Investigating Active-Learning Strategies in Wildlife Ecology College Courses[1]

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Abstract

Active-learning strategies are becoming more common in undergraduate wildlife management courses, but no quantified assessments were found for our discipline. We assessed active-learning strategies during three 50-minute class periods in a wildlife populations course during spring 2009. Our teaching objectives were to address general principles of wildlife harvest management and the learning objectives were primarily student application of principles to real management scenarios. We used active lectures to present our topic and a problem-based group case study to examine a common yet controversial situation of high deer abundance with differing stakeholder attitudes toward deer harvest management. We administered identical pre and post-topic quizzes to quantify student learning. Mean student score (n = 35) on the pre-topic quiz was lower (68%) than the post-topic quiz (79%). About 60% of the scores fell between 60% and 80% for the pre-topic quiz, while 57% of the scores were >80% for the post-topic quiz. Most (77%) student changes in scores between quizzes were positive, with almost half of the students showing >14% improvement. Overall, students ranked their confidence as slightly increased following implementation of active-learning strategies. Our assessment can be used for comparison to future studies, to improve course structure, and to identify and address our teaching deficiencies.

Introduction

Undergraduate-level wildlife management courses typically have relatively small numbers of students (25 to 50, depending on department). Despite these smaller class sizes, active and experiential learning methods have only come to the forefront in wildlife education literature in recent years (e.g., Ryan and Campa, 2000; Moen et al., 2000; Millenbah and Millspaugh, 2003), with the first how-to article for this discipline appearing in 2000 (i.e., Ryan and Campa 2000). Ryan and Campa (2005) illustrated the drawbacks of traditional lecture-based learning, including its passive and rote-learning style, lack of support for higher-order thinking, and long attention span required by students. This is not to say that lectures should not be utilized to facilitate learning; indeed, lectures have their strengths and weaknesses as any approach does, but we need to recognize the weaknesses and under what circumstances they are most applicable and effective (Bonwell, 1996). Regardless of the approach, we agree that "…the essence of good teaching is helping students uncover material, not having instructors cover it" (Ryan and Campa, 2000, p. 171). Students are expected to take no small portion of responsibility for their own learning, not only of facts and concepts but also of critical-thinking, communication, and other higher-order skills (Matter and Steidl, 2000; Ryan and Campa, 2000). As educators we can, however, implement a diversity of active-learning strategies to increase effectiveness in the classroom, as there is much evidence in support of the effectiveness of these strategies (Bonwell and Sutherland, 1996). Ultimately, we would want students in wildlife management classes not only to gain knowledge, but also for them to increase their efficacy in applying knowledge to real-world management situations.

Problem-based learning is a relatively new pedagogical technique for undergraduate courses in wildlife management, and is necessary for bridging the gap between formal education and real-world management applications (Campa et al., 2003; Ryan and Campa, 2005). One complaint from undergraduate students that we and our colleagues often hear is the lack of student recognition of real-world relevance of material presented during class. We believe addressing this issue is the responsibility of the instructor by clearly outlining learning or course objectives (Groccia and Miller, 1996) and implementing active-learning strategies, such as problem-based learning. The problem-based learning process often begins with the instructor presenting the problem, then students being exposed to information to help address the problem, thereby increasing student ability to recognize the usefulness of that information. Students in wildlife ecology must be trained in more than just science and technology; they also must be exposed to management constraints and conditions through political, economic, and social-cultural aspects (Kessler et al., 1998; Brown and Nielsen, 2000), which can be aided through problem-based learning.

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Active-learning strategies are intuitively and anecdotally beneficial learning approaches in wildlife management courses, but we found no evidence of quantified assessments of such approaches within our discipline. Our objective was to quantify the effectiveness of applying active-learning strategies for primarily undergraduate students enrolled in a wildlife management course at the University of Nebraska-Lincoln. Habitat management, harvest management, and people management are three of the primary tools for wildlife management. We chose to teach the topic of wildlife harvest management through active lecturing and problem-based case study approaches as the active-learning strategies during our study.

