Successive relearning (SR) is a strategy in which students do retrieval tasks such as practice quizzes or practice problems spread out over time. Students relearn the course content by being quizzed on it repeatedly throughout the course. SR combines two highly effective learning strategies, retrieval practice and spaced practice. This article explains how SR works and how to implement it in your classes.

Overview of Retrieval Practice, Spaced Practice, and Successive Relearning

Retrieval Practice involves trying to recall previously studied information from memory. Examples include:

- Practice quizzes in which students answer questions: 1) embedded in a reading assignment, 2) at the start of class, 3) at the end of class or, 4) online after class.
- Reading a few pages from a text and then trying to recall the information without looking back at the text.
- At the end of class to writing down the major ideas from lecture without looking at notes.
- After class, covering up class notes and then trying to recall the information.
- In a study group students ask and answer one another’s questions to prepare for an exam.
- Answering clicker or poll questions in class.

Abundant research has demonstrated that retrieval practice is a powerful learning strategy. To illustrate, consider a research study that examined the relative effectiveness of four study methods. In this experiment students read a science article and then took a test one week later to determine what they remembered. Students were assigned to one of the following study methods: 1) read the article one time, 2) reread the article four times, 3) read the article one time and make a concept map of it, and 4) read the article one time and then write down what they remembered without looking back at the article. Students were tested one week after they had studied the article. As shown in the graphs, the retrieval practice group (green bar), in which students read and then tried to recall the information, far outperformed students in the other study methods. Also note that retrieval was much more effective than rereading, a popular study strategy among students.
How does retrieval practice enhance learning? The key cognitive activity in retrieval practice is the act of trying to recall information from memory. Retrieval improves learning because the mental act of recall alters our memory of the material. We make additional connections and associations with the information which strengthens our memory. Every time we recall something from memory we learn more. Another benefit of retrieval is that it helps us identify how well we know the information. If we can’t recall it from memory, we don’t know it or don’t know it very well. We can then allocate more study to the information we do not yet know.

Spaced Practice involves studying material spread out over time, e.g., studying one hour every other day leading up to an exam. Spaced practice contrasts with “cramming” in which students mass their study into one long session, e.g., studying 5 hours the night before a test.

How does spaced practice enhance learning? When there is lag time between study sessions learners start to forget the material. When they study it again, they “relearn” the information and this increases the likelihood that it will be retained in long term memory. Students who cram the day before a test may be able to pass their exam but will quickly forget the information.

Decades of research has shown that spaced practice has a strong positive effect on long term learning. To illustrate, consider a study that compared test performance of students who studied by cramming (one study session) versus spaced practice (four study sessions). All the students had the same total amount of time to study. The graph below shows, from left to right, the proportion of correct answers for students who crammed 4 days, 3 days, 2 days and 1 day prior to the exam. Students who used spaced practice studied for shorter periods of time on 4 separate days before the test. As you can see, students who used spaced practice far outperformed students who crammed even though all the students studied the same overall amount of time.

![Graph showing percentage correct on test](image)

Retrieval Practice + Spaced Practice = Successive Relearning. Retrieval and spaced practice are potent learning strategies on their own. They are even more effective when combined, that is, when retrieval practice is spread out across study sessions. This spaced retrieval practice strategy is successive relearning.
How does SR enhance learning? SR combines the effects of retrieval and spaced practice. Students learn more as a result of retrieval and their learning is enhanced further by spreading out retrieval episodes so that students “relearn” the information across study sessions. Successive relearning promotes more robust, durable knowledge. Students using successive relearning typically outperform other students on exams by 10%, an entire letter grade. In addition, students retain the information much longer. The graph below shows the results of using successive relearning in an introductory psychology class. Students learned 32 core concepts using successive relearning in which they were quizzed periodically on the core concepts throughout the course. They also learned 32 core concepts using their own typical study method. The graph shows the percent correct for successively relearned concepts versus concepts students learn via their typical mode of study.

On the initial test the percentage correct for concepts learned through successive relearning was 12% greater than that of test items in which students used their typical study approach (84% vs. 72%), more than a full letter grade difference.

But wait there is more. . . Researchers also retested students three days and then again 24 days after the initial test to evaluate long term learning. The differences between successively relearned vs. typical study are striking. When students had used their typical mode of studying their performance dropped to 27% and 17%, respectively. In other words, they quickly forget almost everything they had learned. Their performance on successively relearned concepts decreased from 84% to 80% after three days and then to 64% after 24 days. After three weeks students still retained a significant amount of what they had learned through successive relearning.

Research on retrieval practice, spaced practice and successive relearning demonstrates that
1. Students learn more with retrieval practice than with other less effective strategies such as rereading.
2. Students learn more with spaced practice, by spreading out their study rather than cramming.
3. By using successive relearning throughout a course, students may retain concepts well beyond the end of the course, and it may also be much easier for them to relearn those concepts when needed in subsequent classes.
4. Teachers can promote more robust, durable student learning by incorporating successive relearning in their classes.
Guidelines for Implementing Successful Relearning in Your Courses

I. Select content and questions. Identify the content, concepts, skills you want students to learn.
   Recommendation: It is probably not feasible to successively relearn all the content in a course. Target the most important core concepts for successive relearning.

II. Make questions that cover the material you have selected and create a “correct” answer for each question that can be used as corrective feedback.
   Recommendation: Multiple choice questions will work. Short answer questions tend to work better. Write questions that prompt more complex thinking like, “explain how”; “compare and contrast”; “evaluate”; “analyze”; “show how”, “give two examples of.”

