Active homework – preparation for active classes

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Instructors faced with teaching large introductory science courses and dealing with the diverse backgrounds in knowledge, skills, and motivation of 100–500 students have genuine concerns about engaging all students in learning, something more easily achieved in small courses. Low attendance in large lectures, often down to 30–40% by the end of the term, indicates disengagement and lack of involvement by students (Cooper and Robinson 2000). While lectures, as a rule, have limited educational value because people learn by doing rather than by watching and listening (Felder 1997; Powell 2003), the majority of college faculty teach classes in a traditional lecture mode.

Some faculty are still skeptical about pedagogy that advocates using inquiry, active, and collaborative learning instructional strategies to facilitate students' learning, especially in large courses. Their pervasive concern about *covering* content overrides finding additional time for in-class activities that allow students to *uncover* the meaning of concepts. Finding time for grading additional student work is another formidable challenge for faculty. A well-designed active learning exercise effectively replaces a lecture on the same topic, with student understanding and retention potentially exceeding learning gained from a traditional lecture format (Gardiner 1994; Mazur 1997; Handelsman 2004). However, the success of this approach depends on students coming to class prepared to participate in the activity. In this article we focus on active homework – a strategy intended to better prepare students for active learning in class. Regular active homework assignments can help students become more involved in learning, without the overburden of impossible grading loads for faculty.

Research with K-12 students shows a positive effect of homework on student achievement, an effect that increases as students get older (Cooper *et al.* 1998). Information about the effects of homework on learning by college students is unknown because research is lacking. The concept of homework in introductory college physics, chemistry, and mathematics is primarily problem solving (Bonham *et al.* 2003). In contrast, homework in introductory biology generally focuses on readings from a textbook or papers associated with lecture topics (NRC 1997). Students may read and highlight the pages assigned for the class, but do not apply or analyze the information they read to solve problems that help further their understanding. We use the Kappel article (pp 275–282) to model ways to engage students in active homework to advance learning both inside and outside the classroom.

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Student goals

- Increase the efficiency and effectiveness of students' time on homework to prepare for active learning during class.
- Understand the biological concepts underpinning major ecological problems in marine environments.
- Build connections between ecological problems and choices they can make in their own lives.

Instructor goals

- Guide students with active homework that prepares them for class.
- Motivate students to become proficient self-learners.
- Use the outcomes of the homework to build on specific content and concepts in subsequent classes.

Instructional design: from home to class….

Kappel's article provides an overview of threats to marine environments, pointing out that overharvest, habitat loss, and invasive species have major effects on marine communities. The following activities are examples designed to enable students to gain an understanding of the biological concepts that result from these threats. The homework concentrates on changes in community structure as a result of overharvest or introduced species, and the role of strongly interacting species on ecosystems.

Homework directions

After reading the Kappel article, students

- Print out kelp forest Food Web A from the course website (original at http://research.amnh.org/biodiversity/crisis/images/otter1.gif).
- Use a highlighter to identify the links in the food web representing the relationships among sea otters, urchins, and kelp.
- Draw a diagram (model) that explains why kelp forests disappear when sea otters are removed.
- Use the food web to predict the effect of decreases in sea otter populations on herbivorous fish, abalones, sea stars, and large crabs. Explain the predictions in writing.

Students bring their homework to class, with questions 2, 3, and 4 on separate pieces of paper. Now the instructor has choices – if the homework is graded, the instructor can ask students to turn in either question 3 or 4 after using them in class, thereby reducing the numbers of papers to grade. Students know a priori that all homework is treated this way and, in some cases, will not be graded at all. If the homework is not graded, the concepts from the homework will be assessed in subsequent exams.

Active learning in class

Engage students by asking them to compare their diagrams of kelp forest disappearance to Food Web B, projected to the class, from the web page http://research.amnh.org/biodiversity/crisis/images/otter2.gif. The instructor then selects several groups to explain their predictions from question 4 to the class and records them on the overhead. The instructor then gives a brief synopsis of the role of strongly interacting species and covers the current sea otter declines in Alaska (Estes *et al.* 1998; Maldini *et al.* 2004).

Assessment

At the end of this mini-lecture, students use the homework and class discussion to demonstrate their ability to apply their understanding to a new scenario. Using Food Web A they add killer whales, seals and sea lions (information from the instructor's lecture) and predict changes in the food web. Again, selected groups report out to sample the classes' understanding, although written responses from all students or groups provide more complete data.

Additional examples on how the loss of marine species can affect marine environments are provided in Table 1 in the Kappel paper (p 277). Homework could be developed for the loss of species because of introduced species; for example, introduced foxes on Alaskan islands have altered nutrient input from nesting birds and this, in turn, has influenced vegetation communities (Croll *et al.* 2005). Another case involves the multiple threats that are causing the decline of Caribbean acroporid corals.

The next example is an approach for students to actively explore their own impact on the marine environment by examining the harvest methods and environmental effects associated with the seafood they consume. This activity could serve as a prelude to a class on ecosystem-level impacts of overharvesting, including the effects of overfishing and bycatch, or to introduce topics about marine conservation such as marine reserves and bycatch reduction efforts.

Individual impact

In class, students make a table that lists the five most common seafood items in their diet. They indicate the method by which they think the seafood is harvested and any impacts on the environment or other species that might result from this practice. For homework students are directed to the Monterey Bay Aquarium Seafood Watch at www.mbayaq.org/cr/seafoodwatch.asp to look up information on their seafood items and confirm or expand the responses on their table. Students decide which of their seafood selections raises the most serious concerns about environmental effects and which the least. In class, groups of students discuss the homework and choose a "best and worst pick" (available to them locally) from their selections. The instructor polls group results for the most common best and worst choices and records them. Reporters from groups are asked to explain the choices and dissenting views are encouraged. The homework prepares students to further learn about effects of harvest on coastal and open ocean communities.

Final note

The concept of actively engaging students in homework to prepare for class is seldom considered in large courses. Instructors may use quizzes or online questions to hold students accountable for reading, but pay less attention to designing active homework that flows directly into active learning during class. This instructional strategy takes little time relative to the pay-off for both students and instructors. Assessment data based on instructors' specific learning goals will show the degree to which this approach to scientific teaching results in increased student engagement, accountability, and ability to understand the connections of complex ecological models.

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