



Three Methods to Enhance Peer Review in Your Classroom

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We've all done it: asked students to switch papers before turning them in for editing and peer review, only to receive vague critiques that make us wonder if peer review is really worth the time. Some of us have students put sentences on the board for whole class peer review. The sentences go up, but when I ask for edits that might make them better, I hear nothing but crickets.

Although extensive research indicates that peer review of student writing is beneficial and often critical to revision, many teachers are opting to leave it on the back burner. However, research is identifying a number of advantages of online peer review. The comments reviewers provide are easily read and printed. Students tend to maintain greater focus on the task in the online format. Teachers can monitor the discussions and weigh in as they see fit. Technology makes it easy to compare peer review drafts with finished papers to see progress. I've used the methods I'm describing here, and they are making peer review a more productive part of the writing process in my courses.

Facebook

Once you've created a separate account for work purposes, you can also create a "secret" group where you are the administrator. You simply add one student (whom you must "friend" temporarily) and ask that student to add others in the class.

Students can post specific writing assignments on the group "wall,"

indicating who they are so that the peer review can be personalized. From there, peers write comments on each post. The author can update his or her original posts to respond to feedback. This may promote further discussion and "replies" to comments. Using Facebook instead of an online learning platform such as Moodle or Blackboard enhanced participation by 50 percent among my students.

Chat Rooms

If you do use online learning platforms such as Moodle or Blackboard, the chat room function works well for in-class peer review. Websites such as Edmodo provide the same type of chat room for free. Simply hook your laptop to a projector and invite students to use their smart devices to join you online. I ask targeted questions about what the students are writing and reading, and they provide verbal or typed feedback in real time. It places all students at the front of the line for sharing their writing on the "board" quickly and efficiently. Additionally, these chats may be saved and printed.

Accountable Talk

So far, the two platforms I've discussed for using peer review save time in class and enhance levels of participation. However, they do not automatically improve the quality of the peer feedback. To achieve that goal, I've incorporated something proposed by Michaels and O'Connor called Accountable Talk. They propose that students support their opinions with evidence using the following formula: "Student name" + critique + WHY using evidence. I

pre-taught this approach by sharing example conversations with the phrases in bold that I wanted to be reproduced. I asked students specific questions about what they were reading and treated bolded phrases as vocabulary. Students then worked in groups to practice verbal Accountable Talk with realistic situations. We worked on these phrases throughout the semester. I "liked" posts that used them correctly and brought these examples to the class's attention. When students used Accountable Talk, their edits went beyond grammar and spelling. They referenced word choice and format and referred the writer back to the assignment, the textbook, and the grading rubric for evidence to support their opinions.

In my experiences, these three approaches have improved the quality of peer review in my courses. They use class time efficiently and encourage greater student participation. These technologies are also making my classroom more collaborative. I hope you'll consider how they might work in your writing assignments. 🌳

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Learning to Paraphrase and Read Deeply

It isn't always easy to put the ideas of others into your own words, especially if you don't completely understand what you're trying to paraphrase. But the process of doing so almost invariably deepens understanding.

Teachers ask students to read all sorts of texts that they find difficult. There are issues such as new vocabulary, long and complex sentences, and new and complicated ideas. Students aren't used to reading materials like these, and many don't tackle them with sophisticated reading skills.

Fortunately, teachers can help. They can use strategies that improve reading comprehension skills and develop those useful paraphrasing skills as students are doing reading assigned in the course. A great example is Daniel Lloyd, who uses this strategy in all his undergraduate theology courses. He assigns various kinds of required written work (worksheets, short papers, and online discussions) in which students respond to materials in primary and secondary texts. Students must follow these rules: no quotes from the reading, and for every sentence they write that uses information in the text, they must provide a page number citation. If back-to-back sentences use text content, that's fine, but they must include the page citation.

The strategy has lots going for it, starting with the way it encourages close reading of the text. You can't put into your own words what someone else has written without reading carefully. The more carefully the text is read, the better it is comprehended. Students can quote from a passage without necessarily understanding the content. They may recognize at a superficial level that the content is relevant to the professor's prompt, but using a quotation does not require the careful reading necessary to construct a paraphrase. And it is that

careful reading and the accompanying mental processing that begin to develop the kind of critical reading skills students need in college and in life.

