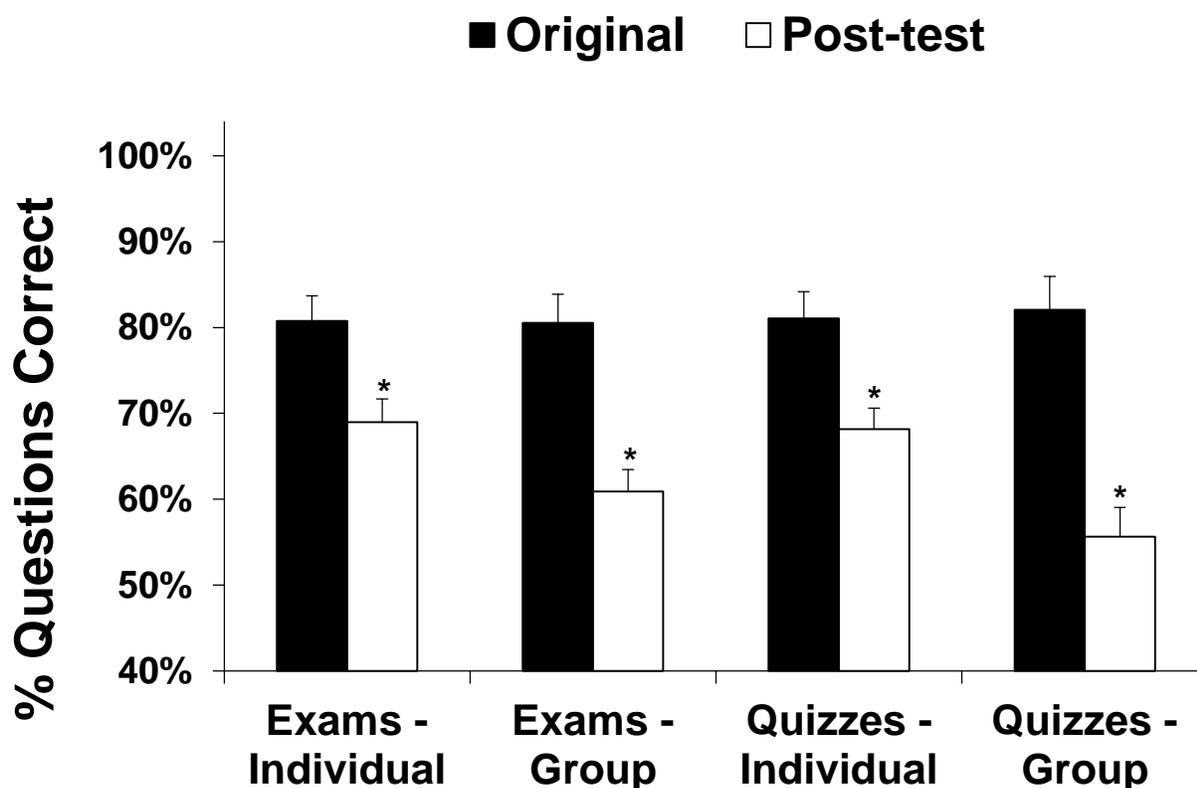
All Students (n = 26)

