

The Prequestion Effect: Why It Is Useful to Ask Students Questions Before They Learn

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Introduction and Overview

Research in cognitive science has brought to light a number of findings that can enhance education. In particular, studies have revealed specific techniques that significantly enhance students' learning in a number of domains. These techniques can be implemented in a variety of course settings, making them useful tools that students and teachers can incorporate into many different types of lessons.

One of the most powerful techniques for enhancing learning is to ask students questions about what they are learning. After students are introduced to some new information—for example, through a class lesson or reading assignment—their learning of that information is significantly boosted by answering questions that require them to retrieve the information. In one study, when sixth grade students reviewed information from their social studies lessons by either completing short practice quizzes or by simply rereading the information from the lessons, they scored significantly higher on later exams when they had reviewed through quizzing (Roediger et al., 2011, Experiment 2). The benefits of *retrieval practice* have been demonstrated in numerous other studies (see Yang et al., this volume), showcasing a simple but highly effective technique for improving learning and retention.

It makes sense to give students practice questions after they have encountered a lesson. What about giving students questions *before* a lesson? This could be a useful approach for teachers to determine what students already know about a topic, which can help them plan lessons accordingly. A less well-known fact, however, is that these questions can actually enhance learning of the lesson that follows. Even if students have not yet learned the information and are merely guessing the answers, engaging with these *prequestions* enables them to better learn the information from a later lesson that is relevant to those questions.

In the following sections, we review the research findings on prequestions and their implications for education. We begin with an overview of the typical approach to studying prequestions. We then include a discussion of the research findings illustrating ways in which prequestions can benefit learning, and why these benefits occur. We conclude with recommendations for teachers about how they can use prequestions in their courses to boost student learning.

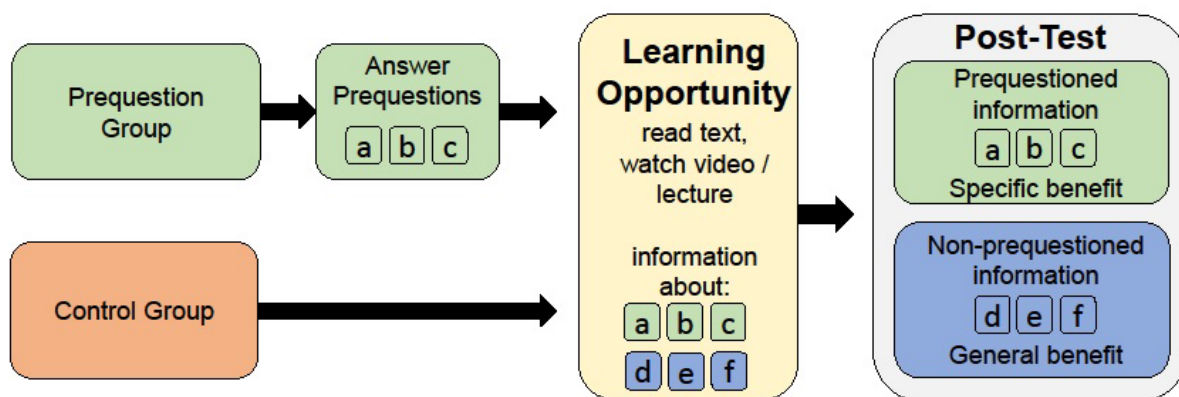
“Pretrieval Practice”: The Benefits of Pquestions

Figure 1 illustrates the design of a typical study on prequestions. Here students are given a learning opportunity in the form of a reading assignment, video, or class lecture. Prior to that learning opportunity, students are given questions on information that will appear in the upcoming reading, video, or lecture. Even if they do not know the answers because they have not yet learned the material,

students are encouraged to offer their best attempt at answering the questions. A group of students that answers prequestions (the Prequestion Group) is most often compared to a group that does not answer prequestions and does not receive any other kind of preview of the lesson (the Control Group). Corrective feedback is typically not provided at the time of the prequestions, but instead students in the Prequestion Group proceed with the learning opportunity right after answering the prequestions.

Figure 1

Overview of the Design of a Typical Study on Pquestions.