Additionally, a lot of research now documents that many students do not understand plagiarism. They know it's wrong. They know it's something they aren't supposed to do, but frequently they don't know how to avoid it. Often because they aren't strong writers, they fall into using the author's words and not their own. This strategy gives them the practice necessary to learn how to paraphrase, which means the strategy is also developing writing skills.

Lloyd identifies a final benefit.

You can't put into your own words what someone else has written without reading carefully.

When students are working closely with the content in a text and rewriting the ideas, it becomes difficult to "press the text into saying what they would prefer it to say" (p. 387). Careful reading and paraphrasing tend to make the message of the text clear. Students may disagree, but they are less likely to use the source to support a position that it doesn't, in fact, support.

It probably won't be an especially popular strategy, but with teacher support and plenty of opportunities to practice, students will end up developing a skill set that will make the work in many courses easier and more productive.

Reference: Lloyd, D. (2016). No quotations, always citations. *Teaching Theology and Religion*, 19(4), 387. 🌱

Learning from Stories

The pedagogical literature deals with so many aspects of teaching; some topics are covered regularly, others not so often, and some only rarely. This may be the only article I have encountered with the goal of offering “a general, interdisciplinary ‘how-to’ . . . for using stories in the college classroom” (McNett, 2016, p. 186).

Gabriel McNett isn’t writing about what we sometimes call “war stories,” those tales of personal conquest that delineate in great and glowing detail the accomplishments of the storyteller. In courses, those stories hinder more than help learning. McNett defines stories broadly, including those that derive from actual cases, those that are narrative based (e.g., stories that involve historical figures), hypothetical stories formatted as scenarios, and those that start with problems that leave listeners working on solutions.

The article highlights a wide range of research that identifies why stories help us learn. McNett says, “Stories are useful in the classroom because humans have a natural disposition for interpreting experiences as stories. . . . Our brains constantly and unconsciously play out scenarios that hone neural pathways and allow the real action, if it is ever taken, to be sharper and more efficient” (p. 185).

A bit more pragmatically, stories can be a great way to refocus wandering minds. Stories connect with emotions; good ones pull us in. They can get students engaged and make content memorable. The article illustrates these benefits with several examples. Early in her insect biology course, McNett shares a letter with students. The letter’s author “Twisted in Tallahassee” describes a lifelong struggle with identity. “Twisted” doesn’t fit in, feels isolated, and has low self-esteem and a poor body image. It turns out that “Twisted” is a twisted-wing parasite, “one of the most bizarre-looking insects one could imagine” (p. 184). Then there’s the letter

Francis Crick (of Watson and Crick DNA fame) wrote to his 12-year-old son, describing what they’d discovered just before it was published. Stories like these create a context that makes the content difficult to forget.

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The liability with stories is that they can become the point instead of supporting the point. I used to tell a story about how my first husband and I argued over how to load the dishwasher. It was a great illustration of ineffective conflict resolution strategies. But I had to stop telling the story because in subsequent encounters with students, more often than not, they remembered the story but nothing about conflict resolution strategies. About that time I encountered a metaphor proposed by philosophy professor Jakob Amstutz that explains the underlying function of stories. They are nails or hooks on which we can hang conceptual knowledge. Hooks and nails derive their purpose from their function. Without that purpose, they have no utility and, in this case, no place in the classroom.

Some faculty shy away from stories because they don’t fancy themselves “storytellers.” They aren’t comfortable using dramatic voices or big theatrical

gestures. With its broad characterization of stories, this article makes clear that the ability to engage in storytelling isn’t a prerequisite for success. Good content can carry a story just as effectively as dramatic presentation. Moreover, the stories used to facilitate learning don’t always have to be told by the teacher. Students have stories and can be helped to share them in ways that enlarge the understanding of others.

