

2017

## Effective Studying is a Science, Not an Art: Teaching Students Scientifically-Based Study Techniques

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### Recommended Citation

Bacon, Pamela L. (2017) "Effective Studying is a Science, Not an Art: Teaching Students Scientifically-Based Study Techniques," *Headwaters*: Vol. 30, 44-58.

Available at: <https://digitalcommons.csbsju.edu/headwaters/vol30/iss1/5>

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# **Effective Studying is a Science, Not an Art: Teaching Students Scientifically-Based Study Techniques**

## **Abstract**

The typical student never receives formal instruction on scientifically-based study techniques. Instead, most students utilize ineffective methods such as rereading and highlighting. After discussing the research on effective and ineffective study techniques, the paper focuses on my attempts to help students change their study skills by providing them with optional reading material, developing an assignment that draws on the research, or requiring them to utilize the techniques on an exam. Based on my experiences, it appears that requiring students to utilize the study techniques in order to earn points resulted in greater adoption of scientifically-based study techniques than informing the students about the benefits of the scientifically-based techniques. In addition to sharing my strategy to incorporate study skills training into an upper division course, I also provide a list of studying resources for students and faculty.

## **Keywords**

Study strategies, college success, students' beliefs about learning

Studying for exams was a grueling and frustrating experience for me in college. My strategy was to reread every assigned reading, which I had diligently highlighted so that nearly every word was pink, yellow, or blue. I also would highlight and reread my class notes. Finally, I would make flashcards for every vocabulary word in the textbook, including terms that were never mentioned in class. I would skim study guide questions, but I was spending so much time rereading and memorizing the book's bolded terms that I usually did not write out answers to the study guide questions—after all, if I knew everything in the book, I could answer anything on a test!

Where had I learned this interesting set of study techniques? Learning how to study was not something I was ever taught to do by my teachers. Instead, my college studying plan was based on my intuition about how to learn, which is how most students develop a studying plan. Basing study techniques on intuition results in college students spending a substantial portion of their valuable study time rereading the textbook, notes, and study guide answers (Karpicke, Butler, & Roediger, 2010). It makes sense that if students want to learn something then they should keep rereading the information because then it will be stored in their memory. Unfortunately, as I will explain later, basing study techniques on these intuitive explanations of how learning works results in a reliance on ineffective study techniques that actually make it hard to learn.

Once students have developed their study strategies, they may use their test scores as an indicator of the effectiveness of the technique. Students who receive high grades on exams may incorrectly assume that the reason for the high grade was the specific way they studied. What students forget is that personal experience is a weak form of evidence. When I studied for a test using my study method, I was unable to compare my performance on that test to my performance had I used different study strategies. Each time I received a B+ on an exam, I had no way of knowing that if I had simply focused on retrieval practice techniques I might have received an A. Instead, I would think that if I had not used my “system,” then I would have received a much lower grade. Relying on personal experience also means students are unable to rule out alternative explanations for their exam scores, such as the exam material focused on material they had previously learned, not the study technique used. Relying on personal experience can also cause students who receive low exam scores to blame the teacher, exam format, or their own lack of ability rather than their poor study techniques. Students may even end up deciding they have “test anxiety” or that they are “bad at taking tests,” both of which can be terminal self-diagnoses that cause students to give up.

The lack of formal study skills instruction in the K-12 system as well as in higher education is surprising because teaching students how to learn effectively and efficiently is one of the top priorities of educators.

Usually the teacher's instructions are simply to "study for the test." This suggestion is often paired with a cautionary tale about what happens to the student who only studies for an hour or two for the exam. Thus students may get the message that the amount of time is what matters, not the study techniques being employed. Additionally, students are often told that people have different learning styles, which contributes to students and teachers believing that each student needs to figure out how they best learn. This also makes it difficult for teachers to make study suggestions, as students may dismiss the suggestions because "that may work for some students, but I have my own study system that works for me."