After the learning opportunity, students are given a post-test to assess what they have learned. For the Control Group, none of these post-test questions have been seen before. For the Prequestion Group, some of the questions have been seen before as prequestions (a, b, and c), and some of the questions have not been seen before (d, e, and f). For the Prequestion Group, this permits a comparison of post-test performance for “prequestioned information” (information from the lesson that was directly addressed ahead of time in the prequestions) versus “non-pquestioned information” (information from the lesson that was not addressed in the prequestions). For the Control Group, because there were no prequestions, all of the post-test questions naturally represent non-pquestioned information.

In a prequestion study, three key comparisons are typically made. First, what is the overall score on the post-test for the Prequestion Group compared to the Control Group? This gives us an idea of the overall benefit of prequestions for enhancing learning. Second, what is the Prequestion Group’s score on the post-test specifically for prequestioned information, compared to the Control Group’s overall post-test score on the entire set of questions? This gives us a closer look at the benefits of prequestions by focusing on learning of the information from the lesson that was specifically addressed in the prequestions. If prequestions enhance learning of information that was specifically addressed in those prequestions, this can be referred to as the “specific benefit” of prequestions. Finally, what is the Prequestion Group’s score on the post-test for non-pquestioned information, compared to the Control Group’s overall post-test score on the entire set of questions? This gives us an idea of whether the benefits of prequestions generalize to information from the lesson that was not addressed in the prequestions. As such, this can be referred to as the “general benefit” of prequestions. As described below, the research on prequestions sometimes shows specific benefits, sometimes general benefits, and sometimes both.

Research on Prequestions

Learning From Reading Materials

Some of the earliest research on prequestions explored their effects on learning and comprehension of reading material. These studies found that prequestions often lead to a specific learning benefit. For example, in a study conducted by Pressley et al. (1990), students were instructed to read a 30-page chapter on adult development in the family. Before reading the chapter, students were assigned to either answer prequestions, read prequestions without trying to answer them, or to a control group in which they received the chapter but did not receive any prequestions. On the post-test, students who answered prequestions performed significantly better than the other two groups. However, this benefit was specific to the prequestioned information. There were no differences in post-test scores between the three groups for the non-prequestioned information. Further, there were no differences in post-test scores between the control group and the group that simply read the prequestions without attempting to answer them. This suggests that attempting to answer the prequestions is a critical ingredient for producing the learning benefits of prequestions.

Richland et al. (2009) also investigated the effects of prequestions on comprehension and retention of reading material. Students in this study were instructed to read a two-page text passage about the visual system. The prequestion group received questions about the text before reading, and the control group did not receive prequestions but instead received extra time to read the text. Through a series of five experiments, the prequestioned group consistently outperformed the control group on the post-test. Similar to the findings of Pressley et. al (1990), the students who received prequestions showed a specific learning benefit for the prequestioned information but did not show a general learning benefit for the non-prequestioned information. The specific benefit of prequestions occurred when the post-test was given immediately after reading the passage (Experiments 1-3, 5), and also when the post-test was given one week after reading the passage (Experiment 4).

Many additional recent studies have explored the effects of prequestions on learning reading material (Hausman & Rhodes, 2018; James & Storm, 2019 see Experiments 1-4; Pan & Sana, 2021). The majority of these studies show that prequestions produce specific benefits on learning of prequestioned information; however, a few studies also show that prequestions produce general benefits on non-prequestioned information as well (e.g., Pan & Sana, 2021). Although the majority of studies on prequestions have examined learning from reading material, this area is only a subset, with recent work also exploring the effects of prequestions on other learning materials such as videos and class lectures.

Learning From Video Materials

Prequisions can benefit learning of information from video-based materials as well. Carpenter and Toftness (2017) had students view a brief video presentation on the history of Easter Island. The prequestion group answered two prequestions prior to each of three segments of the video, whereas the control group viewed the same video segments without answering any prequestions. On the post-test right after the video, the prequestion group significantly outperformed the control group, showing the usual overall advantage of prequestions. The advantage of the prequestion group was particularly strong for prequestioned information but was also present (albeit less so) for non-prequestioned information. Thus, this study demonstrated both specific and general benefits of prequestions on learning from short videos.

Along similar lines, James and Storm (2019, Experiment 5) had students view brief educational videos about ancient life on earth. Students answered prequestions before viewing some of the videos, and other videos they simply viewed without answering any prequestions first. A post-test over all of the

videos revealed a significant specific benefit of prequestions, but no general benefit. Pan et al. (2020) had students view an online video-recorded lecture on signal detection theory in which some students answered prequestions beforehand and other students did not. Answering prequestions led to a significant overall benefit on the post-test. In addition, answering prequestions produced a specific benefit on the learning of prequestioned information, as well as a general benefit (although smaller than the specific benefit) on non-prequestioned information.

