

Research Highlights on Use of Lecture and Active Learning Approaches

Prepared by Maryellen Weimer, grg@psu.edu, blogs at www.facultyfocus.com

275 econ faculty teaching principles courses reported spending 70% of the time lecturing and 20% leading class discussions.

Goffe, W. L., and Kauper, D., (2014). A survey of principles instructors: Why lecture prevails. *Journal of Economic Education*, 45 (4), 360-375.

722 physics faculty members surveyed about 24 research-based instructional strategies (coop learning, peer instruction, activity based tutorials), 12% no knowledge of any of them. Of faculty who tried one or more, 33% no longer using them, 33% were low users, using one or two and 33% high users using three or more

Henderson, C., Dancy, M., and Niewiadomska-Bugaj, M., (2012). Use of research-based instructional strategies in introductory physics: Where do faculty leave the innovation-decision process? *Physical Review Special Topics – Physics Education Research*, 8, 1-15.

Of 2,000 geoscience faculty, 66% reported using lecture in introductory courses nearly every class. Less than 1/3 used interactive techniques other than lecture with questions or demonstrations.

Macdonald, R. H., Manduca, C. A., Mogk, D.W., and Tewksbury, B. J. (2005). Teaching methods in undergraduate geoscience courses: Results of the 2004 On the Cutting Edge Survey of U. S. faculty. *Journal of Geoscience Education*, 53 (3), 237-252.

197 engineering department heads were asked about student-active pedagogies; 82% were aware of the pedagogies listed, 47% reported that faculty in the department had adopted them.

Borregim N., Froyd, J. E., and Hall, T. S. (2010). Diffusion of engineering education innovations: A survey of awareness and adoption rates in U. S. engineering departments. *Journal of Engineering Education*, 99 (3), 185-207.

[Note: these four are discussed in more detail in an article on Instructional Techniques that appears in the March, 2016 issue of the Teaching Professor]

A survey of 744 full and part time faculty teaching at eight technical colleges in Georgia found that lecture was the most used of 18 different instructional strategies with 92.8% of respondents reporting they used it in four or more of the last 10 class sessions. 52.6% said they used it in all 10 of the last 10 class sessions. Full group discussion was used in 7.55 of the last 10 sessions.

Smith, D. J. and Valentine, T. (2012). The use and perceived effectiveness of instructional practices in two-year technical colleges. *Journal on Excellence in College Teaching*, 23 (1), 133-161.

[Note: this research is discussed in more detail in an article on Instructional Techniques that appears in the March, 2013 issue of the Teaching Professor]

The Current Conversation

Here are references and links that illustrate the current conversation about lecture and active learning. Note that most of the articles and posts generated a significant number of comments and in those exchanges, many more perspectives on lecture and active learning emerge.

“In Defense of Lecture” by Alex Small, published in the *Chronicle of Higher Education*, May 27, 2014. <http://chronicle.com/article/In-Defense-of-the-Lecture/146797/>

“Are Lectures Unfair?” blog post by Annie Murphy Paul, September 13, 2015.

Link: http://www.nytimes.com/2015/09/13/opinion/sunday/are-college-lectures-unfair.html?_r=0

Author’s Website providing additional references:

<http://anniemurphypaul.com/?version=meter%20at%200&module=meter-Links&pgtype=article&contentId&mediaId&referrer=https%3A%2F%2Fwww.google.com%2F&priority=true&action=click&contentCollection=meter-links-click>

“In Defense of Continuous Exposition by the Teacher” blog post authored by Derek Bruff, September 15, 2015. <http://derekbruff.org/?p=3126>

“Lecture Me. Really.” by Molly Worthen, a *New York Times* op-ed piece, October 17, 2015. <http://www.nytimes.com/2015/10/18/opinion/sunday/lecture-me-really.html>

Here are some responses to the Worthen piece.

- Josh Eyler, blog post October 20, 2015. <https://josheyler.wordpress.com/2015/10/20/active-learning-is-not-our-enemy-a-response-to-molly-worthen/>
- “Step Away from the Lectern” blog post Maryellen Weimer, the Teaching Professor Blog, November 4, 2015. <http://www.facultyfocus.com/articles/teaching-professor-blog/step-away-from-the-lectern/>
- “A Lecture from the Lectured” by students in a writing course was published in the January 4, 2016 issue of *The Chronicle of Higher Education*. <https://chroniclevitae.com/news/1235-a-lecture-from-the-lectured>