My experiences as a college student have motivated me to identify effective study strategies and to share those techniques with my students so that they will have the tools to study more effectively than I did. In the next section I will highlight some of the most and least effective study techniques, with an annotated list of study skills resources for students and for faculty included at the end of the essay. I then will share my attempts to teach students how to study and the results of my efforts.

## **Effective and Ineffective Study Techniques**

Contrary to what many people believe, it is possible to identify effective and ineffective study techniques by conducting experiments (e.g., Bjork, Dunlosky, & Cornell, 2013; Brown, Roediger, & McDaniel, 2014). For example, in one experiment students were told they were going to be tested on a passage from a textbook (Roediger & Karpicke, 2006a). After all of the students read the passage, some of the students were allowed to reread the passage until they had read it four times. Others read the passage once and then they had to write down everything they could remember about the passage (without ever looking at the textbook again). Both groups were then asked to predict how much they had learned. The students who were allowed to read the article four times thought they had learned more than the students who read the article once and then wrote what they could remember from the article. One week later they were tested on the passage. The results of the test showed that participants who got to reread the article actually scored much lower on the test than the participants who only read

the passage once and then wrote about what they remembered from the passage without consulting the passage again. The results of studies such as the one by Roediger and Karpicke (2006a) may surprise people whose beliefs about learning are based on intuition (including the participants in the study, who were unable to predict how well they had learned the material). When examining the results of decades of research, there is strong empirical evidence that rereading and highlighting are both ineffective ways to learn material (e.g., Brown et al., 2014; Callender & McDaniel, 2009; Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). Instead, techniques that force the learner to retrieve information from memory, such as writing down everything you remember, completing practice tests from memory, and using flashcards, are much more effective (Bjork et al., 2013; Brown et al., 2014; Roediger & Butler, 2011).

Passive techniques such as rereading notes may feel useful because with the help of the notes the student is able to understand the material and it feels familiar (Brown et al., 2014). Rereading helps students develop the ability to recognize the material, but does not help them retrieve the material from memory (Putnam, Sungkhasettee, & Roediger, 2016). A similar process may be at work when students copy their notes by hand or type up their notes by copying the material verbatim, making it a passive technique that does not require much thought (Bjork et al., 2013). Learners often assume that if material feels familiar that it is an indication that they have learned the material; however, familiarity is not strongly related with actual learning, so students may enter an exam thinking they have mastered the material when in fact they are only somewhat familiar with the concepts (Brown et al., 2014; Gilovich, 1991).

The clear message from cognitive research is that learning takes effort (e.g., Bjork, 1994). It is the act of remembering material, making connections between concepts, putting concepts into our own words, creating concrete examples, and asking questions about how and why things work that leads to learning (Putnam et al., 2016). Memory is strengthened by waiting until one is on the verge of forgetting and then trying to retrieve the information, which means that it is more effective to space out one's learning (Carpenter, Cepeda, Rohrer, Kang, & Pashler, 2012). By engaging

in spaced practice, the pathway to the information is strengthened, making it easier to recall it in the future (Carpenter et al., 2012). Another effective technique is to use elaborative interrogation in which one asks how and why things work and then answers those questions from memory (McDaniel & Donnelly, 1996). Engaging in elaborative interrogation helps students organize new material, making it easier to recall later on and understand the concepts more thoroughly (Willoughby and Wood, 1994).

Creating from memory a concept map that visually organizes the material you are learning and then reviewing what was forgotten or incorrect will result in much more learning than looking at a perfectly drawn concept map (Schroeder, Nesbit, Anguiano, & Adesope, 2017). Retrieval practice is also the best way to know if you have learned the material (e.g., Roediger & Karpicke, 2006b). Can you explain the material out loud without looking at your class notes? Can you give an example of a concept without looking at your flashcard? Can you draw a concept map from memory to demonstrate how the material is organized? Can you answer the study guide without looking at the answers? Unfortunately, most students wait until the exam to learn whether or not they have mastered the material.