FIGURE 1A The mean percentage of correct answers on questions from individual and group assessments administered as part of a unit exam or weekly quiz versus a post-test. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
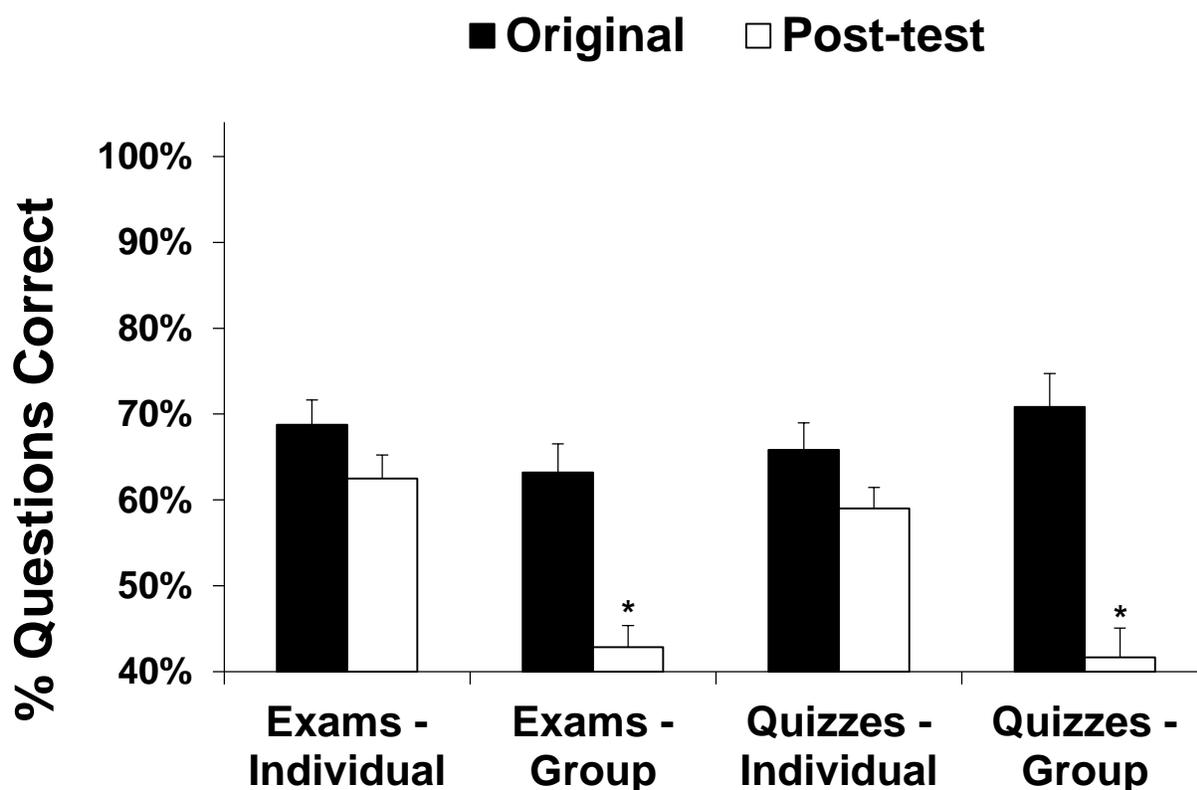
Figure 1B

High-performing Students (course grade = A+, A, A-; n = 8)

FIGURE 1B The mean percentage of correct answers on questions from individual and group assessments administered as part of a unit exam or weekly quiz versus a post-test. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
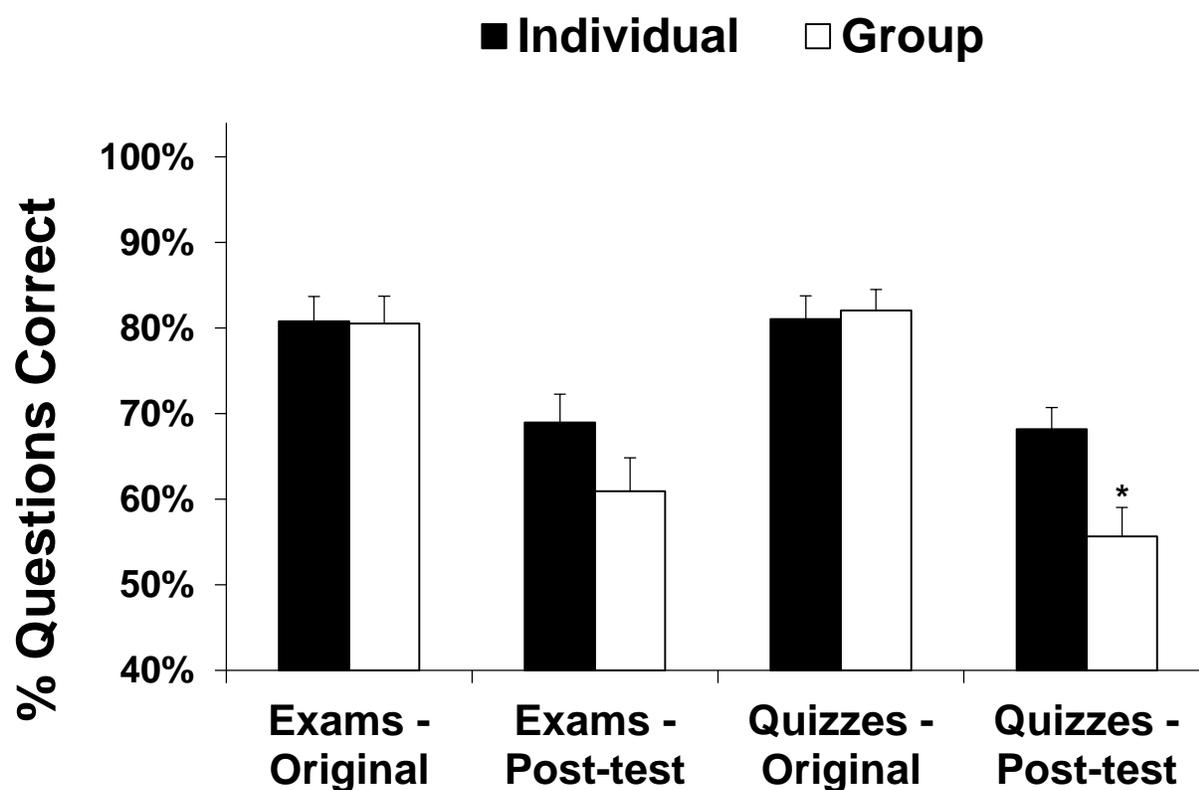
Figure 1C