Methods

Our study was conducted during a University of Nebraska-Lincoln class, Biology of Wildlife Populations, with an enrollment of 42 undergraduate (NRES 450) and three graduate (NRES 850) students during spring semester 2009. The course was designed to cover the principles of population ecology as they relate to management of harvested and non-harvested fish and wildlife species. This included developing and using population models to evaluate management strategies for wildlife, and incorporating sources of stochasticity in population models to assess their effect on those strategies. Learning objectives included students being able to apply these principles and practices in real management scenarios by using higher-order thinking processes, such as synthesizing concepts of population ecology for creative problem solving and justification of why a particular management decision would be better than another (e.g., Ryan and Campa, 2005).

For our study, we chose the topic of wildlife harvest management. Students in the course worked in randomly assigned groups of four to six, which were maintained throughout the semester and included other problem cases and semester-long projects (i.e., cooperative base groups; Johnson and Johnson, 2004). To assess student learning, we administered two identical voluntary quizzes, one prior to and one immediately following the presented material and learning activities. The entire process required three 50-minute class periods. We notified all students enrolled in the class via email of the opportunity to participate in our study (i.e., to complete both quizzes and attend all three class periods) prior to initiation. The 17-item quiz consisted of 13 multiple-choice and three short-answer questions directly related to harvest management. An additional question asked the student to rank their confidence level (very confident, confident, neutral, not very confident, and not confident at all) in a real-world harvest management setting. We allowed 20 minutes for students to complete each quiz.

Students that elected to participate in our study could withdraw at any time without penalty, but only students that completed all aspects of our study were awarded extra credit towards their course grades. Students labeled both quizzes with a unique but anonymous identifier (e.g., the last four digits of their phone number) that allowed us to match pre-topic and post-topic quizzes at the individual level. We also offered an alternative project of similar effort and reward for students who elected not to participate in our study. Our study was approved by the University of Nebraska-Lincoln Institutional Review Board (Project IRB #9806) as exempt from full review.

We developed our teaching objectives for students based on addressing three broad questions relevant to wildlife harvest management: 1) What is the social context of harvest management for wildlife? 2) How is the process of estimating population size and carrying capacity of wildlife species used for harvest management? and 3) How do harvest regulations affect the sex ratio and age structure of a harvested population? Based on our teaching objectives, we developed a case study that described a common scenario for wildlife managers: harvest management of white-tailed deer (Odocoileus virginianus) in an agroecosystem where management objectives included reducing high deer population abundance. The complexity of this scenario is something that most undergraduates have not been exposed to, but would benefit from and almost surely be expected to address as professionals employed by a state wildlife agency (Campa et al., 1996). Setting deer harvest management objectives normally involves numerous stakeholders (e.g., hunters, farmers, insurance companies, conservation organizations, animal rights groups) that typically desire very different management outcomes (e.g., higher versus lower deer abundance, higher deer abundance versus more large-antlered males, no harvest whatsoever regardless of problems associated with high deer abundance). The problem relayed an engaging story that related concept to application, challenged students to make informed and justifiable decisions, incorporated controversy such that no single decision could be determined as the "correct" decision, and was complex enough to encourage teamwork for a successful outcome (Allen et al., 1996).

Following completion of the pre-topic quiz, we stated the teaching and learning objectives and used active lecturing (mini-lectures with breaks for short discussions) for the remainder of the first class period to cover relevant background information about harvest management (e.g., the North American Model of Wildlife Conservation, general harvest monitoring techniques, deer ecology relevant to the case study). These active lectures were 10 to 15 minutes long, followed by a brief 5 to 10-minute discussion to retain student interest and check student comprehension of the material and concepts presented. At the end of the first class, we gave each student a copy of the case study and management questions, but no quantitative information relevant to the case study. We asked students to read the case study prior to the next class period, consider the problems, and think about their approach to address these management problems. This was done not only to increase efficient use of class time, but also for students to relate material presented and discussed during the next class period to the case study problem.

The second class period consisted of several 10 to 15-minute-long active lectures that included the process of a successful harvest management program, specific harvest regulations and their expected outcomes, addressing undesirable population characteristics (e.g., skewed age structures, unbalanced sex ratios), harvest measurement techniques, and management control and constraints. Population size and structure estimation was also presented using the sex-age-kill model (commonly used by state wildlife agencies; Creed et al., 1984; Mattson and Moritz, 2008), but with an example different from that used for the case study problem. Students were then reminded to review the case study again before the third and final class period on the topic of wildlife harvest management.