“Professors Shouldn’t Teach to Younger Versions of Themselves” by Rebecca Schuman in *Slate*, October 21, 2015. http://www.slate.com/articles/life/education/2015/10/professors_shouldn_t_only_teach_to_younger_versions_of_themselves.html

Helping Students Prepare for Cumulative Exams

There are a couple of reasons why students don't like cumulative exams and finals. First, they're more work. Rather than four weeks' worth of material, there's an ever-growing body of content to know and remember. However, the research strongly supports that continued interaction with the content increases the chances that it will be remembered and can be used subsequently. One of the reasons students don't like cumulative exams is that most of them don't know or don't use study strategies that promote content retention. They wait until just before the exam and then they start reviewing. Here's some ways teachers can help student develop and use study strategies that make preparing for and doing well on cumulative exams easier.

- **In comments** the teacher explains the educational rationale behind cumulative finals. They are not being used because the teacher enjoys making courses hard for students. They are being given because research has shown that students remember course content longer and are better able to apply what they have learned. Moreover, the teacher is committed to helping students prepare for those exams throughout the course. And the teacher is open to student suggestions: what could done in class, outside of class, or online that would help students effectively prepare for the cumulative exams?
- **In class** when new content relies on or relates to previous material, pause and let students recall or find that previous content. Where is it in their notes? In the text? How does knowing this previous material making understanding the new content easier? Obviously, this takes time and teachers may not be able to be this deliberate every time, but, they can say there's a connection and students should be looking for it when they study.
- **At the beginning of class** quickly put students in small groups. Give them five (maybe more, maybe less) questions drawn from previous content. Let them find the answers. The first group to get all five answered correctly get bonus points, treats, stars or pats on the back. They get more of the reward if they can also correctly say or list where the answer can be found.
- **At the end of class** during those five minutes of summary time devoted to highlighting the day's content, take a few more minutes or if a summary really isn't needed, take the time to have students review notes taken on a previous day. "Everyone take a couple of minutes and look at your notes for October 23. What are the key ideas you have in your notes?" "What do you have about X in your notes?"
- **Instead of a quiz** students prepare a potential exam question on material covered during the last two weeks. Their questions are submitted before class (in lieu of a quiz) and if the teacher finds five potential exam questions, those are posted on the course website. For the five posted questions, the author of each gest a bonus point.

There are lots of variations here. Students can be given the option of submitting potential exam questions any time during the course. If any of those questions end up on an exam, the student author should get the question correct and maybe they get a bonus point.

There is merit is having student write potential exam questions. It a good review strategy and it gets them thinking about questions, not just trying to memorize answers. They don't write good test questions automatically which means some resources might need to be made

available online and samples of good and not so good questions might need to be discussed in class.

- **On quizzes and exams** include a designated number of items that ask about content from previous units. To reinforce the importance of these questions, maybe they are worth an extra point or if you get them all correct, you get some amount of bonus credit.
- **In study groups** which the teacher can encourage students to form, the group could be given a chunk of content and tasked with preparing a study guide (including study questions) on the material. These study guides could be distributed to other students in the class. This could be a course assignment or an extra credit option.

A revised version of a piece published in the Teaching Professor, Aug/Sep 2013

Quizzes That Deepen Engagement with Course Content

I've been rethinking my views on quizzing. I'm still not in favor of quizzes that rely on low-level questions where the right answer is a memorized detail or a quizzing strategy where the primary motivation is punitive, such as forcing regular reading of assigned material. That kind of quizzing doesn't motivate reading for the right reasons and it doesn't promote deep, lasting learning. But I keep discovering innovative ways faculty are using quizzes, and these practices rest on different premise. Here are seven examples.

Mix up the structure – Elizabeth Tropman makes a strong case for reading quizzes. She changes the quiz structure on a regular basis. Sometimes it's the usual objective questions, other times it's short-answer questions, or it might be a question that asks for an opinion response to the reading. Some quizzes are open-book; a few are take home. What an interesting way to give students experience responding to different kinds of test questions and to keep quiz experiences from becoming stale.

Reference: Tropman, E., (2014). In defense of reading quizzes. *International Journal of Teaching and Learning in Higher Education*, 26 (1), 140-146.

Collaborative quizzing – Lots of different options are being used here. Students do the quiz, turn it over, stand up and talk with a partner, to others in a small group, or with whomever they choose. After the discussion, they return to their quiz and may change any of their answers. Alternatively, students do the quiz individually, turn it in, and then do the same quiz in a small group. The two quiz scores are combined with the individual score counting for 75% of the grade and the group quiz 25% (or some other weighted variation). Collaborative quizzing is an effective way to generate enthusiastic discussion of course content and reduce test anxiety.

