



The Learning Benefits of Questions

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11th Anniversary Reissue

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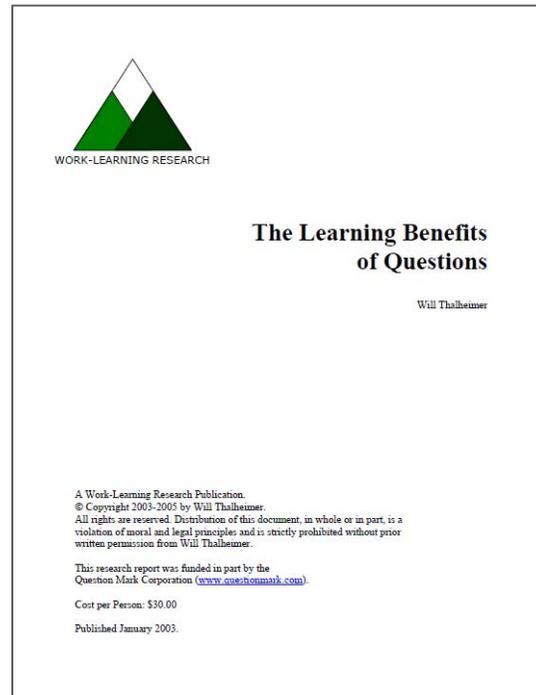


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Introduction to 2014 Reissue

This document was originally published in 2003, with partial support from Questionmark, to whom I am still grateful. At that time, the paper sold for \$30 online. It was not fancy and had poor production values as can be seen in the original title page:



Since that time, people have stopped paying for this type of content on the internet and content marketing has made many more short papers available online. Several years ago, feeling embarrassed about the poor production values in the original; I took the paper down off the Work-Learning Research website.

Remarkably, people still contact me to request it and still refer to it. For that reason, I thought I would reissue it. Its concepts are still valid. Questions still rock, the research is still sound, and you will still get great value from this paper's concepts!

Since the original paper, I've gone on to write about scenario-based questions, questions for audience response systems, and culturally-relevant case questions. You can read papers on those topics at the [Work-Learning Research catalog](#) (all for free).

What follows is the original paper, with a few minor improvements.

Summary

This report reviews research on the learning benefits of questions from the preeminent refereed journals on learning, memory, and instruction. The research shows that questions can produce significant learning and performance benefits, potentially improving learning by 150% or more. Although traditionally used in quizzes, tests, and exams as mechanisms for assessment, questions make their most profound contributions when they are designed specifically to produce learning.

Well-designed questions are particularly effective because they (1) provide learners with practice retrieving information from memory, (2) give learners feedback about their misconceptions, (3) focus learners' attention on the most important learning material, and (4) repeat core concepts, giving learners a second chance to learn, relearn, or reinforce what they previously learned or tried to learn.

Questions have beneficial effects whether they are presented before or after their associated learning material. Prequestions focus learners' attention toward the queried concepts during learning, while postquestions provide retrieval practice and feedback on information that has already been learned. Both prequestions and postquestions provide the substantial benefits of repetition.

Questions are most effective when they are relevant to the learner. Irrelevant questions can actually hurt learning and performance by creating tangential memory structures and distracting learners from important concepts. Postquestions produce their most important results when they prompt learners to retrieve information from memory in the same way they will retrieve that information later in their performance situations (on the job, on tests, during learning and practice). Questions that focus on higher-order information—in contrast to minutiae and trivia—are more powerful in producing learning. Questions have specific, not general, effects on the information that is queried, so a question should be created for each important concept. Questions can motivate learners to engage in learning activities despite their tendency to overestimate their ability to remember.

The empirical evidence is overwhelming. Questions are one of the most powerful tools for building learning environments and promoting successful performance. For optimal results, questions must be designed specifically to support human learning. This report illuminates the intersection of human cognition and question design, providing both a practical understanding of questioning and a hard-edged research review of the learning benefits of questions.

How This Research Report Is Organized

The first part of the report describes the findings in a concise and readable format. A checklist that outlines how questions should be used appears at the end of this first section. The second part of the report provides questions to reinforce and enrich your learning. These questions are highly recommended. The third part of the report presents extensive research support and background information. The 90 research articles cited in the report are listed at the end.

More Than Just Assessments

When we think of questions, we often think of quizzes, tests, and exams. Questions used in assessments enable us to measure learning, evaluate instructional methods, and hold learners accountable for their efforts. They may also encourage learners to take notes during instruction and study them afterwards. Seeing questions only as fodder for assessments pushes us away from their most important use—as powerful mechanisms to improve learning.

Because questions used in assessments are designed to evaluate competence and not improve learning per se, their learning benefits are sometimes lacking. A question's design determines the cognitive effect it will have on learners, and it is this cognitive effect that produces memory and performance results. Designing questions specifically to improve learning is the best way to maximize learning outcomes.

Understanding Human Learning

To be effective, instructional designs have to support the human learning system, not work against it. Just as an automobile enables us to travel in comfort if and only if we put gas in the tank—not water, beer, or maple syrup—the machinery of learning affords us with improved learning and performance if and only if we create instructional designs that work within its parameters. To begin our exploration of questions, we must first understand how they produce their effects on human learning.

The goal of all learning interventions is to prepare learners to retrieve information from memory. Some learners need to perform on the job, requiring them to recall what they've learned and put it into practice. Some learners need to retrieve information from memory to be creative or innovative. Others simply need to retrieve information to pass a test, feel confident, or impress those around them.