III. Feedback is important and improves students’ learning.
    Recommendations:
    • Delayed feedback is more effective than immediate feedback, e.g., students take a practice quiz and don’t see the correct answer until they complete the quiz; students take a practice quiz at the start of class and get feedback at the end of class.
    • Explanatory feedback, that explains why answers are correct or incorrect, is more effective than just seeing the correct answer.
    • Encourage students to review and use feedback.

IV. Schedule practice sessions. Create a spaced schedule for quizzes and problems/questions.
    Recommendations:
    • Students should practice retrieval with all the content several times during the term. Spread out practice quizzes so there is one or more days between them. For example, if an exam is in two weeks students could do five practice quizzes with two days between each.
    • Consider giving practice quizzes before, during or after each class period. This will create enough opportunities to include core content in multiple practice quizzes.

V. Make practice quizzes cumulative.
    Recommendation: As the term proceeds, practice quizzes should include not only questions on new material but questions from previous quizzes. Try to ensure that students will answer all the questions 4-5 times during the term. Successive relearning of core concepts throughout the semester will also prepare students for the final exam and increase the likelihood they will remember the material beyond the end of the course.

VI. Make sure that students answer questions correctly multiple times.

VII. Incentivize practice quizzes.
    Recommendations:
    • Practice quizzing should be low stakes, e.g., students earn practice credit which counts toward a small percentage of the course grade. Research shows that students like and see the value in low stakes quizzing.
• Further incentivize practice quizzes by including practice quiz questions on course exams.

VIII. Explain and justify to students the value and role of successive relearning in the course
Recommendations:
1. Emphasize . .
   - that retrieval and spaced practice are highly effective learning strategies
   - that the goal is more robust, durable learning, i.e., greater student success/achievement/better grades
   - the importance of long-term retention, e.g., successive relearning will help them do better on the course final and in subsequent classes where they will need to know the concepts
   - that successive relearning is an effective way to become more knowledgeable and competent in the subject

Examples of Implementing Successive Relearning

Example 1: Bill Cerbin’s successive relearning pilot project
Context: PSY 370: Educational Psychology, 40 students in teacher education and psychology.
Quizzes
• Created 24 practice quizzes, one for every class reading assignment
• Quizzes were a combination of multiple choice and short answer questions.
• Created explanatory feedback for each quiz question.
• Quizzes were cumulative in that each quiz included questions from previous quizzes. Students saw and answered all the quiz questions multiple times during the semester.
• Quizzes were spaced at least one day apart.
Procedure
• Start of the course—In class and on syllabus I explained the use and role of practice quizzes in the course.
• Students took an online practice quiz after reading the assignment for each upcoming class period. After completing the quiz, they received a link to quiz feedback.
• Students received participation credit for completing practice quizzes, totaling ~8% of the course grade for completing all the quizzes. Further incentivized the quizzes by including some quiz questions on the course exams.
Results—Results are anecdotal; the pilot was not a formal research project.
Highlights
• 38/40 students completed all the practice quizzes
• On SEIs, students rated quizzes as the most significant learning resource in the course.
• Quizzes served a second purpose – to increase students’ relevant prior knowledge of the topics to be discussed in each class.
• Quizzes were low stakes – not a significant threat to course grade.
• Quizzes took place outside of class time.
• Contacted the students via email 4 months after the end of the semester and asked them to complete an online test, 23 multiple choice and 2 short essay questions. Twenty-one students completed the follow-up test. The mean score on the multiple-choice was 90%.
Students also answered two essay questions. I did not do a formal analysis of the answers, but overall students used course knowledge to answer one or both essay questions. Their answers were informed by what they had learned in the course. They were not “person-on-the-street answers.”

Lowlights
- A few students “cheated,” by taking quizzes without reading the assignments, e.g., low quiz scores, <50% correct. I contacted students with low scores and reminded them of the importance of quizzes for their learning, but did not disqualify their quiz.

Difficulties and shortcomings
- Writing good quiz questions and appropriate feedback is significant work.
- Did not systematically track the use of quiz questions. This resulted in using some questions more times than other questions across the semester.
- I omitted a key feature of successive relearning. Technically, students should answer quiz questions until they answer each one correctly. There was no way to ensure this via the LMS. In other words, there was no guarantee that students answered each question correctly on each practice quiz.
- I did not monitor whether and how students used the quiz feedback.

Example 2: 4-minute video by Scott Cooper, UWL Biology, at the CATL Teaching Symposium: Facing Forward in May, 2021. Scott describes how he uses practice quizzes in his course. He does not use successive relearning per se, but his presentation illustrates some of the logistics involved in using practice quizzes in a course.
  1. Link to one-page summary of Scott’s project
  2. Link to 4-minute screencast Scott describes how and why he used practice quizzes in his class

Example 3: The power of successive relearning and how to implement it with fidelity using pencil and paper and web-based programs. A journal article that describes various ways to implement successive learning.
Abstract. Successive relearning (SR) is a promising strategy to improve student achievement that combines two effective learning techniques—retrieval practice and spaced practice. Our aim in this article is to help instructors and students effectively use SR. We begin by briefly discussing current evidence for its efficacy, and then we describe the steps for implementing it with fidelity and details on how it can be implemented using pencil-and-paper materials. We also assessed the degree to which some flashcard programs instantiate the attributes to support SR. Many of these programs can be adapted to implement SR for mastering the kinds of content that are often foundational for introductory courses in psychology, including simple associations, key-term definitions, labels for objects (e.g., names of brain structures), and the steps in processes. Accordingly, this Teacher-Ready Research Review provides instructors and students with recommendations on and tools for how to harness the power of successive relearning.
References


Additional Resources

For additional resources related to the science of learning for students and educators, see Taking Learning Seriously