Reference: Pandey, C., and Kapitanoff, S. "The Influence of Anxiety and Quality of Interaction on Collaborative Test Performance." *Active Learning in Higher Education*, 2011, 12 (3), 163-174.

Quizzing with resources – Students take detailed notes on the reading because they're allowed to use those notes during the quiz. The same approach works with quizzes that cover content presented during class. Students may use their class notes while taking the quizzes. The pay-off is a good (or better) set of notes for use during exam preparation. Ali Resaei reports that open-note quizzing coupled with collaboration resulted in significantly higher final exam scores in his quantitative research methods course.

Reference: Rezaei, A. R., (2015). Frequent collaborative quiz taking and conceptual learning. *Active Learning in Higher Education*, 16 (3), 187-196.

Quizzing after questioning – Before the quiz occurs, students are given the opportunity to ask questions about potential quiz content. The instructor and the class work on finding the right answer or discussing the merits of possible responses. If someone asks a question that stimulates a lot of good discussion, that question becomes the quiz question and students have the designated amount of time to write an answer. Or if a variety of good questions have been asked, answered, and discussed by a variety of students, the professor who shared this option may tell students they've just had their quiz and everyone present gets full credit. This approach encourages students to ask better questions and facilitates substantive classroom discussions.

"Community Space" quiz support – Audrey Deterding came up with this alternative "to inspire the often dull quiz routine." At the beginning of the class, two randomly selected students have

three minutes to write anything from assigned materials on the chalk/white board, which become a “community space.” Students may use anything that’s been written there during the quiz. The two students may collaborate with each other during the three minutes; the rest of the class remains silent. A student selected to write may decline, but a replacement will not be chosen. “The expectation that they [students] may have to share information in the community space motivates most students to closely read the assigned materials. They want to help their classmates perform well on the quizzes and they don’t want to appear lazy or irresponsible to their peers.” She also reports that the approach encourages collaborative learning and creates a sense of community in the class.

Reference: Deterding, A. L., (2010). A new kind of “space for quizzes. *The Teaching Professor*, November, p. 3.

Online quizzes completed before class – Students complete an online quiz before class. The quizzes are graded electronically with a compiled summary going to the professor so there’s enough time to look at the most frequently missed problems and/or to identify areas of misunderstanding. Then class time can be used to address those concepts that are giving students the most trouble.

A way to make up a missed question – It’s the standard daily quiz format; three conceptual questions answered during the first five minutes of class. No make-ups are allowed but the three lowest scores are dropped and one missed quiz question per day can be made up by voluntarily participating during class discussions. This is one of several motivational features of this quiz design.

Reference: Braun, K. W. and Sellers, R. D., (2012). Using a ‘daily motivational quiz’ to increase student preparation, attendance and participation. *Issues in Accounting Education*, 27 (1), 267-279.

The advantage of regular quizzes is that they provide ongoing opportunities for retrieval practice and much cognitive psychology research (like that summarized in the reference below) documents the benefits of frequent testing. Regular quizzing does improve class attendance and it gets more students coming to class prepared. Those are not trivial benefits, but with a few different design features, quizzes can also promote deeper engagement with the content, further the development of important learning skills, and provide teachers and students with feedback that promotes learning.

Reference: Brame, C.J. and Biel, R., (2015). Test-enhanced learning: The potential for testing to promote greater learning in undergraduate science courses. *Cell Biology Education-Life Sciences Education*, 14 (Summer), 1-12.

An expanded version of a Teaching Professor Blog Post, March 30, 2016.

Group Exams (or Quizzes)

When first introduced to the idea, many faculty strongly object. Grades are measures of individual mastery of material. A student can come to a group exam unprepared and get a higher grade than they would have earned otherwise. Or even if a student comes prepared, they don't have to think or speak for themselves. They can let the group decide on the answers. It seems like cheating. Students get credit for answers they don't know.

The faculty who use group exams respond to these concerns with a variety of interesting design details, briefly highlighted here.

- Use small groups, 3 or 4 students, even partners. The smaller the group, the greater the pressure to share what you know and the harder it is to depend on the rest of the group for answers. Don't underestimate the power of peer pressure to motivate preparation.
- Don't give group grades; use individual grades but allow the students a designated time for collaboration. Students first take the exam, then they meet with their group (but without their completed exam) and discuss questions they couldn't answer or weren't sure about. After that discussion they have a brief period of time to make answer adjustments on their exams, if they've been persuaded that they should.
- Control the content of the collaboration. Say it's a 50 question m/c test. Students do 40 questions individually. They jointly answer the remaining 10 questions.
- Give a grade that combines the individual and group grade. Students do the exam, turn it in and then do the same exam as a group. Their individual grade counts for 80% of their grade with 20% coming from the group grade. It could be a 60-40 ratio or each exam could count for half the total grade.
- If you're interested in the possibility and want to see if there's benefits for your students, start out by letting students collaborate on a quiz.