Middle-performing Students (course grade = B+, B; n = 10)

FIGURE 1C The mean percentage of correct answers on questions from individual and group assessments administered as part of a unit exam or weekly quiz versus a post-test. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
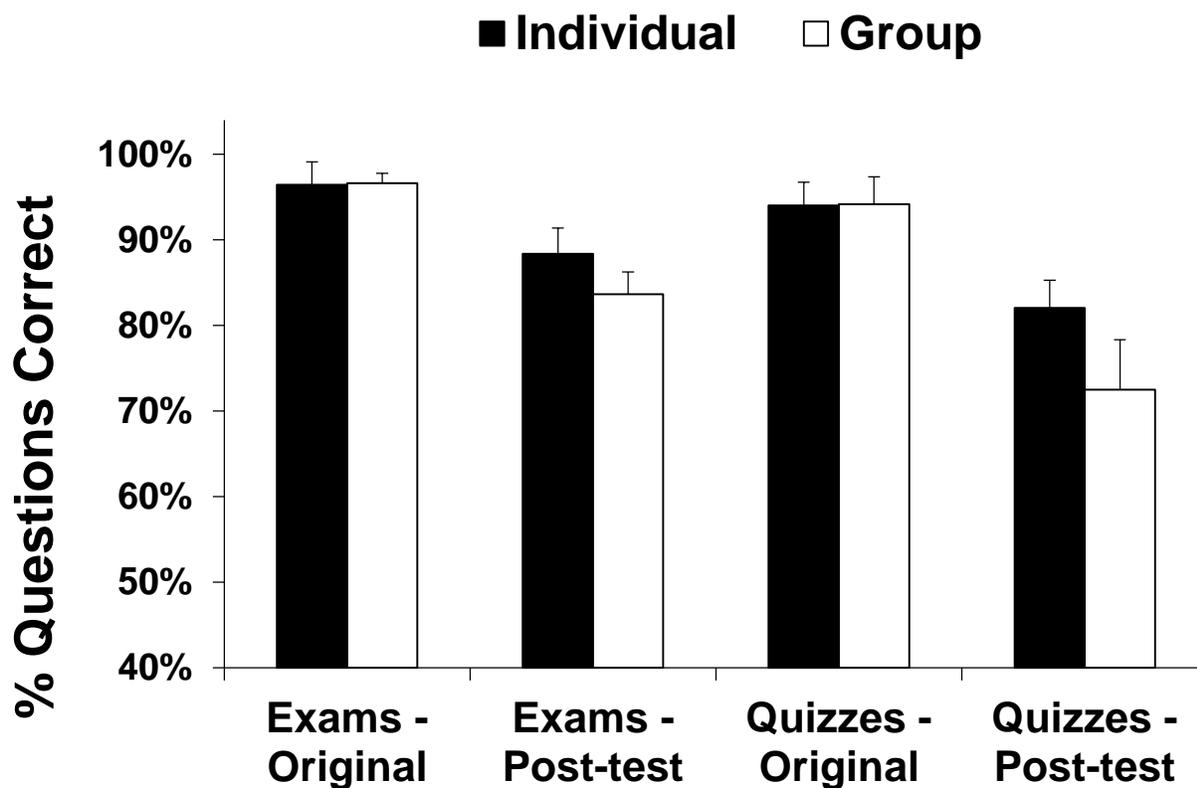
Low-performing Students (course grade = B-, C+, C; n = 8)