The ability to retrieve information is a function of both learning and forgetting. We want to maximize learning and minimize forgetting.

$$\text{Retrieval} = \text{Learning} - \text{Forgetting}$$

We must also learn information in such a way that it is easily accessible from memory. Accessibility of learned information depends upon many things, including (1) how recently the learned information was thought about, (2) how often it has been thought about, (3) its level of emotional importance, and (4) the similarity between the learning and retrieval contexts.

These are important considerations because they hint at the complexity of human learning and warn us against simplistic nostrums. We must be aware of these considerations when we create questions and schedule their use.

Different Types of Questions Have Different Effects

Questions can come either before or after the information for which they are relevant. They can be delivered one at a time or simultaneously. When we mass questions together before learning, we can call them “prequestions.” When we mass them after learning, we can call them postquestions (or quizzes, tests, and exams). When questions are used during learning events, we can call them “inserted prequestions” or “inserted postquestions.”

Whether they are inserted or not, prequestions tend to produce one set of effects while postquestions tend to produce a different set of effects. Prequestions help learners to focus their attention on the targeted information when they encounter it later.

Postquestions provide learners with practice in retrieving information from memory. They also can be used to provide learners with feedback.

Both prequestions and postquestions provide repetition of the learning material and motivation for study. They also guide learner attention to the type of material queried by the questions. Table 1 on the next page outlines the benefits and limitations of both types of questions.

Taking a Look at Each Type of Question Effect

After Table 1, we will examine each type of question effect. We will then add up the percentage learning improvements to estimate the total impact of well-designed questions.

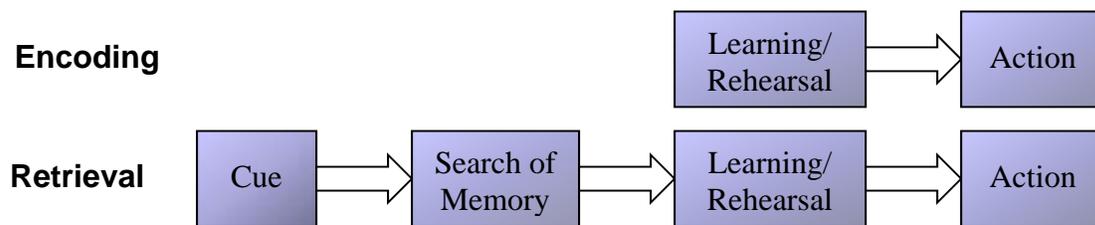
Table 1

| | Prequestions | Postquestions | Both Types of Questions |
|-------------|--|--|--|
| Benefits | <p>FOCUS ATTENTION Helps learners focus attention on the learning material targeted by the questions.</p> | <p>RETRIEVAL PRACTICE Provides learners with practice retrieving the question-relevant information from memory.</p> <p>FEEDBACK Provides learners with feedback to correct their misconceptions.</p> | <p>REPETITION Provides repetition of learning material.</p> <p>FOCUS ATTENTION Helps learners focus on the kind of learning material targeted by the questions.</p> <p>MOTIVATION TO STUDY Provides learners with information about their ability to retrieve information, which may motivate them to engage in additional learning activities.</p> |
| Limitations | <p>Takes learner attention away from learning material not targeted by the questions.</p> | <p>Benefits of retrieval practice are greater if learners correctly answer most of the questions.</p> <p>Feedback must be effectively delivered.</p> | <p>Learning is improved only if learners pay attention to the questions and attempt to answer them.</p> |

Retrieval Practice

If retrieval is what we want learners to do with their learning, it makes sense to give them practice doing it. The research is very clear about the benefits of retrieval practice. It has been shown to improve learning by 30 to 100%, and it is especially good at limiting the ravages of forgetting.

Most people don't think about the retrieval-practice benefits of testing. Indeed, the whole concept may seem bizarre. For this reason, I'm going to take some time to describe how it works. Retrieval differs from the encoding stage of learning.¹ In the diagram below, note how the encoding process is missing the cue and memory-search processes.



When we learn something we are basically connecting two or more concepts in memory. Research psychologists call this encoding. When we learn that “occlude” means “to block,” we encode this connection and create it in memory. Rehearsal is similar because it reconfirms the connection between concepts. A simple learning experience may proceed as follows: (1) we learn that “occlude is a synonym for the verb to block or obstruct,” (2) we rehearse this connection, mentally vocalizing the words “occlude means to block,” (3) we take action by saying out loud “occlude means to block or obstruct.”

Retrieval occurs when a cue triggers a search of memory. Cues can be either external stimuli (like a question or situation) or internal stimuli (like a thought, idea, or insight). Suppose we teach plumbers to use a torque wrench to tighten ceramic valves. In essence, we want to prepare their memory system to use ceramic valves as a cue to trigger a search of memory and to prompt them to use the torque wrench properly.

Questions work in a similar way. They act as cues to trigger memory searches, and ultimately, recall of the appropriate thoughts and answers. When we ask, “Why was it possible for President Nixon to go to China when earlier U. S. presidents were unable to overcome political opposition to such a move?” we prompt learners to search their memory for information about Nixon, China, and political brinksmanship. When we ask, “What does occlude mean?” we prompt learners to search for the word “occlude” and its connection to the concept “to block.”

¹ In the diagram above, “Learning” in “Learning/Rehearsal” refers to the process by which learners understand and/or think about the concepts being taught. “Learning” can be broader than this, of course.

Many people find it helpful when I use a forest metaphor to explain retrieval practice. Imagine your memory as a deep dark forest, where each tree represents some piece of knowledge. There are millions of trees in the forest of your memory. Searching through this forest is a daunting task. You have to slog through dense undergrowth to find the information. Once you've found it however, you've tramped down the undergrowth enough to mark your way. If you should have to search for that information again, you'll be better able to follow the path. In fact, the more you travel the same route through memory, the more defined the path becomes. We're aiming for a paved road. This is especially valuable because time enables the undergrowth to reinvigorate itself, which may obscure the path to that information—and lead to forgetting.