Here's a brief description of the benefits regularly reported by those who use group exams.

- They reduce exam anxiety. Student feel less anxious when they know the testing situation includes an opportunity for collaboration.
- They offer students convincing evidence that they can learn from other students.
- They model how problem solving occurs in most professional settings. In those arenas people have access to resources, contact experts, consider different options, and argue about the best solution.
- Group exam discussions teach students how to identify credible arguments. How do students know when they should change their minds? Who should they believe? Given the opportunity to change answers based on what someone else says directly faces students with the tough issue of who to believe and when to trust your own judgment.

Group Exam Resources

Group exams are being used by a number of faculty and their effects on students and learning are being studied. Here's a reading list for those interested in learning more.

Clinton, D. B., and Kohlmeyer III, J. M. "The Effects of Group Quizzes on Performance and Motivation to Learn." *Journal of Accounting Education*, 2005, 23 (2), 96-116.

Hoke, M. M., and Robbins, L. K. "The Impact of Active Learning on Nursing Students' Clinical Success." *Journal of Holistic Nursing*, 2005, 32 (4), 348-355.

Kapitanoff, S. H. "Collaborative Testing: Cognitive and Interpersonal Processes Related to Enhanced Test Performance." *Active Learning in Higher Education*, 2009, 10 (1), 56-70.

Pandey, C., and Kapitanoff, S. "The Influence of Anxiety and Quality of Interaction on Collaborative Test Performance." *Active Learning in Higher Education*, 2011, 12 (3), 163-174.

Rao, S. P., Collins, H. L., and DiCarlo, S. E. "Collaborative Testing Enhances Student Learning." *Advances in Physiology Education*, 2002, 26 (1), 37-41.

Russo, A., and Warren, S. H. "Collaborative Test Taking." *College Teaching*, 1999, 47 (1), 18-20.

Slusser, S. R., and Erickson, R. J. "Group Quizzes: An Extension of the Collaborative Learning Process." *Teaching Sociology*, 2006, 34 (July), 249-262.

Sroug, M. C., Miller, H. B., Witherow, D. S., and Carson, S. "Assessment of a Novel Group-Centered Testing Scheme in an Upper-Level Undergraduate Molecular Biotechnology Course." *Biochemistry and Molecular Biology Education*, 2013, 41 (4), 232-241.

Weimer, M. *Learner-Centered Teaching: Five Key Changes to Practice*. (2nd ed.) San Francisco: Jossey-Bass, 2013. (see pages 81-83)

Maximizing Learning Potential in Testing Events

Prepared by Maryellen Weimer
grg@psu.edu blogs at www.facultyfocus.com

Relevant Research

- Benassi, V. A., Overson, C. E., & Hakala, C. M. (Editors). (2014). Applying science of learning in education: Infusing psychological science into the curriculum. Retrieved from the Society for the Teaching of Psychology website: <http://teachpsych.org/ebooks/asle2014/index.php>
--an amazing free resource with chapter summarizing much of the current research on learning with many chapters written by those doing the research and writing about it with accessible language and suggestions for implementing what the research has established
- *Brame, C. J. and Biel, R. (2015). Test-enhanced learning: The potential for testing to promote greater learning in undergraduate science courses. *Cell Biology Education—Life Sciences Education*, 14 (Summer), 1-12.
--Identifies six benefits that accrue when student “test” themselves on course materials. It’s an evidence-based study strategy that teacher can use to encourage better performance on exams
- Jonsson, A. (2013). Facilitating productive use of feedback in higher education. *Active Learning in Higher Education*, 14 (1), 63-76.
--a review of 103 studies done since 1990 identifies five characteristics of feedback that promote learning from and acting on teacher provided feedback
- Momsen, J. L., Long, T. L., Wyse, S. A. and Ebert-May, D. (2010). Just the facts? Introductory undergraduate biology course focus on low-level cognitive skills. *Cell Biology Education—Life Sciences Education*, 9 (Winter), 435-440.
--“Of the 9,713 assessment items [test questions] submitted to this study. .93% were rated Bloom’s level 1 or 2—knowledge comprehension. Of the remaining items 6.7% rated level 3 with less than 1% rated level 4 or above.” (p. 437)
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okorafor, N., Jordt, H., and Wenderoth, M. P., (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences (PNAS)*, 111 (23), 8410-8415.
- Allen, D., (2014). Recent research in science teaching and learning. *Cell Biology Education—Life Sciences Education*, 13 (Winter), 584-5.
- Weiman, C. E., (2014). Large-scale comparison of science teaching methods sends clear message. *Proceedings of the National Academy of Sciences (PNAS)*, 111 (23), 8319-8320.
--The Freeman, et. al. meta-analysis, the largest statistical analysis of research on active learning clearly discusses its findings, however, the statistical methods used are difficult to understand for those without a statistical background. Allen has written a short, very clear summary of the research and its findings, which appears in an open access