## **Exposing Students to the Research on Study Techniques and Learning**

In every class I teach, I talk to my students about the “science of studying.” In addition to spending time talking about scientifically-based studying techniques, I also provide students with links to podcasts, videos, magazine articles, and blogs that explain the techniques in detail. When I post study guides, I remind students of the scientifically-backed study techniques and provide them with links to the study skills material. Unfortunately, what typically happens was that the students who were already getting A’s might glance at some of the resources, whereas the students who could have benefitted the most from a change in their study skills would tell me they were too busy to do additional reading about study skills or to try a new study technique. In fact, it was a great semester when even 2 or 3 students looked at the studying resources I had posted!

Because of the limited impact of my attempts to provide students with optional material on study techniques, I decided to introduce the material as a homework assignment so that all students would be required to read the material and discuss it. Introductory psychology was the perfect class to formally teach students about how to study because the material related to topics covered in introductory psychology, students tend to struggle on the exams, and many of the students are first years and thus may be more open to changing their behavior. In preparation for the lab period when we discussed study techniques, students filled out a survey describing how they studied and their beliefs about learning. The introductory students reported spending an average of 6 hours studying for exams. Thus, it is not likely that the poor performance on intro exams is due solely to lack of effort. Instead, their specific study techniques probably contributed to their difficulties. Students reported that they spent about 75% of their study time rereading their notes, rereading their study guides (often referred to by students as “going over” their study guide), and making vocabulary flashcards. The remaining 25% of their time was spent self-testing on material besides vocabulary. Students believed that the techniques they used were effective ways to study for an exam. Students acknowledged that cramming for an exam was an ineffective strategy, but many students reported engaging in this practice because they were so busy. Students also acknowledged that there were other retrieval techniques that were effective, but few actually used those techniques.

At the end of the semester, the introductory psychology lab students were asked the degree to which they had changed their study techniques based upon the scientific research presented in lab regarding effective study techniques. About half of the students reported that they had changed their techniques, but often times the transformation was rather minor. Some students reported that they reduced the amount of time they spent rereading their notes, some began using spaced practice, and some reported increased self-testing practices. Unfortunately, many students reported no change in their studying behavior. Some students explained that they had already developed an effective study strategy that worked for them, so they had no reason to change. To be fair, it is likely that some students were using effective techniques prior to our intervention. However, it is also the case

that some students were still claiming that rereading their notes and the study guide were working well for them. Another large group of students acknowledged that they should abandon their ineffective techniques, but that it was too difficult to change their habits at this point.

Having students read and discuss the research on studying did not have a dramatic effect on introductory psychology lab students' behavior. Although students modified the amount of time spent rereading, it was still the technique they used the most. During lab, some students argued that it didn't matter what the research said, because everyone learns differently. They therefore could acknowledge the results of the studies discrediting rereading, but maintain the belief that they were the rare exception for whom rereading was effective.

## **Helping Students Developing Their Study Skills**

This fall, rather than hoping my junior and senior social psychology students would spontaneously change their study skills after reading about the techniques, I designed a series of assignments that made using scientifically-based study techniques part of their homework grade. Creating low-point assignments that required students to practice the techniques resulted in the most positive changes in studying behavior I have ever observed, particularly among students who had less than a 3.0 cumulative GPA.

I started the studying project by having students complete a freewrite at the start of class in which they had to describe how they typically study for a psychology exam, focusing on (a) how many hours they tend to spend studying, (b) how many days before the exam they start studying (c) what they actually do when they “study”, and (d) how effective their techniques are. After students turned in their freewrites, I told the students that they had a studying assignment for their upcoming exam. Students were told that they needed to use retrieval practice, spaced practice, or elaborative interrogation techniques to study for the exam (see links in the resources section below). Students were told that they needed to try a new technique, so if they wrote in their freewrite that they used retrieval practice, then I would want them to try spaced practice or elaborative interrogation.