What does this metaphor tell us about retrieval practice?

1. Retrieval practice helps prevent forgetting.
2. Retrieval practice is a valuable adjunct to encoding because it provides something encoding cannot—memory searching.
3. Retrieval practice is only valuable if it follows useful routes through memory. For practical purposes, this means that we as the question developers must ask the right questions and learners must have enough information to make successful searches of memory.
4. More retrieval practice is better than less retrieval practice.

Feedback

When learners are prompted to retrieve information, they will sometimes retrieve the wrong information or take the wrong action. In these cases, feedback can help learners overcome their misconceptions. Research has demonstrated that, if used appropriately, feedback can improve learning results by 15 to 50%.

To produce maximum benefits, feedback should generally be brief, providing just enough information for the learners to understand their mistakes. However, if the learning material is complex or if learners are performing poorly, more extensive feedback may be warranted. Feedback that is too extensive or that is provided unnecessarily for correct answers may irritate learners and prompt them to turn away from beneficial feedback. If feedback can be delayed somewhat rather than given immediately, it can produce additional learning gains of 10 to 25%, especially for information that needs to be remembered over time. Finally, after feedback for an incorrect response, learners who are given follow-up questions on the same learning point gain an opportunity to practice the correct retrieval route through memory.

Focus Attention

Prequestions help learners to focus on the information targeted by the questions. For example, if before an e-learning program begins we ask learners the question, “What is the synonym for the word occlude?” they’ll be more likely to pay close attention when “occlude” is used in the program. Research shows that prequestions delivered in mass before learning are likely to improve learning results by 5 to 40% on the targeted information. Inserted prequestions may produce even greater effects because learners are less likely to forget them before they encounter the targeted information.

Prequestions are two-edged swords. They help learners to focus on the information targeted by questions, but they also take attention away from the information not targeted and lessen learning of that information. Because of this, it is critical that prequestions target the most important information in the learning material.

Both prequestions and postquestions have a more general focusing effect. Over time, learners figure out which information is most valuable for them to focus on. If quizzes in a history class always have questions about the dates of events, learners quickly learn to focus their limited attention on dates. If a simulation prompts management trainees to answer questions about how to deal with their direct reports, learners will gradually come to focus on these interactions.

Like the specific focusing effect, this general focusing effect can also prompt learners to deemphasize learning material that may be important. Learners in our history class may learn that the Battle of Hastings took place in 1066 but forget the importance of the battle to English history. Our management trainees may learn to focus only on their direct reports but forget the importance of their peers and their bosses. Questions should be written to prompt learners to pay attention to high-priority information, and more generally, to the kind of information that is recurrently important for them to learn.

Repetition

Repetition is arguably the most important learning factor, typically improving performance by 30 to 110% for initial repetitions and by 15 to 45% for additional repetitions. Questions prompt at least one repetition of a learning point. If a lecture teaches expectant parents that colostrum is the substance that breastfeeding newborns receive from the mother during the first few days of life, a subsequent question about colostrum provides a repetition of that concept. Prequestions can also provide repetitions, especially if they are delivered with feedback. First we give learners a prequestion, then we give them feedback on their answer, then we give them material relevant to that prequestion. Of course, providing several questions on one learning point provides multiple repetitions.

Questions not only provide repetitions, they also space those repetitions over time. Spacing has been shown to improve long-term retrieval by 5 to 40% or more. Spacing occurs because there is a natural delay between questions and their targeted information, regardless of whether the question comes before or after the targeted information.

To optimize learning, repetitions must be meaningful. Rote repetitions were once used to help learners memorize information. These mindless repetitions were rightly criticized for their simplistic content and for the general boredom they instilled in learners. If repetitions cover meaningful concepts and are delivered in a spaced manner, learners will use them productively to improve their learning. Verbatim repetitions of questions are acceptable after a long delay, but in general it's better to vary the questions somewhat. In other words, to cover the same learning point, it's best to create repeated questions that utilize different background scenarios, answer choices, and/or formats.

Motivation to Study

Instructors have always depended on graded tests to motivate their students to study notes and engage in other learning activities. Although sometimes helpful, this use of questions is a weak substitute for the other opportunities that questions offer. Learners may study for tests, but they typically use poor learning strategies, preparing only as the test approaches and only with the purpose of regurgitating the material. In workplace settings, learners do not typically study for training programs, though they have been known to prepare vigorously for credentialing exams.

Despite these caveats, questions may sometimes serve the purpose of encouraging learners to spend more time engaged in learning activities, whether these involve studying, reading, discussing, or practicing. This function is vital because learners are often overly optimistic about what they will be able to remember. This can cause them to skim learning materials, forgo practice exercises, and avoid repetitions. Questions can provide learners with a reality check on their ability to retrieve information. Those that learners see as meaningful, realistic, and job-related are particularly effective.

Rough Estimates of Percentage Improvements

We have looked at the ways that questions improve learning and have seen that each can provide learning improvements. Table 2 on the following page depicts these improvements in percentages. These ranges are not firm predictions but are provided to help you put the power of questions into perspective. Actual improvements depend on the type of learning material, the way it is delivered, the characteristics of the learners, and many other variables.

