

Counterintuitive Findings on What Improves Long-Term Learning

“Should errors be avoided during the learning process, or are they an important component of effective learning?” ask Courtney Clark and Robert Bjork (University of California/Los Angeles) in this chapter in an online book from the American Psychological Association. This question has been debated for decades, and there are logical arguments on both sides. Behaviorist B.F. Skinner said teachers should carefully scaffold learning, leading students through one small step at a time so they don’t make mistakes. Students naturally try to avoid errors, and many teachers see it as their responsibility to make learning manageable and protect students from making mistakes.

But Clark and Bjork say that “errorful” learning – deliberately introducing “desirable difficulties” into the learning process – produces deeper and longer-lasting results.

Learning can be seen along two dimensions, they say: a student’s current performance and a student’s underlying, long-term learning. Current performance can be misleading. On Monday, for example, a student might be able to correctly name all the countries of Europe on a blank map with national borders – but the student may have looked at a filled-in map a few minutes before the test, and on a Tuesday re-test (without an opportunity for review), Luxembourg and Malta might slip the student’s mind. We would be satisfied that underlying learning was solid only if the student could fill in the map on Tuesday and again a week later. In other words, “current accessibility” of learning tells us very little.

It’s also true that if a student cannot access a piece of information, that doesn’t necessarily mean learning hasn’t occurred, say Clark and Bjork. What if the student was given a much more difficult test – on a blank sheet of paper, draw the borders of all the European countries, and fill in their names. A student could totally fail this test and yet have a good knowledge of European geography on a test with more clues. In addition, some bits of information are more readily accessible than others. Students who live in California can probably tell us immediately that Sacramento is the state capital, but if asked for the capital of Michigan, they might have to struggle to retrieve the answer – is it Detroit, Ann Arbor, or Lansing? Probably Lansing. So the level of difficulty is a key variable in the errorful learning approach.

Clark and Bjork say there are three proven ways to introduce “desirable difficulty” into the learning process: spacing, interleaving, and testing. Each makes things a little harder for students and surprisingly results in better long-term retention and students’ ability to apply learning to new situations:

- *Spacing* – Cramming the night before an exam (massed practice) may work short-term, but it’s not an effective strategy for long-term learning. Students retain information far better by spacing study sessions with breaks between each one. The

spacing is important – students should return to the material just as it’s beginning to slip away, so there’s a struggle to retrieve it. This cements the learning a little more each time.

- *Interleaving* – There is a tendency for teachers and coaches to *block* practice for a particular skill, for example, a tennis coach getting student to do backhands again and again before moving on to serving, or a math teacher having students repeatedly practicing subtraction with remainders. Teachers and students can be fooled because blocked practice seems to be producing good performance on the focus skill – but numerous studies in sports and academic subjects have shown that mixing several skills together during practice – interleaving – is far more effective, especially when the ultimate goal is performing the task in combination with other skills, as is almost always the case in tests and real-world settings.

- *Testing* – Most people see tests as simple measures of what we know and are able to do. But psychologists have discovered that in addition to that, tests are “memory modifiers” – retrieving information strengthens the memory and makes it easier to recall in the future. In one experiment, a group of students studied a passage four times while another group studied it once and immediately took three recall tests. When the students were tested right away, the first group did better, but when they were tested a week later, the study-test-test-test group far outperformed the study-study-study-study group.

In all three of these conditions, students make errors as they try to retrieve information that’s not at their fingertips. Isn’t that detrimental? Doesn’t guessing wrong reinforce errors in students’ minds? Or could it be, ask Clark and Bjork, that spaced, interleaved, and testing conditions are effective *because* they lead to errors?

That is precisely the finding of another set of studies on pre-testing. Students who took a difficult pre-test and got almost every problem wrong – and then received helpful feedback – did better on a final test than students who memorized the pretest and better than those who carefully studied the material. The conclusion: “pretests can guide effective encoding,” say Clark and Bjork.

Another study compared students whose teacher helped them successfully solve complex math problems (the direct instruction group) with students who worked in groups trying to solve the same problems and failed to do so (the productive failure group). “During a final lesson, a teacher helped the productive failure group analyze their failed attempts and provide correct methods,” say Clark and Bjork. “On a final test, the productive-failure group outscored the direct-instruction group on both complex problems as well as more straightforward problems.”

Are difficulties ever undesirable? Definitely, say the authors. Distractions during tests aren’t helpful, and the benefits disappear if the difficulty level is too great for

students. The basic point, they say, “is that for a difficulty to be desirable, a given learner must, by virtue of prior learning or current cues, be able to overcome that difficulty.”

“With so much to learn,” Clark and Bjork conclude, “students crave methods that make learning fast and easy. One basic message of this chapter is that methods that improve learning typically make learning seem harder, not easier. However nice it might be to have a magic wand to offer teachers and students, one that can get students to learn a foreign language in two weeks or become competent pianists after only a few lessons, what we offer, instead, are difficulties, but difficulties that promote durable and flexible long-term learning and transfer.”

These findings have direct implications for how teachers present material, organize practice, orchestrate review – and how they teach students how to study. “Students can improve their efficiency by knowing both what and how to study,” the authors continue, “and when to stop studying when it is futile or no longer needed... [S]tudents need to become metacognitively sophisticated as learners, which includes knowing not only how to manage their own learning activities, but also knowing how to monitor the degree to which learning has or has not been achieved.”

“When and Why Introducing Difficulties and Errors Can Enhance Instruction” by Courtney Clark and Robert Bjork in *Applying Science of Learning in Education: Infusing Psychological Science Into the Curriculum*, American Psychological Association, edited by Victor Benassi, Catherine Overson, and Christopher Hakala, 2014 (p. 20-30), <http://teachpsych.org/ebooks/asle2014/index.php>; Clark can be reached at courtneyclark@ucla.edu.

What Students Worry About Entering Different Levels of Schooling

Three graphs in *ASCA School Counselor* present data on students' biggest worries and struggles entering each level of schooling:

Entering elementary school:

- Being away from parents – 28%
- Learning to sit still and listen to teachers – 24%
- Making new friends – 18%
- Learning and following school procedures – 20%
- Other – 10%

Entering middle school:

- Peer issues and peer pressure – 20%
- Adjusting to multiple teachers – 17%
- Opening lockers – 16%
- Managing time – 11%
- Finding their way to classes – 11%
- Other – 4%
- Organization – 2%

Entering high school:

- Homework – 20%
- Peer issues and peer pressure – 18%
- Finding way to classes – 14%
- How to maneuver lunch time/accompanying social issues – 13%
- Post-secondary planning – 11%
- Extracurricular activities and choices – 9%
- Opening lockers – 6%

- How to access school services (nurse, guidance counselor, administrators, etc.) – 4%

“What Do Students Entering Your School Seem to Worry About or Struggle With Most?” in *ASCA School Counselor*, May/June 2014 (Vol. 51, #5, p. 40), no e-link available