Some educators avoid stories because telling them feels like wasting time that could be used for covering more content. But stories can help teachers accomplish important learning objectives. Here are just some that are listed and discussed in the article: capture student attention, personalize the instructor, enhance classroom atmosphere most noticeably by reducing stress, associate a concept or theme with a story, communicate facts in a more accessible way, and represent exceptional, underrepresented, or unique perspectives (p. 190).

McNett says, “Stories have been part of our history since archaic humans rubbed pigments on rocks and cave walls.” They continue to be an integral part of our existence. Why shouldn’t they be a thoughtful, purposeful part of the learning experiences we provide students in our courses?

Reference: McNett, G., (2016). Using stories to facilitate learning. *College Teaching*, 64 (4), 184–193. 🌳

Facilitating Discussion

It's another of those phrases frequently used and almost universally endorsed but not much talked about in terms of implementation. What does facilitating discussion *mean*? Two faculty researchers, Finn and Schrodtt (2016), frame the problem this way: "The literature is replete with descriptive accounts and anecdotal evidence but lacks the kinds of empirical investigations that could create theoretical coherency in this body of work" (p. 446). They decided our understanding of discussion facilitation could be deepened with an operational definition that resides in an instrument to measure it quantitatively.

Beyond developing the instrument, they wondered what learning-related outcomes discussion facilitation accomplished. Does it motivate learning? Can discussion promote those behaviors that reflect interest and involvement in learning across courses and in activities outside the classroom?

Developing the instrument was the first task. To do so they used literature on discussion to generate an initial pool of 75 items. Three hundred and sixty undergraduates were asked to use those items to rate the discussion facilitation skills of the instructor they had in the course that met prior to the class in which the data were collected. Analysis revealed five factors involved in effective discussion facilitation.

- **Affirms students' discussion:** This aspect of discussion facilitation accounted for 45 percent of the variance, which was significantly higher than the other four factors. It included high ratings on items such as, "My teacher encourages participation during class discussions," and, "My teacher values what students say during class discussions." These data confirm a fundamental feature of effective discussion facilitation. Teachers must "patiently" and "positively" encourage students to contribute during discussion (p. 448).

- **Organizes discussion:** Discussions benefit from instructor guidance and direction, as long as they stop short of controlling the discussion. From the overall structure of the discussion, to promote the sense that it is going somewhere and to keep it on track, effective facilitation involves keeping the discussion focused on the designated topic. That focus needs to be achieved with guidance, a kind, constructive direction that sets the boundaries of the discussion without dictating or more subtly controlling what can be said within those boundaries. Participation in a discussion is dampened if there's a sense that participants aren't free to express relevant ideas, opinions, and perspectives.

- **Provokes discussion:** The skill here is sparking discussion with controversial statements (i.e., points that can be debated). The teacher needs to give students reasons to want to discuss something. Sometimes that's effectively accomplished when the teacher assumes a devil's advocate role. Interestingly, Finn and Schrodtt (2016) found this factor generated mixed reactions from students. "Playing 'devil's advocate' with an air of inquisitiveness is quite different from playing 'devil's advocate' with an air of superiority" (p. 459). Discussion facilitation involves a nuanced use of verbal and nonverbal communication skills.

- **Questions students:** What you want to hear is, "My teacher asks students thought-provoking questions." Rather than questions with straightforward answers, these are open-ended, probing, even leading questions. When these kinds of questions are regularly infused throughout the discussion, they can help to provide the structure a discussion needs. They can continue to provoke student interest, but, more importantly, they

can make students think.

- **Corrects students:** Only accounting for 3.6 percent of the variance, this factor ended up being assessed with only three of the 33 items on the second version of the instrument. The idea here is that students appreciate teacher discussion facilitation that ensures that when it ends, they have information that is correct and enhances their understanding of course content.

As part of exploring the relationship between discussion facilitation and student interest and engagement, the researchers used a "student perceptions of instructor understanding" scale. It measures the extent to which students think instructors understand or misunderstand them, such as with, "My teacher understands the questions I ask." The second study documented that "when instructors provoke and organize discussions using a variety of questions, employ responses that affirm students, and correct discussions to focus on course content, such behaviors are directly associated with student interest and engagement in the course, as well as indirectly predictive of both outcomes through perceived understanding" (p. 459).