Other studies have found that prequestions significantly benefit students' learning of information from video-recorded lectures about psychology concepts (Toftness et al., 2018) and information theory (St. Hilaire & Carpenter, 2020). The specific benefits of prequestions consistently occurred across these studies, and the general benefits sometimes occurred but were less consistent than the specific benefits.

Classroom-Based Research

Studies conducted in real classrooms suggest that prequestions can be an effective tool for boosting students' learning of their course information. In one of the earliest classroom studies, Swenson and Kulhavy (1974) had fifth- and sixth-grade students read a text about the history and culture of Ako. Some students answered prequestions before reading sections of the text, and other students simply read the text without answering any prequestions. On a post-test given both immediately and one week later, students who answered prequestions significantly outperformed students who simply read the text. Answering prequestions produced a strong specific benefit on prequestioned information, but no general benefit on non-prequestioned information.

More recently, Carpenter et al. (2018) explored the effects of prequestions in an undergraduate psychology course. Some students answered prequestions immediately before each day's lesson, and other students did not. At the end of each day's lesson, all students completed a post-test over the information from that lesson. A specific benefit of prequestions occurred in that students who answered prequestions scored higher on the post-test over prequestioned information. However, no general benefit of prequestions occurred. That is, answering prequestions at the beginning of class did not boost learning of non-prequestioned information, relative to a control group of students who received the same lesson but did not answer prequestions beforehand.

Studies conducted in real classrooms can be subject to scheduling constraints and other factors inherent to the course that sometimes affect the comparisons that can be made. For example, some studies incorporated prequestions as part of the normal course routine for all students in a middle school science course (McDaniel et al., 2011) and an undergraduate chemical engineering course (Geller et al., 2017). The lack of a true control group (for whom prequestions were withheld) means that direct comparisons of the effects of prequestions relative to no prequestions are not available from these studies. However, both of these studies showed significant improvements from students' performance on the prequestions (asked at the beginning of class) to the same questions asked again at the end of class or at the end of a lesson unit, as well as to new never-before-seen questions from the same lessons. McDaniel et al. (2011) further explored the frequency of practice questions over the course of an entire academic term, and they found that the more often students encountered a practice question over a given concept (e.g., as a prequestion before class, then again as a question at the end of the unit, then again later as a practice question on a review for the exam, etc.), the better students learned that particular concept.

de Lima and Jaeger (2020) explored the specific benefits of prequestions on fourth- and fifth-grade students' learning of a science text passage about rockets. Students first read the text with some of the information omitted that they had to fill in (e.g., "A revolutionary e_____ has been developed"), and

other information intact (e.g., “The Americans sent a rocket called Apollo 11 to the moon”). Afterward they read the same text again with all of the information intact (including the earlier phrase that they had to fill in, “A revolutionary engine has been developed”). On a post-test a week later, students scored significantly higher for the information that they originally had to fill in, compared to the intact information that they simply read twice. Filling in the omitted information also led students to be more confident in their learning at the time of the post-test. Although this study does not include measures of the general benefit of prequestions (due to the fact that all students learned the text passage using both approaches), it demonstrates the specific benefits of using a method that is well-suited for young students and appears to increase confidence in learning as well.

In summary, the research on prequestions shows consistent and reliable specific benefits on learning. Most often, prequestions enhance learning of the information that is directly addressed in the prequestions. Some studies show that prequestions can also produce more general benefits on the learning of non-prequestioned information, but this finding is less consistent. There does not appear to be any detriment to using prequestions.

Why Do Prequestions Benefit Learning?

One proposition is that prequestions are beneficial because they increase students’ engagement with the learning material. When students receive questions prior to a learning opportunity, those questions might pique their interest in the information they are about to learn. Students may, as a result, invest more attention in the learning material and in finding out the answers to the prequestions.

Indeed, a common challenge encountered by students is the need to sustain attention to a learning task. Even inadvertently, attention often shifts to other things while reading or viewing a lecture. This tendency is ever-present, with some studies estimating that about one third to one half of students experience mind wandering during a lecture (Lindquist & McLean, 2011). Fortunately, there is evidence that prequestions can help with this. One recent study found that students who received prequestions before a video lecture (compared to students who did not receive prequestions) reported lower rates of mind wandering during the lecture, and less mind wandering led to significantly better learning of the lecture material (Pan et al., 2020).