During the final class period devoted to harvest management, we presented the case study in more detail, including expectations of students justifying their management strategies (i.e., expecting them to use higher-order thinking processes). Students then formed their cooperative base groups, discussed the case study, completed an exercise that involved estimation of deer population size and structure based on the sex-age-kill model, and formed their management strategies. The case study included two differing stakeholder views of how the deer population within a fictitious management unit should be managed. Essentially, hunters claimed an unacceptably large decline of large-antler deer ("trophy deer" or "big bucks") had occurred in past years whereas farmers claimed a substantial increase in crop damage had resulted from an unacceptably large increase in deer abundance. The case study was supported by harvest data for students to use as inputs within the sex-age-kill model framework and to evaluate deer population characteristics based on model outputs (Ryan and Campa, 2000). Students were expected to perform as state agency wildlife managers and address this realistically controversial management issue by simultaneously considering both stakeholder groups. Students implemented group-learning strategies (e.g., cooperative learning) to evaluate this problem, estimated deer population size and structure from the data provided, and addressed the case study problems through justified management actions and alternatives.

Based on their sex-age-kill model calculations and the case study description, students were asked four questions: 1) Was the buck harvest up or down from the previous year? 2) Are the big bucks really gone from this management unit? 3) Did the deer population in the management unit increase, as the farmer claimed, or did it decrease, as the hunter claimed? and 4) What harvest management action(s) would you implement to make both the farmer and the hunter happy? Students were expected to justify their decisions based on evidence from their calculations, the material presented during class, and any previous knowledge of deer biology and harvest management. Group outcomes (i.e., justified management decisions) were discussed informally but every attempt was made to actively engage all groups during the discussion (e.g., asking groups about their outcomes, groups expressing opinions or inquiring about outcomes of other groups). Each of the four case study questions was discussed in detail and accompanied by the correct population size and structure estimates from the sex-age-kill model using the data provided. Students also completed the post-topic quiz during the final class period.

We paired quizzes based on the unique identifiers provided by students to measure the effectiveness of our active-learning strategies for wildlife harvest management. We graded quizzes where each of 13 multiple-choice questions was worth one point and

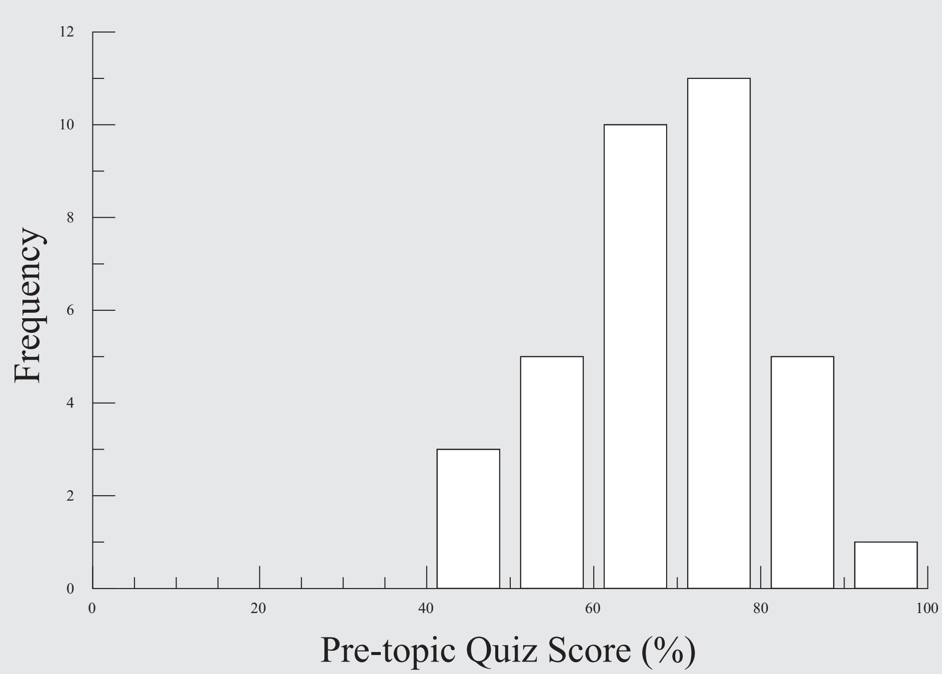

Figure 1. Distribution of student scores from the quiz administered before applying active-learning strategies for teaching wildlife harvest management.

each of three short-answer questions was worth either two or three points depending on the question, for a maximum possible quiz score of 21 points. We used ProStat version 4.81 (Poly Software International, Pearl River, NY) for data analysis, including estimating linear regression models and 95% confidence limits (CLs).