Not only is this instrument of value to subsequent explorations of discussion facilitation, it is a great tool for instructors who wish to understand the specific components of effective discussion facilitation. Kudos to these researchers for developing an instrument with both empirical and pragmatic utility. Best of all, it offers a clear description of how a teacher facilitates a discussion.

Reference: Finn, A. N., & Schrodtt, P. (2016). Teacher discussion facilitation: A new measure and its associations with students' perceived understanding, interest and engagement. *Communication Education*, 65(4), 445–462. 🌱

Understanding Figures, Tables, Graphs, and Charts

“If a picture is worth a thousand words, it should be given that much of your time,” says Edward Tufte. Biology professor Amy Wiles says it was what got her started thinking about the importance of visual representations in her field: “Students need to be visually literate just as they need to be verbally literate, but skills required to develop visual literacy are often overlooked in undergraduate education” (p. 336). Instructors, used to seeing how data are organized in tables and graphs and comfortable with diagrams that visually represent relationships, don’t stop to think how unfamiliar those may look to students. We should ask ourselves, how much instructional time is devoted to helping students make sense of these ways of communicating content?

Wiles decided to do something about this in her biology courses. Her strategy isn’t all that innovative. It makes use of the course textbook she has students bring to class. She starts with a succinct introduction to the material contained in or relevant to a particular figure in the text. She uses “figure” in a broad sense. Visual representations in her courses include charts, tables, graphs, and diagrams.

Then students examine a designated figure in the text, and after they’ve had a chance to look at it, they talk about it with peers seated nearby. Often students are silent because they don’t know what to talk about. Wiles encourages them to start describing what they’re seeing. She follows her first article with another that highlights the kinds of conversations student have when they talk about the figures. Even though those conversations are very discipline specific, they illustrate how students struggle with content represented visually. While they are discussing the figures, she walks around the room listening and responding to what they are saying. She gives them feedback on their conversations, answers questions, asks questions that challenge

them to see more in the figure, comments about how content in the figure relates to other course concepts, and so on. The activity concludes with an instructor summary that may include concerns that came up in one group but are relevant to the whole class.

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Wiles also spends time in class using textbook figures and modeling how they should be approached and understood. She explains how each figure is routinely laid out. If it’s a chart, it’s the axis that first needs to be examined, then the shape of the curve, and finally its relationship to the axis. She talks about charts first in terms of the row and column headers. And she explains how diagrams work and how they are often used to capture the action at one point in a dynamic, moving process.

Once students get used to looking at figures, she challenges them to start drawing their own visual representations. They can create a figure using elements in the textbook, or they can create something that visually represents content that’s not presented that way in the text or class. Some learners are more visually inclined, and graphically relating content aids their understanding, as has been discovered in research on concept maps.

Despite their initial discomfort, students responded favorably to this activity. A sizeable majority in all four of the courses where Wiles used it said it taught them to read and interpret figures (84 percent) and that it helped them learn more than the traditional lecture

(88% vs. 74%). Seventy-five percent said talking with peers facilitated their understanding better than examining the figures on their own. They reported using figure analysis when studying on their own and said they were more confident examining figures as a consequence of taking this course.

Besides gains like these, there were several side benefits. The activity engaged students, in part because the instructor was walking around and commenting on their conversations. In trying to understand the figure itself, students grappled with course content in class with an instructor there to answer questions. Moreover, it’s an activity that gets students using their textbooks. The activity demonstrated why the text has value and how it can help students learn. If students have their books in class, then teachers can use them for other purposes as well.

Wiles does offer one important bit of advice. When using an activity like this, a textbook with “good” figures is essential. She also notes that figure analysis is “appropriate to any course, content-heavy or not, whose material may be readily presented in pictures and diagrams” (p. 343). She’s writing about biology, but information is communicated graphically pretty much across the board today. We should be teaching students how to interpret information configured as figures, tables, charts, graphs, and diagrams.