Table 2

| Learning Factor | Representative Minimum Improvements | Representative Maximum Improvements |
|--|--|-------------------------------------|
| Retrieval Practice Retrieval practice—even without feedback—has been found to improve learning results. | 30% | 100% |
| Feedback Feedback produces better learning results than no feedback. ² | 15% | 50% |
| Focus Attention Prequestions and learning objectives produce similar effects and improve learning outcomes when presented before learning material. ³ | 5% | 45% |
| Repetition When meaningful repetitions of learning material are provided, learning results are better than if no repetitions or fewer repetitions are provided. ^{4 5} | 30% | 110% |
| Motivation to Study Tests and other forms of examination are generally considered to motivate studying. ⁶ | Percentages Not Known | Percentages Not Known |
| TOTAL IMPROVEMENTS | 40% (a) | 150% (b) |
| | <i>a, b = to be conservative, the totals are divided by 2.</i> | |

² Delayed feedback produces better learning than immediate feedback by 10 to 25%.

³ These numbers represent research on both non-inserted prequestions and learning objectives.

⁴ When initial repetitions are compared to no repetitions, the representative minimum is 30%, and the maximum is 110%. When subsequent repetitions are compared to fewer repetitions, the representative minimum is 15%, and the maximum is 40%.

⁵ Although questions inherently utilize some spacing, this effect may be small because one repetition with minimal spacing may not produce a large result, and certainly not the 5 to 40% improvements typically created by spacing. To be conservative, spacing's improvements are not used in the overall calculation.

⁶ There aren't enough formal research studies on the power of tests to motivate additional learning activities to calculate percentage improvements with certainty. One reason for this is the difficulty in separating the effects of testing from those of grading, at least in the population that is most easily used as experimental subjects (i.e., college students). Although *Motivation to Study* is likely to create benefits, to be conservative, it is not used in the total calculation of percent improvements.

| <h2 style="text-align: center;">How-To-Use-Questions Checklist</h2> | <p style="text-align: center;">Check if complete</p> |
|--|--|
| <p>1. Overall Advice</p> <ul style="list-style-type: none"> a. Ensure that questions are meaningful and are perceived by the learners as relevant to them. Questions should prompt the kind of retrieval behaviors that learners will have to make in their performance situations (for example, on the job, on assessments, in further learning efforts). b. Questions that query higher-level information are generally more effective than questions that focus on details, facts, and other minutiae. Similarly, questions that ask learners to recall information are typically more effective than multiple-choice questions, which are typically more effective than true-false questions. Because recall questions produce logistical difficulties, their use may need to be limited. c. In general, questions have to be read and answered to produce learning benefits. Questions are more likely to be deeply processed when they are meaningful, relevant, interesting, personal, and challenging (but not too challenging). d. If a learning point is important, ask a question about it. | |
| <p>2. Retrieval Practice</p> <ul style="list-style-type: none"> a. Create postquestions that give learners realistic practice with the kinds of problems, skills, and decisions for which they are being prepared. b. Avoid postquestions that prompt learners to retrieve irrelevant or unimportant information from memory. c. Before providing learners with postquestions, ensure that they are provided with enough learning so that they'll be somewhat successful in answering the questions. | |

| | |
|---|--|
| <p>3. Feedback</p> <ul style="list-style-type: none"> a. When learners respond poorly to a question, give them brief, targeted feedback that helps them understand their error. b. Where possible, delay feedback. But don't delay feedback if learners are in danger of practicing incorrectly without it. c. After giving learners feedback for a poor response, give them at least one additional opportunity to practice the correct retrieval route to the learned information. d. Feedback should generally not contain praise for correct answers or handholding for incorrect answers. | |
| <p>4. Focus Attention with Prequestions</p> <ul style="list-style-type: none"> a. Prequestions should be carefully created so that they focus on the most important upcoming learning material. b. Prequestions should be delivered to learners so that they won't be forgotten before the learners encounter the question-relevant information. | |
| <p>5. Repetition</p> <ul style="list-style-type: none"> a. Both prequestions (with feedback) and postquestions can be used as a method of repeating key learning points. b. Repetitions need not be verbatim. In fact, while querying the same learning point as a previous question it is usually better to vary the background scenario of the question. c. Repetitions must be meaningful or learners will ignore them. d. Spaced repetitions are particularly useful in keeping learners motivated and helping them to realize how easy it is to forget. Questions that are delivered to learners with significant delays after the original learning can be particularly effective in motivating learners to engage in learning activities. e. The more repetitions on each of the learning points, the better those points will be learned, up to a point where the marginal improvements are insignificant. | |

Questions for Your Learning Benefit

To use these questions to deepen your learning, answer them completely before looking at the correct answer or reading the feedback. The correct answers are hidden in plain view so that you don't inadvertently look at them. A string of seven capitalized letters are presented after each question—for example, "BCADABC." You will be told which one of those letters represents the correct answer. If the correct answer is "B," the correct answer choice will be highlighted as follows: "Correct choice, Sixth Letter: BCADABC." Note how "B" is the sixth letter of the capitalized letter string.

Question 1.

Which of the following learners will get the benefits of retrieval practice?

- A. The ones who answer questions fully before looking ahead to the answers and feedback.
- B. The ones who read the questions without answering them, look ahead to the correct answers and feedback, and then review the questions again.
- C. Both groups of learners will receive the benefits of retrieval practice.

Don't look ahead to the answer! Stop now!

Correct choice: Second Letter: BACBABC

Answering questions produces retrieval practice, whereas reading them does not. Although all questions act as cues, if learners don't search memory for the correct answer they are not getting the benefits of retrieval practice.

To get the maximum benefits of questions, learners must answer those questions before receiving answers or getting feedback. You too will learn more fully if you make an attempt to answer the questions provided here. Have fun!

Question 2.