Results and Discussion

A total of 35 students elected to fully participate in our study, i.e., completed both quizzes and attended all relevant classes on harvest management. Two students withdrew from the study (i.e., they did not complete the post-topic quiz). Students had a mean score of 67.6% (SE = 2.1; n = 35) for the pre-topic quiz, with a range of 42.9 to 90.5%. For the post-topic quiz, students improved the mean score to 78.8% (SE = 2.1; n = 35), but the range of scores remained similar to the pre-topic quiz (range = 42.9 to 95.2%).

The distribution of scores shifted from about 60% of the scores falling between 60% and 80% for the pre-topic quiz to about 57% of the scores >80% for the post-topic quiz (Figures 1 and 2). Most (77%) student changes in scores from the pre-topic to the post-topic quiz were positive, with almost half of the students showing >14% improvement. A weak relationship existed (r = 0.41, n = 35) when we plotted improvement in score (score [%] of post-topic quiz minus score of pre-topic quiz; y) as a function of score (%) of pre-topic quiz (x; Figure 3). The linear regression model had an intercept of 35.1 (95% CL = 15.8 to 54.5) and a coefficient of −0.35 (95% CL = −0.64 to −0.07). This suggested that, although the confidence intervals were large, for each 1% increase in score of the pre-topic quiz, the improvement in score could be expected to decrease by about 0.4%. This seemed logical, as students with lower pre-topic quiz scores should show greater improvement through exposure to a larger quantity of new information in comparison to students with higher pre-topic quiz scores.

Students were consistent with the correct answer for both quizzes 61% of the time, while answering incorrectly for the pre-topic quiz but correctly for the

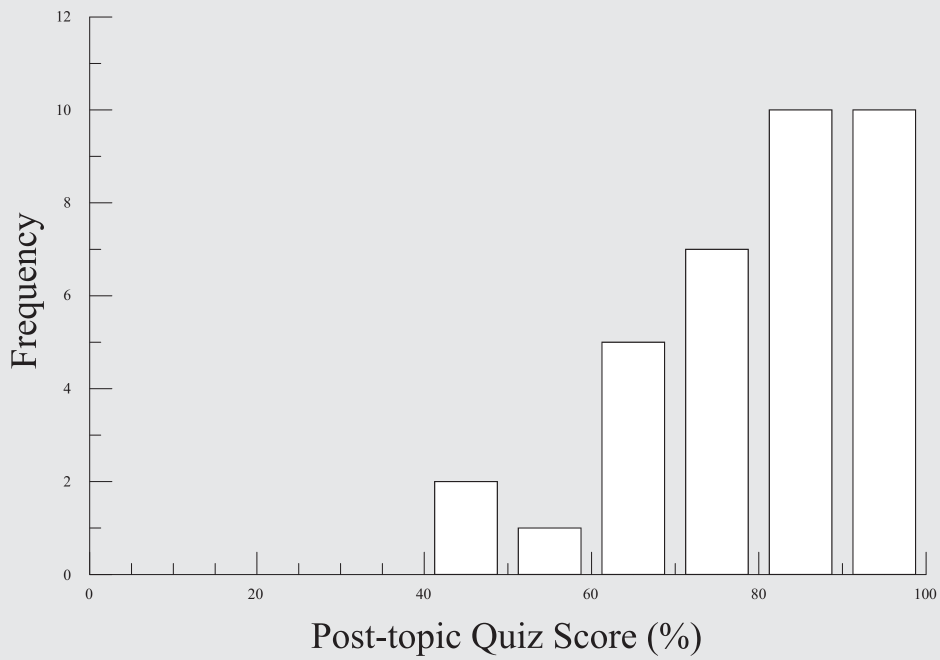

Figure 2. Distribution of student scores from the quiz administered after applying active-learning strategies for teaching wildlife harvest management.