Reference: Wiles, A. M. (2016). Figure analysis: A teaching technique to promote visual literacy and active learning. *Biochemistry and Molecular Biology Education*, 44(4), 336–344.

Wiles, A. M. (2016). Figure analysis: An implementation dialogue. *Biochemistry and Molecular Biology Education*, 44(4), 345–348. 🌱

Mind Wandering

Many students don't pay much attention in class. They come to class, but most of the time, only their bodies are present. When they study, that demanding task occurs as they attend to a host of other, often more engaging mental activities. It is a problem, but maybe our expectations are unrealistic. As Pachai, Acai, LoGiudice, and Kim (2016) say, "It is unreasonable to expect students to continuously pay attention while listening to a lecture, reading a textbook, or studying for an exam. The mind naturally wanders, shifting attention from the primary task at hand to internal, personally relevant thoughts" (p. 134). In fact, researchers estimate that Pachai and colleagues say that our minds wander 30–50 percent of the time during our daily lives. It happens to teachers, students, and everybody else.

However, educational settings have features that make them ripe for mind wandering. Learning tasks are typically lengthy, and most are mentally taxing; both conditions are conducive to mind wandering. Most students aren't used to listening to someone speak for extended periods of time. Textbooks are long, generally with considerable new vocabulary and often on topics students don't think of as interesting. It's hard to stay focused on the reading. When there are only two or three tests in a course, they cover large chunks of content, which makes studying a formidable task. However, even though mind wandering should be expected, when the tasks involve learning and the mind is not focused on that task, the learning suffers. The authors note, "Attention is a limited resource necessary to maximize learning. Simply put, students cannot learn what they are not paying attention to" (p. 142).

Despite the importance of focused attention, mind wandering is not without benefits. Mind wandering is mostly measured with thought probes. Subjects are listening, reading, or studying, and at various intervals they are asked to

report what they were thinking about just before the probe. Increasingly the measurement involves technology: brain wave signatures that show up on EEGs or by visual attention. Research has established that when the mind wanders, the eyes blink significantly more.

Analysis of responses to thought-probe questions reveals many of the reported thoughts are future-oriented, primarily planning for things that need to be done in the future. Perhaps even more beneficial is work showing that enhanced creativity and problem solving stem from mind wandering. If there's a break and then a task that's not terribly demanding, mind wandering can creatively confront the larger, more complicated tasks. In other words, sometimes problems can be solved when the focus isn't on solving them. In some research, when subjects returned from a break, they were able to generate more creative solutions. And finally, mind wandering can provide beneficial relief from boredom. It provides the short break needed to refresh and refocus.

The most useful part of this well-documented exploration of mind wandering are the authors' four strategies for more effectively managing student attention in classrooms.

1. **Integrate "checkpoint" questions throughout lectures:** Ask questions that require students to retrieve what they have just learned. If their minds have been wandering, they may have only learned part of the new information, learned it superficially, or learned it incorrectly. Retrieval practice is a chance to solidify their knowledge, pick up anything they missed, and correct something understood incorrectly. The reclaiming and reworking of new knowledge promotes long-term retention.
2. **Promote active learning through demonstrations, discussions, or other activities:** This uses a range of

instructional approaches and reduces mind wandering. When the action stops and something new starts, most wandering minds return.

3. **Encourage students to try mindfulness meditation training through campus or online resources:** Pachai and colleagues say, "Mindfulness meditation training is a promising solution to many issues of attentional and behavioral regulation" (p. 141). The supposition is that it reduces mind wandering by promoting awareness of the present. Students aren't thinking about what's ahead but are focused on what's happening at the moment, and this awareness of the present makes for quicker returns from mental side trips.

4. **Allow students to mind wander when it will not significantly affect learning:** This suggestion implies accepting the inevitable. Learners' minds will wander so take action to control when that occurs. Let there be breaks and lower-stakes learning opportunities, which these authors describe as chances to relearn or review new information.