Your instructional design team can't decide about the benefits of questions and they ask you for advice. They pose a scenario and ask you to determine which design will produce the best learning. They tell you to note that each design prompts the same amount of learning time. Which of the following designs will promote the best retrieval of the key learning points two weeks after the learning event?

- A. Learners get a one-hour lecture followed by one hour of review on the same material.
- B. Learners get a one-hour lecture followed by one hour of questions and feedback on the same material.
- C. Both designs will produce similar results.

Don't look ahead to the answer! Stop now!

Correct choice: Sixth Letter: BACBABC

Learners who get questions and feedback will do better on subsequent retrieval opportunities than learners who only review the material.

The learners who only get review do not receive the benefits of having to search memory. Performance, whether it involves on-the-job work or test-taking tasks, always requires retrieval. Learners who practice retrieval during learning do better later when they have to perform.

Question 3.

After brilliantly answering your instructional-design team's query, you decide to pose a question to them. You basically ask them the same question they asked you, but you change the second answer choice by removing feedback. What should the answer be now? Which of the following designs will promote the best retrieval of the key learning points two weeks after the learning event?

- A. Learners get a one-hour lecture followed by one hour of review on the same material.
- B. Learners get a one-hour lecture followed by one hour of questions on the same material. Learners do not get to view the correct answers or read any feedback.
- C. Both designs will produce similar results.

Don't look ahead to the answer! Stop now!

Correct choice: Third Letter: ACBCABC

Believe it or not, the answer is still the same! Retrieval practice is so powerful that feedback is not required to make it more effective than a passive review of the learning material.

Whether learners get feedback or not, they still get the benefits of retrieval practice by correctly answering questions. They still respond to cues with searches of memory. The one caveat is the following. Learners must be somewhat proficient in answering the questions to get the benefits of retrieval practice. I'm assuming that with one hour of lecture the learners will do fairly well on the test questions. If the material is very difficult for the learners and most of their retrieval practice attempts are failures, then feedback will be necessary to make this option more effective than review.

Question 4.

You're a high-school teacher and you want to make sure your students remember their geometry concepts so they can do well on their SATs (college qualifying exams), which they'll be taking within six months. You create well-designed quizzes that you administer every Monday, Wednesday, and Friday. Which of the following strategies will improve performance on the geometry-related SAT questions? Circle the letter of each answer choice that you think will produce learning benefits. More than one answer may be correct.

- A. Make the quizzes cumulative, having 30% of the questions come from previous topics.
- B. If more than 40% of your learners get an answer wrong, give the whole class feedback and then ask another question that covers the same learning point.
- C. Provide a significant number of questions on each quiz that ask learners to recall the definition and meaning of critical terminology.
- D. Review key concepts with learners immediately before each quiz.
- E. Give learners the correct answers and feedback a day after, instead of immediately after, each quiz.
- F. Model your questions after actual SAT questions.

No peeking. Answer the question first.

Feedback will be provided for each option on the following page.

Feedback for Question 4

- A. Make the quizzes cumulative, having 30% of the questions come from previous topics.

Cumulative testing is an excellent way to provide both repetition and spacing. It also may encourage additional study of previous material. It has the added advantage of encouraging learners to think about disparate topics at the same time, a prerequisite for creative thinking and insight.

- B. If more than 40% of your learners get an answer wrong, give the whole class feedback and then ask another question that covers the same learning point.

Feedback helps learners to correct their misconceptions, so it will definitely be valuable for those who get answers wrong. It may also be valuable for those who get answers correct but aren't strong in their understanding. Giving learners a second opportunity to make a correct retrieval practice is definitely a good idea. For those who get the answer correct, it's a repetition. For those who get it wrong, it's a second chance to correctly search memory.

- C. Provide a significant number of questions on each quiz that ask learners to recall the definition and meaning of critical terminology.

The SAT requires the ability to use concepts in problem solving. Asking learners about terminology is likely to prompt them to focus their attention on terminology, which will not help them perform well on the SAT.

- D. Review key concepts with learners immediately before each quiz.

While I don't believe that this strategy has been researched, it seems likely that such reviews will improve learner performance on the quiz and thus increase the number of correct retrieval practices.

- E. Give learners the correct answers and feedback a day after, instead of immediately after, each quiz.

Delayed feedback—and spacing in general—is beneficial for long-term retention of learning, which is the case here.

- F. Model your questions after actual SAT questions.

This will aid performance because it increases the relevance of the retrieval practice. Of course, it will also make it less likely that learners will pay attention to learning material that is unrelated to SAT preparation—material that may also be important for these learners to learn and remember.

Question 5.

It is a truism that ideal instructional designs sometimes get in the way of good instructional designs. People who create instruction must always deal with tradeoffs. Sometimes we have to bend designs to fit client requests. We may have logistical concerns—time and cost constraints—that make some designs feasible and others unworkable. Sometimes learners are willing to try new instructional designs; other times they’re not.

Forget about these types of constraints for a moment and think about the design of these questions—the ones you’re answering right now. What could I have done differently to improve your ability to retrieve these concepts and use them in your work over the next several months?

I’ll provide you with some ideas on the following page, but please write your answers below to facilitate your own learning.

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Feedback for Question 5

- ◆ Provide more repetitions.

I managed to cover some learning points more than once (especially retrieval practice, for example), but other key learning points were given only cursory exposure. I could have provided more examples or given you a second or third batch of questions, perhaps even prompting you to access some e-learning to augment the material in this paper.

- ◆ Space learning out more widely in time.

This paper can be read in an about an hour, which is not very wide in terms of spacing. I might have been able to improve your long-term retention if I had encouraged you to wait one day or more before answering the questions or reading the research section.