FIGURE 1D The mean percentage of correct answers on questions from individual and group assessments administered as part of a unit exam or weekly quiz versus a post-test. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
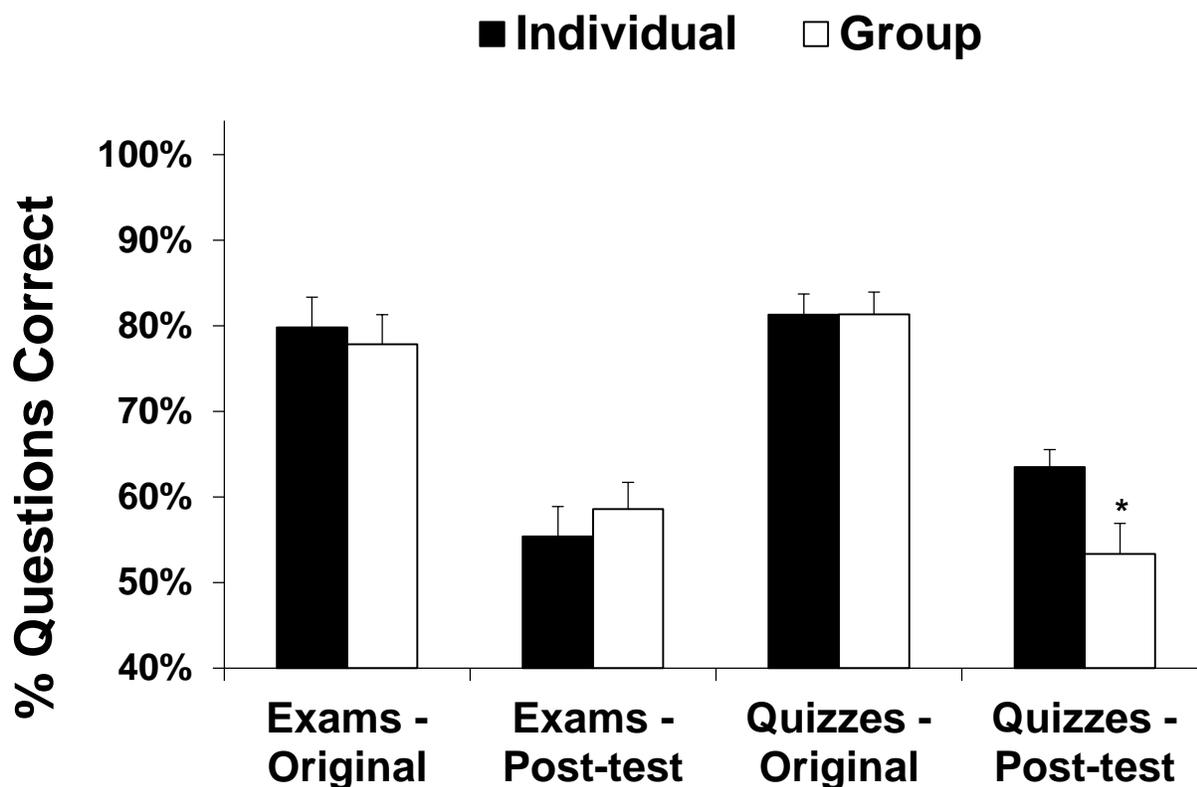
Figure 2A

FIGURE 2A The mean percentage of correct answers on questions from unit exams and weekly quizzes administered in an individual format versus a group format. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.