This is an excellent article. It proposes a realistic understanding of mind wandering. Mind wandering can't be entirely eliminated. It should not be thought of as inexcusable and completely without merit. The instructional objective ought to be efforts aimed at doing what can be done to circumvent it when attention is most crucial for learning. And if your mind happened to wander while reading this, look again at this last paragraph, and you'll have the essence of what you missed.

Reference: Pachai, A. A., Acai, A., LoGiudice, & Kim, J. A. (2016). The mind that wanders: Challenges and potential benefits of mind wandering in education. *Scholarship of Teaching and Learning in Psychology*, 2(2), 134–146. 🌱

Exploring What the Syllabus Communicates

The syllabus is often described as a road map to the course. But along with laying out the direction and details of the course, it also conveys messages about what the course will be like. These messages are not communicated explicitly but are more a function of the language and tone of the syllabus. A group of psychology faculty agreed, but they also wondered if the theoretical framework of the syllabus might influence students' perceptions of the course and its instructor.

To test that hypothesis, Richmond, Slattery, Mitchell, Morgan, and Becknell created two syllabi: one that represented learner-centered approaches to course design and one that represented teacher-centered approaches. They modified a rubric created by Cullen and Harris in a work published in *Assessment & Evaluation in Higher Education* and used it to guide construction of the two syllabi. The rubric identified learner- and teacher-centered factors in three areas: community (how accessible the teacher was), power and control (the focus of the syllabus with respect to policies), and evaluation and assessment (the relative emphasis on learning and grades). The learner-centered syllabus created for the study focused more on student learning, and the teacher-centered one focused more on the delivery of course content.

To ascertain whether each syllabus was correctly perceived as teacher- or learner-centered, they were blindly rated on 12 subfactors, derived from the three main factors, and both were correctly identified. Examples from each of the syllabi are included in the article.

These two syllabi were then given to 90 introductory psychology students, who received course credit for participating in the study. The students were given either the learner- or teacher-centered syllabus. They were told to read the syllabus, took a quiz on it, and then were asked to rate the instructor (who they were told wrote the syllabus) on 12 teacher

behaviors taken from a Teacher Behavior Checklist (TBC), developed empirically, that listed the characteristic behaviors of master teachers (behaviors such as effective communication, preparation, enthusiasm, flexibility). They also rated the hypothetical teacher on another instrument that measures levels of teacher rapport with students.

The syllabus subtly hints at what instructors believe about students, how much they care about learning, and whether the learning environment in the course will be open and inviting or closed and controlled.

The findings confirmed both of the authors' hypotheses. Students did perceive the instructor who wrote the learner-centered syllabus as having significantly higher master teacher behaviors than the instructor with the teacher-centered syllabus. They also rated the teacher with the learner-centered syllabus as having significantly higher rapport with students.

For instructors who worry about establishing connections with students in online courses, the results of this study are promising. They indicate that messages about who they are and what they hope will happen in the course can be conveyed by the course syllabus. It can be used to help set the tone for the course.

For instructors with face-to-face classes, there is an important caveat. The study setting was, in the words of the researchers, "highly controlled" and "artificial." In face-to-face courses the syllabus is often delivered by the

instructor who in most classes then talks about it at length. How the instructor's presence and discussion of the syllabus affects students' perceptions of it were not studied in this work. There are some instructors who now make the course syllabus available online before the class convenes so students may first review it without the instructor being present. We don't know at this time if their initial impressions are changed when they meet the instructor in person.

Whether the syllabus is first encountered with or without the instructor's being present, work like this confirms the importance of this artifact of teaching. We've recognized its value as a road map for some time now. There are many articles and some books that delineate the various course details that can be included on the syllabus, often recommending a collection of them. What isn't as regularly recognized are these important "meta" messages that lurk between the lines of this course document. The syllabus subtly hints at what instructors believe about students, how much they care about learning, and whether the learning environment in the course will be open and inviting or closed and controlled. It's more than just a road map. The syllabus strongly suggests what the trip will be like.

Work like this should encourage us to look closely at our syllabi. What would students conclude about us and our course? It's an important part of how they are introduced to both.