- ◆ Delay feedback more.

The questions are provided and then feedback is immediately given. I might have improved your learning by encouraging you to wait a day to look at the feedback, or even by providing feedback to you after you'd answered all of the questions.

- ◆ Use prequestions.

Prequestions could have been used to help guide your attention toward the most critical concepts.

- ◆ I could have used inserted questions.

Inserted questions may have helped you focus on the most important material, given you retrieval practice to reinforce key concepts immediately after they were learned, and provided you with corrective feedback if my prose had led you to concoct some inappropriate understandings.

- ◆ Encouraged more recall questions instead of multiple-choice questions.

In our real-world performance situations, the type of retrieval required of us is typically open-ended cued retrieval. In other words, we have to come up with our own options. Multiple-choice questions don't enable us to practice this type of retrieval because they provide options for us.

Question 6.

So you want more recall questions. Okay, how about figuring out what this paper did well in terms of instructional design and the use of questions.

I'll provide you with some ideas on the following page, but please write your answers below to facilitate your own learning.

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Feedback for Question 6

- ◆ Utilize questions that are tied to key learning points.

Questions are beneficial. The questions in this paper have been designed to provide you with correct retrieval practice and corrective feedback. Questions are only valuable if they are tied to the objectives of the learning, give learners retrieval practice, and focus their attention on key concepts.

- ◆ Utilize questions that mirror practical situations.

Questions are more valuable if they focus on useful information and ask learners to retrieve information in a way similar to how they will do it on the job. The questions in this paper were aimed at doing just that, providing situations resembling those in the real world in which these types of issues will surface (for example, instructional design and teaching).

- ◆ Repeat key learning points.

Questions aimed at the key learning points naturally tend to repeat the points that are discussed in the learning material. As discussed previously, more repetitions could have been provided. Note that questions don't have to do all the work of repetition, or any other learning factor. This paper used repetition in many ways—repeating key concepts in the introduction, in tables that mirrored the text, in examples that reinforced previous statements, and in the research section's recap of key points.

- ◆ Space the learning over time.

Even small spacings are better than no spacing. Questions repeat learning points at spaced intervals. Questions 4, 5, and 6, because they deal with several learning points, naturally create spacings between the time that learners answer the question and the time they get feedback on the individual points. The research section repeats learning points after a delay as well.

- ◆ Use questions as prequestions.

The questions act as postquestions for the initial section of the paper and as prequestions for the research section.

- ◆ Provide feedback.

The questions provide feedback to correct your misconceptions. The research section also provides feedback. It's not intended or targeted feedback, but learners could use it as feedback to clarify points from the questions.

Research Background

The remainder of this document will outline the research that supports the arguments already put forth. While the first two sections were written to convey practical information in a concise and readable format, the next part will focus on providing supporting information. This section will not be as easy to read as the previous sections. Nevertheless, for those interested in the research support—or for those who want to enrich their learning with repetitions, reinforcement, and elaborations—this section will be very beneficial to read. You can ignore the citations in parentheses, or you can view the complete citation with its title and source information at the end of the research report.

Questions

Almost all research reviews of questions and testing support their learning benefits (Hamaker, 1986; Richardson, 1985; Dempster, 1997; Dempster & Perkins, 1993; Rickards, 1979; Rothkopf, 1982; Crooks, 1988). Questions have produced learning benefits in both well-controlled laboratory experiments and in situations that realistically mirror long-term retrieval demands (Jones, 1923-1924; Gates, 1917; Spring, Sassenrath, & Ketellapper, 1986; Spitzer, 1939; Nungester & Duchastel, 1982).

Questions Must Be Processed to Produce Benefits

Questions must be read and processed in order to produce beneficial learning effects. Learners don't automatically use the questions that are provided. Learners who are given incentives to answer inserted questions learn more than those who do not receive such incentives (Frase, 1971; Frase, Patrick, & Schumer, 1970). Questions delivered verbally by a teacher produced better learning than the same questions provided in written form (Rothkopf & Bloom, 1970; Rothkopf, 1972), presumably because learners are more motivated to process questions when they are delivered by a person. Learners who have opportunities to peek ahead to answers perform more poorly than learners who are forced to answer the questions before seeing the answers (Anderson, Kulhavy, & Andre, 1971, 1972). Learners will forgo the benefits of retrieval practice if given the chance.

As designers of instruction, we can't just create questions. We have to make sure that learners use them. In addition to methods inspired by the research cited above, it is likely that questions that are meaningful and performance-related will motivate learners to fully process the questions. It may also be helpful to encourage learners to evaluate their responses based on an external criterion (Garner & Alexander, 1981).

Learners Sometimes Need to Be Motivated. Questions Can Help.

Research on learners illustrates that they are poor at predicting their ability to perform well on future tests (Glover, 1989a; Pressley, Snyder, Levin, Murray, & Ghatala, 1987) and, in fact, they are often overconfident in their ability to retrieve information in the future (Bjork, 1994; Ghodsian, Bjork, & Benjamin, 1997).

This inaccurate assessment of their own memory abilities causes many learners to skim learning material instead of processing it thoughtfully. When learners think they know a concept, they turn their attention elsewhere. They stop taking notes, avoid review and repetition opportunities, forgo practice, and generally don't devote enough attention to strengthening their learning and preventing forgetting.