Figure 2B

FIGURE 2B The mean percentage of correct answers on questions from unit exams and weekly quizzes administered in an individual format versus a group format. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
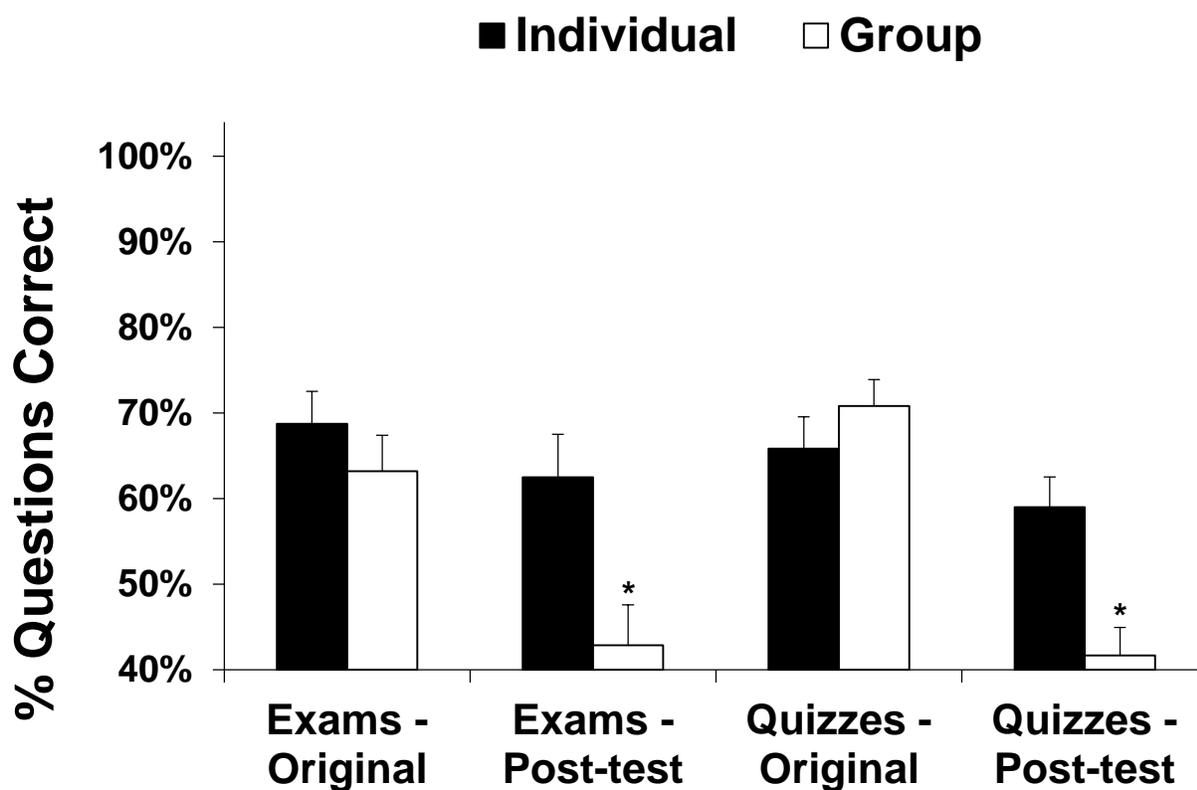
Figure 2C

Middle-performing Students (course grade = B+, B; n = 10)