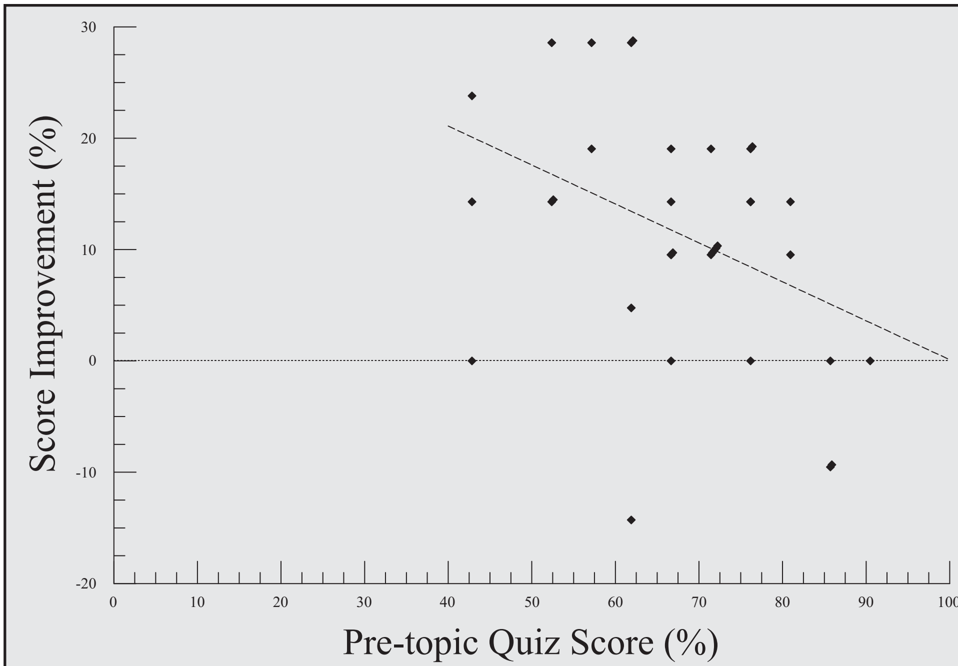

Figure 3. Student improvement of score (*y*) as a function of student score from the quiz (*x*; *n* = 35) administered before applying active-learning strategies for teaching wildlife harvest management. Linear regression resulted in the model $y = 35.1 - 0.35x$, with a somewhat weak relationship (*r* = 0.41).

post-topic quiz 18% of the time. Students did not recognize the correct answer during either quiz 13% of the time, and answered correctly for the pre-topic quiz and incorrectly for the post-topic quiz 8% of the time. For the latter, twelve students showed this question-level performance decrease for one question, seven students for two questions, four students for three questions, and one student for five questions.

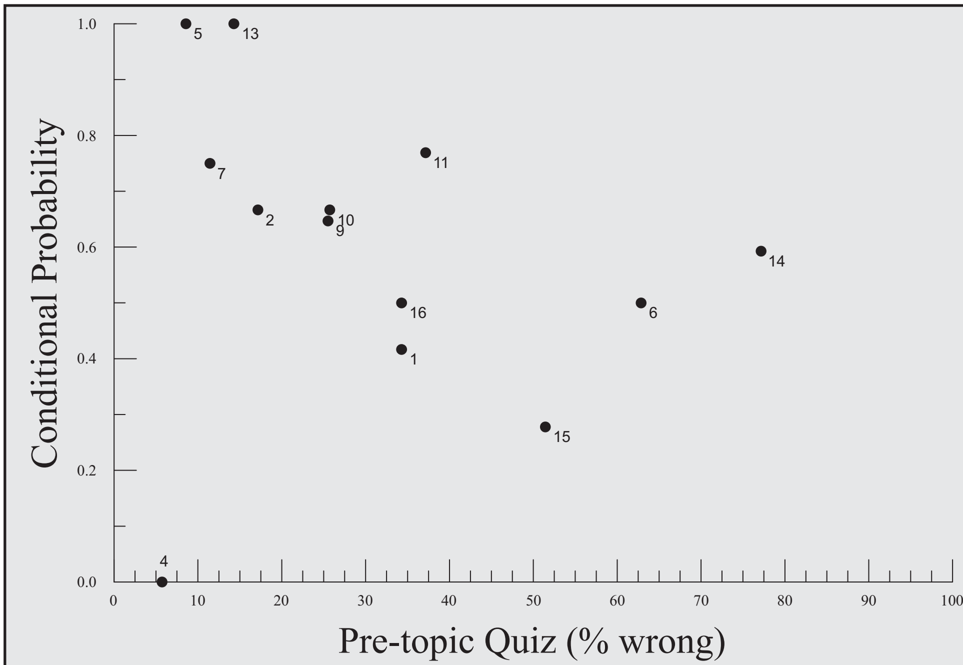

Figure 4. Conditional probability of a student answering a question correctly on the post-topic quiz following an active-learning approach given that the student answered the question incorrectly on the pre-topic quiz. Numbers associated with points identify multiple-choice question number.