Research has demonstrated that inserted postquestions help learners to calibrate their comprehension of learned materials (Glover, 1989a; Pressley, Snyder, Levin, Murray, & Ghatala, 1987). When learners know they aren't doing well, they're more likely to devote themselves to additional learning activities. Spaced questions may be especially appropriate in this regard because learners are particularly poor at assessing their ability to remember over time. Our cognitive machinery lets us assess our current knowledge, but it doesn't enable us to forecast the various forgetting curves of each piece of knowledge we hold in memory. Although answering questions can't help us predict the future, it can tell us how much we've already forgotten and how much more learning we still have to do.

Questions can also help learners overcome their tendency to engage in learning activities only when the performance situation approaches. (Mawhinney, Bostow, Laws, Blumenfeld, & Hopkins, 1971). When learners cram in this way, they may do well in the short term but forget important information over longer periods.

Finally, questions may be especially useful when large amounts of learning material must be assimilated. Researchers have found that, for many learners, long periods of learning produce decreasing attention to the learning task (Rothkopf, 1982; Surber, 1992). Questions that intervene within these long intervals can help learners to maintain attention and learning (Rothkopf, 1982).

Retrieval Practice Is Better Than Equal Time Spent Reviewing

Many researchers have found that testing people after they have learned something is more effective in improving their later performance than providing additional time to study the material (Nungester & Duchastel, 1982; Hogan & Kintsch, 1971; Cuddy & Jacoby, 1982; Kuo & Hirshman, 1996; Izawa, 1992; Allen, Mahler, & Estes, 1969; Jones, 1923-1924). The one caveat to this is when the performance situation immediately follows the learning situation. Although testing is more effective than additional learning

in generating performance after normal delays (10 minutes or more), additional study time—rather than testing—has been found to create better performance when the performance situation occurs immediately after the learning (Hogan & Kintsch, 1971; Wenger, Thompson, & Bartling, 1980). Of course, for most training and educational situations performance is not immediate, so this finding would not apply. In real life, retrieval practice produces superior performance than additional study and review.

Repetitions of Questions Facilitates Learning

Providing more questions on the same learning point is better than providing fewer questions up to a point of diminishing returns (Boyd, 1973; Izawa, 1992; Allen, Mahler, & Estes, 1969; Modigliani & Hedges, 1987; Glover, 1989b; Bangert-Drowns, Kulik, & Kulik, 1991; Crooks, 1988). Bahrck, Bahrck, Bahrck, and Bahrck (1993) found that learners taking 26 tests with feedback outperformed learners taking 13 tests with feedback, producing 33% more retention on subsequent tests given several years later. Similarly, repeating questions within a single test can improve performance somewhat on later tests (Toppino & Brochin, 1989; Cuddy & Jacoby, 1982). Boyd found that repeating inserted questions (using both a prequestion and a postquestion) improved learning results over single questions by 29%.

Learning Effects of Questions Tend to Be Information-Specific

It may be tempting to see questions as a way to energize learners or to provide them with some sort of general motivation. Although this is partly true, questions tend to produce the greatest learning benefits only for the information targeted by the questions. This applies to prequestions because they prompt learners to focus their attention on the targeted information (Rothkopf, 1966; Frase, 1967). In fact, non-targeted information in the learning material is actually learned more poorly and paid much less attention (Rothkopf & Billington, 1979).

Postquestions have specific effects on information that is queried, not a general facilitative effect on all material that is learned (Runquist, 1983; Carrier & Pashler, 1992; Nungester & Duchastel, 1982). This is true because successfully answered questions get retrieval practice and such practice lays down very specific routes through memory. Inserted postquestions do produce a slight generalized effect as well, prompting learners to focus their subsequent attention on information that is similar in kind to type targeted by the previous questions.

From a practical standpoint, if we want testing to increase the likelihood that a particular piece of information is not forgotten, we must ask a question about that piece of information.

Focusing Effects of Prequestions

Prequestions improve overall learning and work much like learning objectives do when they are presented to learners before learning events (Hamilton, 1985; Klauer, 1984; Rothkopf, 1982; Hamaker, 1986; Anderson & Biddle, 1975). For example, Rothkopf (1966) found that providing inserted prequestions with feedback improved learning by 169% over situations when no prequestions were used and providing prequestions alone improved performance by 129%.

How learners approach new material is affected by previous questions. Learners may change their attention or cognitive processing as they work on the new material, as has been found in the adjunct-question research (e.g., Rickards, 1979; Rothkopf, 1966; Frase, 1967). For example, Rothkopf and Bisbicos (1967) found that certain categories of questions given to learners on previous unrelated material affected what they learned in subsequent learning opportunities. Learners did better on questions about people's names and numerical data when they had previously gotten similar questions on already-read text passages. Similarly, Sagerman and Mayer (1987) found that learners did better on verbatim questions when they had previously gotten verbatim questions and conceptual questions when they had previously gotten conceptual questions⁷.

Questions (without Feedback) Only Provide Benefits When Correct Responses Are Made

Questions without feedback only have an effect for items that are successfully answered (Glover, 1989b; Runquist, 1983; Allen, Mahler, & Estes, 1969; Hogan & Kintsch, 1971; Modigliani, 1976). This makes sense because the benefits of questions without feedback are all due to retrieval practice. If learners practice incorrectly by getting the answer wrong, they don't get retrieval-practice benefits. Of course, most of our tests provide feedback, which benefits incorrect answers.

⁷ This phenomenon can have detrimental effects when we continually test learners on meaningless fragments of facts, figures, and folderol. In training situations, we typically want learners to have broad understandings first and knowledge of facts second. In educational situations, we want learners to learn how to think, observe, test their hypotheses, learn general themes, etc. The preponderance of rote testing only serves to produce people who can remember facts. It's not the people who do well on quiz shows like Jeopardy who produce innovations, create art, and develop provocative ideas; it's the people who use their minds to understand things deeply.