FIGURE 2C The mean percentage of correct answers on questions from unit exams and weekly quizzes administered in an individual format versus a group format. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
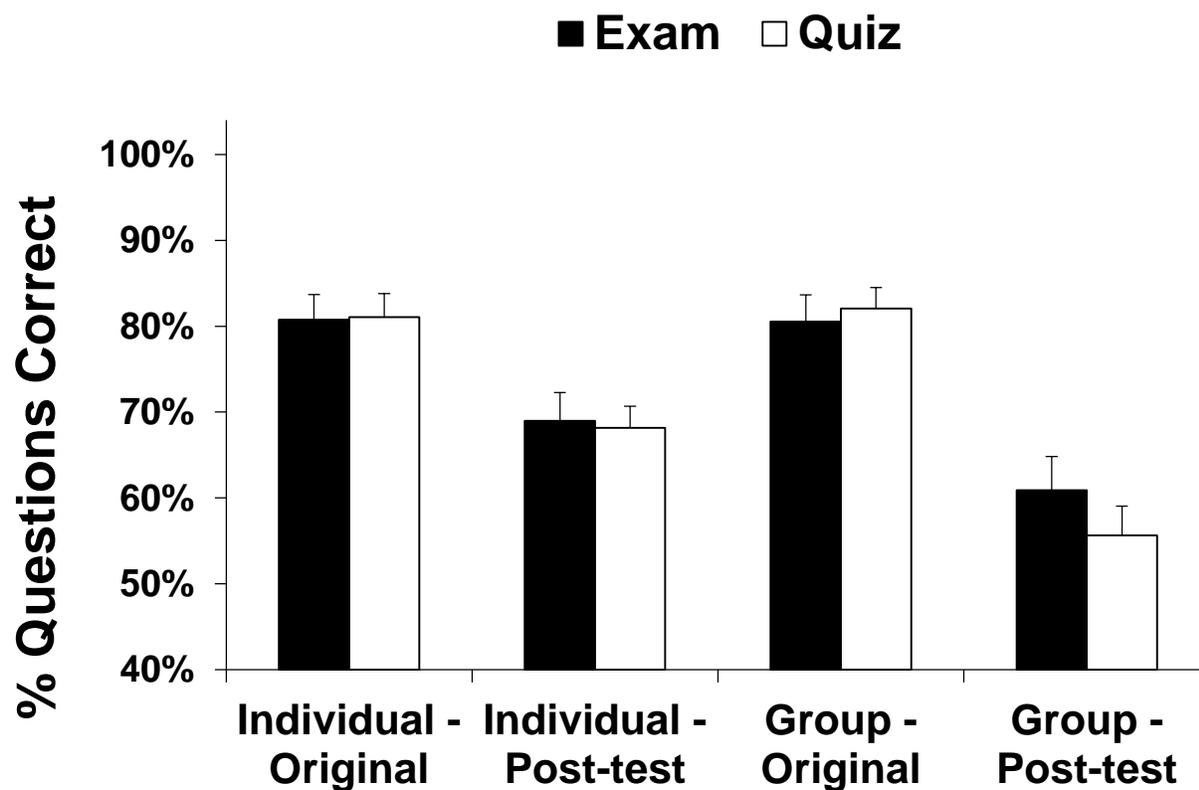
Figure 2D

Low-performing Students (course grade = B-, C+, C; n = 8)

FIGURE 2D The mean percentage of correct answers on questions from unit exams and weekly quizzes administered in an individual format versus a group format. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
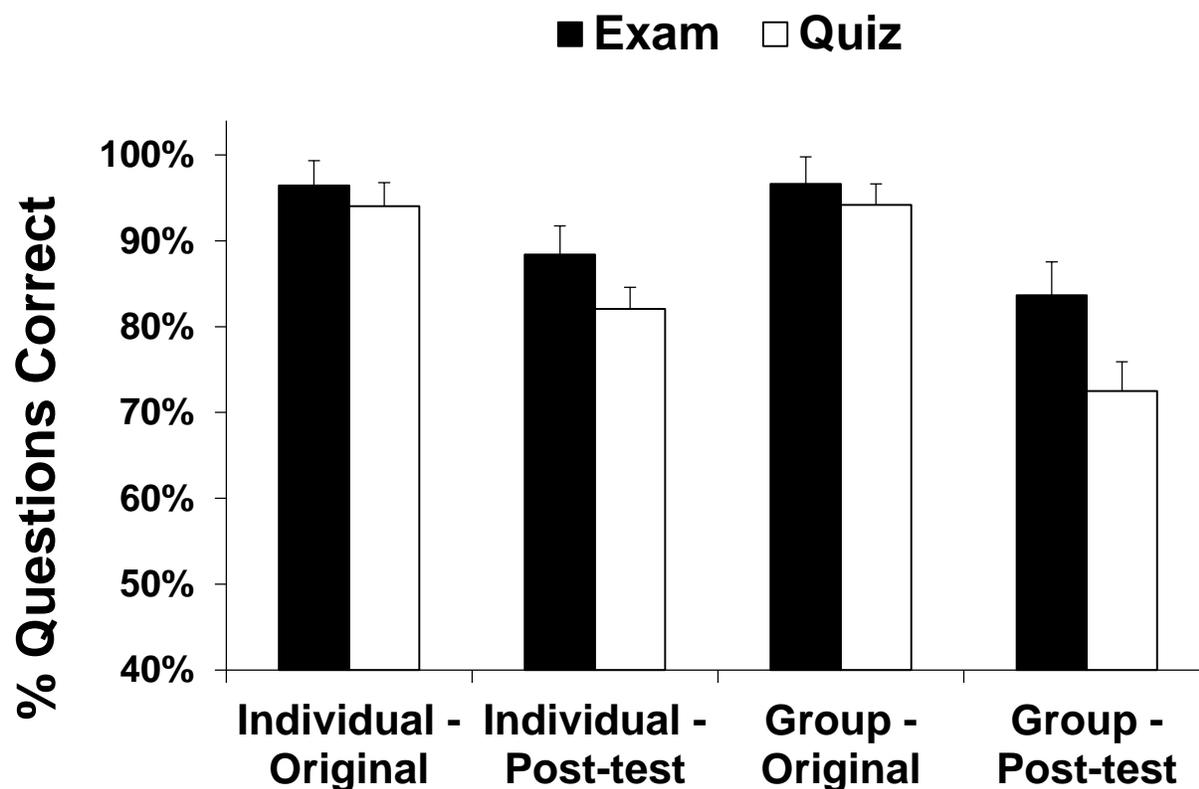
Figure 3A