After class I reviewed their freewrites and identified which techniques they should consider, and I commented on any problematic strategies that they listed. The results of the freewrites suggested that even juniors and seniors relied on rereading their notes and study guides, rereading class material, and making vocabulary flashcards that encouraged them to mindlessly memorize definitions rather than put the term into their own words. Thus, nearly every student had the opportunity to develop more effective techniques.

Students were assigned to read three blog entries from *The Learning Scientists* about the three techniques and then come to class ready to commit to one of the techniques for exam 1. At the start of the next class period, I had the students divide up into study groups of 3-4 students with other students who were using the same study technique. Students met with their groups to talk about how they planned to study for the exam using the technique. The groups set up times to meet outside of class to study. Later the students turned in individual study plans that required them to draw on the material from the blog site and to create a specific plan leading up to the exam. Students then provided feedback to the group members regarding their plan, which also was graded. Students had to provide me with “creative evidence” of their studying, which frequently was a selfie of their group studying together, a picture of flashcards asking for real world examples of concepts, colorful concept maps, and other fun ideas. Finally, after they took the exam they completed a brief survey and wrote a reflection on their study techniques.

To further encourage students to try new techniques, I included a study guide question that required them to make a large concept map that incorporated specific experiments, showed connections between concepts, and showed how the concepts differed from each other. It was a challenging task for my students. Rather than hoping that the students would spend time working on the concept map while they completed their study guides, I had students break into their “study groups” and create the concept maps on a whiteboard during class. I then went around to each group and challenged those who stopped before they had identified all of the links and intervened with the groups that had major problems with their maps. To further reinforce the importance of concept maps, I included a

scaled down version of the concept map on the exam, requiring students to explain *why* they had drawn the concept map the way they did. Later in the semester, I gave them the outline of a concept map that they could use to learn about cognitive dissonance theory for the upcoming exam. Students could print off copies of the concept map so that they could practice filling it in from memory. Compared to past semesters, this group of students did very well on the cognitive dissonance test questions, likely due in part to testing themselves with the concept maps. I was surprised by how many students told me later that the concept maps were helpful to them. For example, one student wrote, “I found that the use of the concept map made the information more interrelated or connected. In other words, drawing all of the connections between different concepts and grouping them into like-minded ideas made retrieving the information a lot easier.” In fact, more than one student answered the question on the course evaluation about “what aspects of the class contributed most to your learning?” by mentioning concept maps.

I also began providing students with a small number of applied questions at the start of class to help them with retrieval practice. I would tell them to work in small groups to answer the questions without looking at their notes. Sometimes they realized that no one remembered enough to answer the question, at which point I would remind them that the fact that they could not answer the question indicated they had not yet learned the material. These activities are always ungraded, but they did provide students with another opportunity to retrieve the information.

After the success of the studying project on the first exam, I encouraged my students to continue to use the new study techniques, but I did not have any homework assignments related to studying for exam 2. I noticed that some of the lower performing students in the class showed a decrease in their grades from exam 1 to exam 2. In talking to a few students it became clear that students had stopped meeting in study groups after the first exam. This prompted me to provide students with a small amount of extra credit if they could provide me with evidence that they studied using one of our techniques for exam 3. This time the evidence was due a few days before the exam in order to reduce the amount of cramming on the night before the exam. The most common approach was to form

a study group to quiz each other. Even though students could only earn extra credit once, I had multiple students who had worked with two or even three different study groups! Although I did not feel that I could give additional extra credit related to studying, most of my students continued to form study groups before exam 4 and the cumulative final.

## **Conclusions**

Providing students with assignments that force them to develop their study skills rather than providing students with the information alone led to increased adoption of scientifically-proven study techniques. These changes were possible even with students who had spent years utilizing other study techniques. On the other hand, it is sobering to think that many of my students had completed nearly their entire college careers using ineffective study techniques by the time they took social psychology. Based on my experience teaching an upper-division content course, I conclude that study skills training can be added to a course without detracting from the main learning goals of the class. Although I was concerned that my social psychology students may object to using class time to talk about something other than social psychology, none of the students complained that we were spending time talking about cognitive psychology; instead, they appreciated how much they had learned about social psychology.