Feedback Creates Better Learning

Researchers who have reviewed research articles on feedback have concluded that feedback was very effective in producing learning benefits (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991). In fact, many investigators have been so sure of feedback's effectiveness that they have simply assumed it improves learning and have gone on to discuss other variables that affect its impact (Kulik & Kulik, 1988; Mory, 1991; Kulhavy, 1977; Kulhavy & Stock, 1989). Bangert-Drowns, Kulik, Kulik, and Morgan (1991) did a meta-analysis of research studies and found that feedback generally aided performance, especially when the studies were methodologically sound.

Studies that have compared giving feedback to not giving feedback generally have found fairly sizable improvements with feedback (Karraker, 1967; Kulhavy & Anderson, 1972; Kulhavy, Yekovich, & Dyer, 1976; Surber & Anderson, 1975; Sturges, 1978; Clariana, Ross, & Morrison, 1991; Webb, Stock, & McCarthy, 1992). Similarly, studies that have compared giving corrective feedback (giving learners the right answer) to giving only feedback about whether an answer was right or wrong have shown advantages for corrective feedback (Phye, 1991; Phye & Sanders, 1994).

Feedback is most beneficial for incorrect answers. It was once believed that feedback reinforced correct responses, but research has shown that feedback works by correcting errors (Guthrie, 1971; Surber & Anderson, 1975; Peck, van den Bosch, & Kreupeling, 1985). Guthrie (1971) found that feedback had almost no effect on correct answers but that it produced a whopping 474% improvement when provided for incorrect answers. These results show that the more difficult the material—that is, the more questions that are answered incorrectly—the more it is critical to use feedback to correct errors.

Spaced Repetitions Are Better

Repetitions of questions that are spaced apart are more effective than those that are massed together (Whitten & Bjork, 1977; Izawa, 1992; Glover, 1989b; Modigliani, 1978; Bahrack, Bahrack, Bahrack, & Bahrack, 1993; Shebilske, Goettl, Corrington, & Day, 1999; Bahrack, 1979). For example, Bahrack, Bahrack, Bahrack, and Bahrack (1993) showed that spacings of 56 days outperformed spacings of 28 days, which in turn outperformed spacings of 14 days. Glover (1989b) found that repeating a test spaced by one day produced significantly higher retention than repeating a test immediately.

Delayed feedback, a form of spacing, is better than immediate feedback (Sassenrath & Yonge, 1968, 1969; English & Kinzer, 1966; More, 1969; Sturges, 1969, 1972; Phye & Andre, 1989). Sassenrath and Yonge (1968) gave learners a test immediately after giving them feedback, followed by a second test 24 hours later. On the immediate test, learners who got delayed feedback performed the same as learners who got immediate feedback.

However, on the more important and realistic delayed test, learners who got delayed feedback performed better than those who got immediate feedback.

Some Questions Are Better Than Others

In general, asking people to recall information (for example with essay or short-answer tests) is better than giving them recognition questions (such as multiple-choice or true-false questions) (Glover, 1989b; Runquist, 1983). Learners who expect an essay test or another recall test tend to outperform those who expect a multiple-choice or another recognition test on both recall and recognition tests (Meyer, 1934, 1935; Neely & Balota, 1981; Foos & Clark, 1983; Schmidt, 1983; d' Ydewalle, Swerts, & De Corte, 1983; Foos & Fisher, 1988). These advantages have to be weighed against logistical and cost concerns. Recall questions are easier to create, but the answers they generate are more difficult to evaluate. Moreover, it is much harder to provide feedback for recall questions than for recognition questions, and automatic branching to augmenting learning material is almost impossible.

Research on inserted postquestions has shown that higher-level questions promote better learning than lower-level questions. When adjunct questions are added to text, questions about higher-order information rather than those about specific details promote performance that is more flexible and transferable to different performance situations (Hamaker, 1986; Andre, 1979). In some studies, higher-level adjunct questions promoted better retention of higher-level information and equal retention of lower-level information (Andre & Thieman, 1988; Sagerman & Mayer, 1987; Watts & Anderson, 1971). These results are consistent with the finding that learners who think more deeply about information will remember more and perform better (Craik & Lockhart, 1972). When we use questions that prompt deeper thinking, we decrease the likelihood of forgetting.

Inserted Postquestions Promote Learning

Questions provided within learning events (questions presented to learners very soon after the information being targeted) can facilitate learning. In what has come to be known as the adjunct-question research, Rothkopf (1965, 1966), Frase (1967), Rothkopf and Bisbicos (1967), and others found that adjunct postquestions improved retention on question-relevant information presented in text passages much more than when learners read the text passages normally. For reviews of this literature, see Hamaker (1986), Hamilton (1985), Rickards (1979), Rothkopf (1982), Anderson and Biddle (1975), Faw and Waller (1976), and Andre (1979). Using a similar learning mechanism, questions presented to learners after lecture segments have also been shown to aid learning (Gall, Ward, Berliner, Cahen, Winne, Elashoff, & Stanton, 1978), as have “self-assessment questions” presented to learners as they listened to audiotaped prose (Parkin, Wood, & Aldrich, 1988).

Learning More

For those with a research background, the citations listed on the following page are an excellent place to learn more about the inner workings of questions.

For practical information on how to create questions that are meaningful and realistic, see the Work-Learning Research catalog for additional in-depth articles on question-writing and other learning-related topics.

www.work-learning.com/catalog.html

For general research-based information about learning and performance, or for instructions on how to sign up for a monthly electronic newsletter focusing on learning-and-performance research, visit the Work-Learning Research website at:

www.work-learning.com

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