FIGURE 3A The mean percentage of correct answers on questions from individual and group assessments administered as unit exams versus weekly quizzes. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
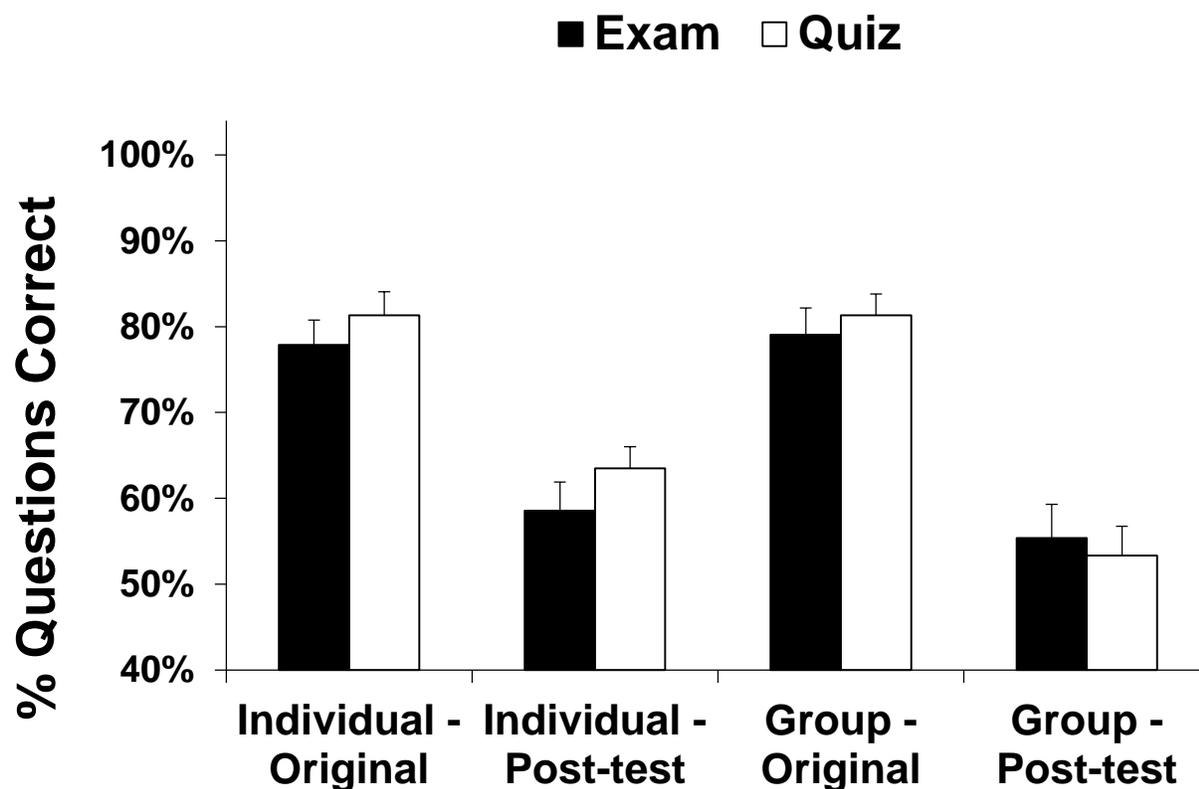
High-performing Students (course grade = A+, A, A-; n = 8)