Three particular multiple-choice questions (2, 15, and 16) seemed to cause confusion for students, as five or six students answered these questions correctly for the pre-topic quiz but incorrectly for the post-topic quiz. The correct answer for two (15 and 16) of these three questions was the choice containing two of the other choices (e.g., "Both a and d"). Retrospection suggests that these students may have concentrated on the choice presented both visually and verbally during the active lectures as opposed to the additional correct choice that was only presented verbally. We have no explanation for these students incorrectly answering the other question (2) during the post-topic quiz, as this question was repeatedly addressed during presentation and discussion of the topic. Similarly, the correct answers for four questions (1, 6, 14, and 15) were not identified in either the pre-topic or post-topic quiz by >20% of the students. Two (1 and 6) of these questions were of basic logic related to harvest management. However, retrospection suggests that clarification of answer choices for the other two questions (14 and 15) may reduce student confusion and improve student scores. The two sets of seemingly problematic questions for students seemed to be evenly distributed among our three learning objectives, suggesting that information provided to students was not significantly deficient for any single learning objective. Further, students generally did recognize incorrect answers because most questions had relatively high conditional probability of being correctly answered on the post-topic quiz given an incorrect answer on the pre-topic quiz (Figure 4). For example, Question 14 was quite difficult, because 80% of students answered incorrectly on the pre-topic quiz, but 60% of those students answered correctly on the post-topic quiz. Question 15 was again problematic with 51% of students answering incorrectly on the pre-topic quiz, and only 28% of those answering correctly on the post topic quiz.

When evaluating their level in confidence in making population management decisions for a state wildlife agency, 6% of students decreased in confidence, 51% of students showed no change in confidence, and 43% of students showed at least a one-level increase in confidence from the pre-topic to the post-topic quiz. Mean change in level of confidence was positive (0.4), which we believe was a positive indicator of student learning. Students with decreased confidence may not have initially recognized the complexities involved with making harvest management decisions.

We felt that students generally benefited from our implementation of active-learning strategies. However, to help alleviate the deficiencies in either student learning or instructor presentation of our topic, in the future we would allow an extra class period for this particular topic, including more time spent on the case study. This may allow for an additional case-study question and perhaps a short writing assignment. For example, a writing assignment could be either a short press release designed to explain the process and outcomes of the case study to the general public (i.e., the stakeholders), or it could be assigned to be an internal agency report containing a formal explanation of the methods, results, and justified management recommendations. Of course, if additional class periods were necessary, a balance between more effort on a particular topic and less effort on other topics within the course during the semester would have to be determined. Also, for future assessments, we would suggest also comparing student scores by groups to determine if any patterns existed. For example, if a group did not effectively implement group-learning strategies, their individual scores might indicate common deficiencies.

Higher preparation time and effort is often required by instructors to implement active-learning strategies, but this may be partially offset if student comprehension of material increases such that the number of questions they ask decreases. Of course, the ultimate goal is the accrual and application of knowledge by students. Here, we presented a specific example of active-learning strategies, such as problem-based learning, for wildlife ecology and management educators. Given the increasingly complex professional environment ahead for our current wildlife students, providing classroom demonstrations that increase knowledge and communication skills directly relevant to real-world situations is required for success (Ryan and Campa, 2000). Our assessment suggested that applying active-learning strategies in a wildlife ecology college course seemed to positively influence student learning, and hopefully will increase post-graduate success for students.

Summary

Our quantification and assessment of active-learning strategies using wildlife harvest management as a topic suggested that our efforts resulted in positive learning by students, and we met our learning objectives for our chosen topic. Although our assessment could not include a comparison with passive-learning strategies for the same topic, we documented positive student learning using an active approach, for comparison to future studies, to improve structure of future undergraduate courses, and to allow us to improve our own teaching deficiencies. Additionally, our approach can be extended to other topics and disciplines to measure student learning.

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