journal. Weiman's commentary is also worth reading. It too offers an understandable summary with easier graphics, plus insightful and pointed comments.

Michael, J. "Where's the Evidence that Active Learning Works?" *Advances in Physiology Education*, 2006, 30, 159-167.

--an excellent review of the research with special emphasis on evidence supporting active learning in the sciences

Prince, M. "Does Active Learning Work? A Review of the Research." *Journal of Engineering Education*, July 2004, 223-231.

--a comprehensive and compelling analysis of the impact of active learning experiences

Cohan, M., (2009). Bad apple: The social production and subsequent re-education of a bad teacher. *Change Magazine*, November-December, 32-36.

-- "I have a confession to make. I was a bad teacher. I was not mean or abusive to students, and I didn't make capricious demands, ignore my syllabus, grade while under the influence, or test students on material I had not taught. . . " But a clear sign of bad teaching Cohan says was his thinking about students. "They were enigmas to me, and I didn't know how to deal with the varying levels of interest, commitment, and ability they brought to class. All I knew how to do was to expect of them what I had always expected of myself-not perfection, exactly, but something close to it." (p. 32)

Gallagher, T. J. "Embracing Student Evaluations of Teaching: A Case Study." *Teaching Sociology*, April 2000, 28, 140-146.

--recounts how a new teacher responded to a case of not-very-good student ratings

Review Sessions

Favero, T. G. (2011). Active review sessions can advance student learning. *Advances in Physiology Education*, 35 (3), 247-248.

--review session activities that have students reviewing the material, not the teacher

Innovative Exam Alternatives

Corrigan, H. and Craciun, G. (2013). Asking the right questions: Using student-written exams as an innovative approach to learning and evaluation.” *Marketing Education Review*, 23 (1), 31-35.

--students write and answer their own test questions, and are graded on the content and difficulty of their questions

Bassett, H. M. (2016). Teaching critical thinking without (much) writing: Multi-choice and metacognition.” *Teaching Theology & Religion*, 19 (1), 20-40

--after answering each multiple-choice question, student provide a short written rationale for their answer which is graded along with the answer.

Knierim, K., Turner, H., and Davis, R. K. (2015). Two-stage exams improve student learning in an introductory geoscience course: Logistics, attendance and grades. *Journal of Geoscience Education*, 63 (2), 157-164.

--students complete exams in two stages; first, they do a typical closed-book exam on their own and then, they do an open-book or take-home exam, alone or in collaboration with others, depending on how the teacher designs this testing strategy. Usually the first stage score counts more than the second stage.

Group exams – see handout

Ways to reduce test anxiety

Roney, S. D., and Woods, D. R. (2003). Ideas to minimize exam anxiety.” *Journal of Engineering Education*, 92 (4), 249-256.

--found that letting students determine the weight of two major course grades reduced exam anxiety

Crib sheets – see the Teaching Professor Blog, February 27, 2013 (www.facultyfocus.com)

Innovative Grading Options

Jhangiani, R. (2016). The impact of participating in a peer assessment activity on subsequent academic performance. *Teaching of Psychology*, 43 (3), 180-186.

--students take a short answer quiz, submit with a number identification. Completed quizzes are passed out with a grading rubric. Each student grades two quizzes. If the quiz grades are the same, the grade counts, unless the student who took the quiz disagrees with the grade. If the grades are different or the student objects to the grade, the teacher grades the quiz.

Golding, T. L. (2010). Final fitness and the Louisiana 2-Step. *The Teaching Professor*, August-September, 1-2.

--students take their math final, turn in their pencil, receive a key and red pencil. They grade their final, marking correct and in correct answers and awarding partial credit. The teacher reviews and adjusts student grades, as necessary.