Just as we have decided that it's important for first year students to learn the foundational skills needed to be college students, such as how to write, read, discuss, and present, perhaps it is time for us to add learning how to study to our list. Of course, this is one instance in which First Year Seminar or the future version of the course would not be the appropriate class to develop study skills. Study skills will be best learned in courses that assess learning using in-class exams so that students can develop the skills embedded within a course. By helping our students develop their study skills, we will be creating an inclusive classroom in which all students have the tools needed to learn.

## Recommended Resources

### *Blogs*

- Learning Scientists Blog: A fantastic blog created by cognitive psychologists that offers resources for teachers and students: <http://www.learningscientists.org>

- How to study using...

Retrieval Practice (self-testing): <http://www.learningscientists.org/blog/2016/6/23-1?rq=How%20to%20study%20using%20retrieval%20practice>

Spaced Practice (and why cramming is bad): <http://www.learningscientists.org/blog/2016/7/21-1?rq=Learn%20how%20to%20study>

Elaborative Inquiry (asking questions): <http://www.learningscientists.org/blog/2016/7/7-1?rq=learn%20how%20to>

- A concept map demonstrating the impact of retrieval practice: [https://csbsju.instructure.com/courses/5404/files/261376?module\\_item\\_id=86627](https://csbsju.instructure.com/courses/5404/files/261376?module_item_id=86627)

### *Videos*

- Brief Videos of the Learning Scientists' Techniques: <http://www.learningscientists.org/videos/>
- A 9-minute video that discusses six study techniques identified in the Learning Scientists' blogs: <https://www.youtube.com/watch?v=CPxSzyIrcI>
- Dr. Stephen Chew, a cognitive psychologist, developed a video series entitled *How to Get the Most Out of Studying*:

Introduction video: *How to study long and hard and still fail ...*

or how to get the most out of studying. Developing a mindset for successful learning: <https://www.youtube.com/watch?v=htv6eap1-M&index=1&list=PL85708E6EA236E3DB>

Video 1: *Beliefs that make you fail or succeed*: <https://www.youtube.com/watch?v=RH95h36NChI>

Video 2: *What students should know about how people learn*: <https://www.youtube.com/watch?v=9O7y7XEC66M>

Video 3: *Cognitive principles for optimizing learning*: <https://www.youtube.com/watch?v=1xeHh5DnCIw>

Video 4: *Putting principles for learning into practice*: <https://www.youtube.com/watch?v=E9GrOxhYZdQ>

Video 5: *“I blew the exam, now what?”* <https://www.youtube.com/watch?v=-QVRiMkdRsU>

### Articles

- A summary of the research on study appropriate for first-year students: Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). What works and what doesn't. *Scientific American Mind*, 24, 46-53.
- An article written for students detailing time-management strategies and other helpful advice: Putnam, A., Sungkhasettee, V. W., & Roediger, H. L. (2016). Optimizing learning in college: Tips from cognitive psychology. *Perspectives on Psychological Science*, 11, 652-660.
- A much more detailed summary of the research on studying appropriate for faculty: Bjork, R. A., Dunlosky, J., & Kornell, N. (2013). Self-regulated learning: Beliefs, techniques, and illusions. *Annual Review of Psychology*, 64, 417-444.

- The study comparing test scores between participants who reread vs. participants who wrote about the passage from memory: Roediger, H. L., & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17, 249-255.

### *Books*

- A book written by cognitive psychologists for teachers, students, and parents who want to learn about the research on learning without reading journal articles. The authors give practical advice and use stories to illustrate important concepts from cognitive psychology. Brown, P.C., Roediger, H. L., & McDaniel, M.A. (2014). *Make it stick: The science of successful learning*. Cambridge, MA: The Belknap Press of Harvard University Press.

### *Podcasts*

- A fantastic documentary that provides compelling stories of people switching from less effective to more effective study techniques: <http://www.americanradioworks.org/documentaries/the-science-of-smart/>

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