Reference: Richmond, A. S., Slattery, J. M., Mitchell, N., Morgan, R. K., & Becknell, J. (2016). Can a learner-centered syllabus change students' perceptions of student-professor rapport and master teacher behaviors? *Scholarship of Teaching and Learning in Psychology*, 2(3), 1–10. 🌱

Knowledge Decay

It's jargon, and in this case "knowledge decay" refers to how fast students forget what they have learned for a test. There's a general sense among faculty that they forget a lot, quickly. Research would respond to our general impressions with answers that clearly support "it depends" conclusions. A study done in a chemistry class illustrates this. The research team started with the big general question. Does knowledge decay occur in chemistry courses? And if it does, when? The study answered these questions with data collected in three different courses: an undergraduate chemistry course for nursing students, another for nonscience undergraduates, and another for high school honors students. As would be expected, these course exams contained different content, but all of them included "open-ended, course-specific, conceptual, and skill questions" and were administered at approximately one-month intervals (Bunce, VandenPlas, & Soulis 2011, p. 1233). Following each exam, students took quizzes that repeated a subset of the test questions at one of three time intervals: two-to-five days after the exam, six-nine days after, and 10–17 days after. Each student took one of the quizzes at one of the time intervals, and the interval was randomly selected.

They found that "students enrolled in courses in which the continued spiral use of chemistry concepts is not evident, frequent quizzing opportunities are not provided, and a final exam is not given experience a significant decrease in achievement during the first 48 h following a test" (p. 1231). The continued spiral use of the content refers to curricula in which students get course content on a need-to-know basis. The concepts are revisited several times during the chapter and across several chapters with more detail provided in each encounter. Moreover, the amount of knowledge lost in these courses was stable. After the initial decay, it did not

decline further.

Beyond this general conclusion are details that show how context affects educational outcomes. For students in two of these courses (nursing and high school honors chemistry), knowledge decay did not occur. The researchers' first supposition was that these student cohorts were motivated. Nursing students have exams they have to pass to be licensed, and honors students

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are motivated to achieve good grades for college admission, but nonscience majors don't have those motivations in chemistry courses. However, when the research team analyzed the motivation data collected on nonscience majors, the results did not justify concluding that a lack of motivation was the reason the nonscience majors experienced knowledge decay.

What was different about the course for nonscience majors was the absence of quizzes between major exams and no cumulative final exam. The nursing students had daily quizzes. The high school students had some additional quizzing but were also required to regularly submit homework, which was graded. Students in both of these courses took cumulative finals. What appeared to prevent knowledge decay in this study would not surprise those in cognitive psychology, whose work has repeatedly demonstrated the value of retrieval practice. New knowledge is remembered better and longer the more often it is retrieved. Students need to review regularly. They need to face questions (on quizzes and in homework) that cause them to recall what they have recently learned. The connections between what

they already knew and what they've just learned need to be cemented, and when that new information is integrated with the old, it becomes part of a learner's working knowledge base.

Beyond this further confirmation of the value of repeated exposure to content are larger implications that pertain to the tendency of many faculty to accept widely held assumptions. It may well be that in a particular course, given the content, how it is taught, and the students enrolled in the course, significant amounts of knowledge decay occur that can be pegged to motivational issues. But that conclusion should not be taken as fact without further analysis. Motivation is frequently a problem in required courses not in the students' major, but it wasn't the problem in this chemistry course and wasn't the most likely reason for the knowledge decay.

We continue to want simple, generalizable answers to questions that appear straightforward. As these researchers note, their work addresses the first in a set of questions. Does knowledge decay occur, and does it occur quickly? As is invariably the case, their answers offer insight and lead to more questions. "Future studies could investigate the causes of decay of knowledge in a more systematic fashion" (p. 1236). They think the causes may include the presence or absence of repeated occasions of tests and quizzes, student ability, student motivation, teaching style, interactive versus passive classrooms, and the use of cumulative finals, among others. It's not a straightforward question with a simple answer.

Reference: Bunce, D. M., VandenPlas, J. R., & Soulis, C. (2011). Decay of student knowledge in chemistry. *Journal of Chemical Education*, 88, 1231–1237. 🌿