FIGURE 3B The mean percentage of correct answers on questions from individual and group assessments administered as unit exams versus weekly quizzes. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.
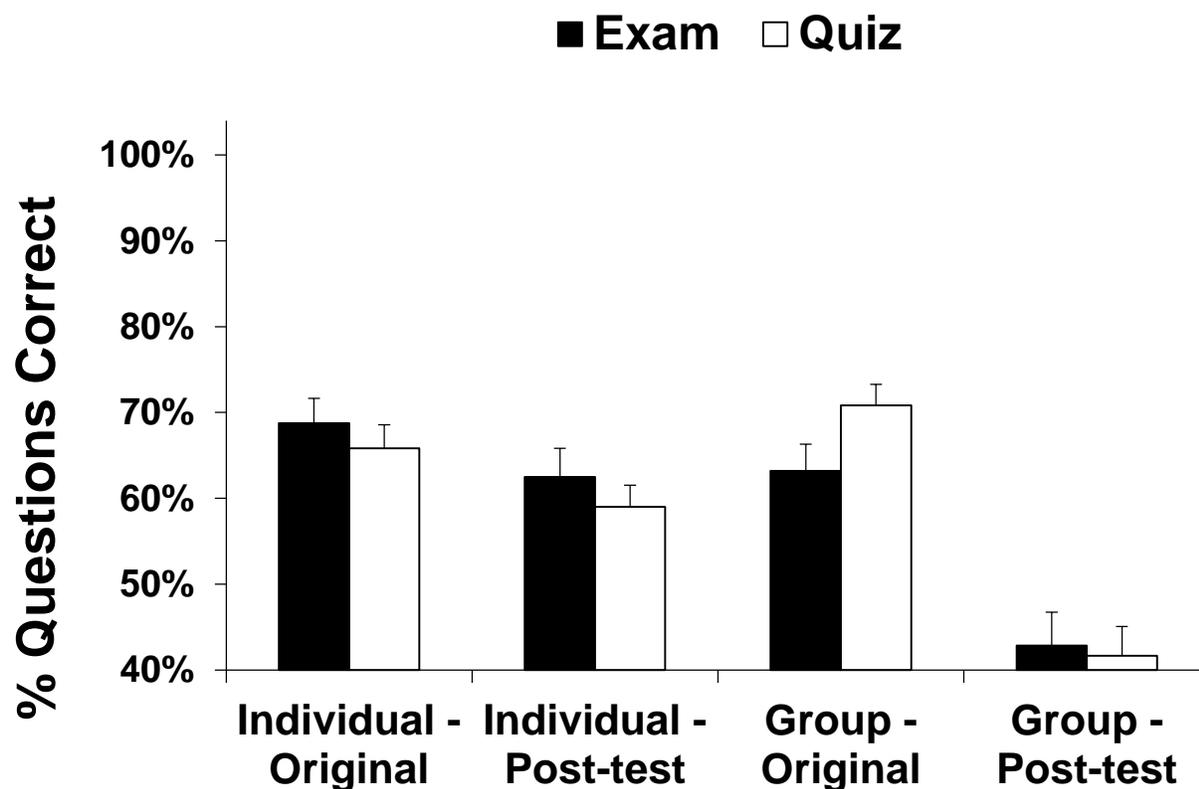
Figure 3C

Middle-performing Students (course grade = B+, B; n = 10)

FIGURE 3C The mean percentage of correct answers on questions from individual and group assessments administered as unit exams versus weekly quizzes. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.

Figure 3D

Low-performing Students (course grade = B-, C+, C; n = 8)

FIGURE 3D The mean percentage of correct answers on questions from individual and group assessments administered as unit exams versus weekly quizzes. Post-tests were administered at the end of the semester and consisted of select questions from unit exams and weekly quizzes. Original scores are those from questions on unit exams and weekly quizzes which were used for post-tests. Post-test scores are those from questions on post-tests with scores for questions derived from unit exams and weekly quizzes shown separately. Asterisks (*) represent a statistically significant difference ($P < 0.05$) in means between individual and group assessments as determined by Student's t tests.