One study used eye-tracking technology to explore where students focus their attention in a reading passage after receiving prequestions. Lewis and Mensink (2012) had students read a text about humanitarian efforts of the Gates Foundation. One group received prequestions before reading (e.g., “What causes Tuberculosis to spread through the air?”), and the other group simply read the passage without seeing any prequestions beforehand. While reading, the eye movements of each student were recorded using a head-mounted eye-tracking device. Students’ eye movements revealed a specific pattern in which students who received prequestions (compared to students who did not) focused their attention more on the prequestioned information in the reading. That is, if students received prequestions before reading, they spent a longer amount of time re-reading parts of sentences that were directly relevant to those prequestions (e.g., “Tuberculosis is spread through the air when people who have the disease cough, sneeze, or spit”), and they also spent a longer amount of time looking back to these relevant sentences after they had moved on to the subsequent parts of the reading passage. However, for sentences in the reading that were not directly relevant to the prequestions, no differences in re-reading time occurred for students who received prequestions compared to students who did not. On an essay test in which students were asked to recall everything they could remember from the reading passage, the group that received prequestions recalled about twice as much of the prequestioned information as the control group, but they did not recall more of the non-prequestioned

information. Thus, the specific benefits of prequestions occurred (but not the general benefits), and these specific benefits appear to be linked with where students focused their attention during reading.

Using a different approach, St. Hilaire and Carpenter (2020) also explored the role of attention in learning from prequestions. Before viewing a video lecture on information theory, one group of students was given prequestions and the other group was not. All students were then asked to take notes during the video over any information that they felt would be important to learn. If students had received prequestions, they were significantly more likely to write down prequestioned information in their notes while viewing the video—that is, information from the video that was relevant to answering the prequestions—but they were not more likely to write down non-prequestioned information. Performance on the post-test revealed a specific benefit of prequestions, such that students who received prequestions outperformed students who did not, but only on the prequestioned information and not on the non-prequestioned information. Furthermore, the advantage of the prequestion group over the control group only occurred when students successfully included the prequestioned information in their notes. If students who received prequestions happened to not include in their notes a piece of information from the video that was relevant to a prequestion, they did not remember this particular piece of information any better than the control group on the post-test. Thus, prequestions increase the chances that students will notice the prequestioned information, but not to a perfect degree. As in all learning experiences, some information might fall outside the window of attention, and if it does, this information would not be learned as well as information that receives full attention.

Thus, prequestions likely benefit learning through focusing students' attention to parts of the learning material that are directly relevant to those prequestions. This focused attention appears to coincide directly with later memory, in that the prequestioned information that is made more noticeable is also more successfully remembered later on. Such a pattern likely explains the common tendency for prequestions to have specific benefits, but not always general benefits, on learning. Future research should explore additional ways that prequestions might benefit learning, such as the potential impact of prequestions on students' motivation and goals.

What Kind of Benefits Can Be Expected from Prequestions?

Prequestions work best for enhancing learning of information that is directly presented during a learning opportunity. Given that prequestions help students focus attention on prequestioned information, it is important that the prequestioned information be clearly noticeable so that students can attend to it and readily see the relevance of this information for answering the prequestions. Thus, prequestions are likely best suited for learning facts and concepts that are explicitly stated in a lesson, rather than information that is not stated but must be inferred.

Indeed, one study found that prequestions did not benefit learning when the prequestions required students to use the information in a reading passage to infer answers that were not directly stated. Hausman and Rhodes (2018) had students read a text passage about glaciers, either receiving prequestions beforehand or not. Factual prequestions were those for which the answers were directly stated in the reading (e.g., "How much of the earth is covered by glaciers during an ice age?"), whereas conceptual prequestions were those for which the answers were not directly stated (e.g., "What is a consequence of higher levels of carbon dioxide in the atmosphere?") but could be inferred from various other information that was stated throughout the text. For example, the text directly stated that higher levels of carbon dioxide led to warmer temperatures and that cooler temperatures lead to lower sea levels due to the formation of glaciers that hold frozen water. Together this information could be used to infer the answer that higher sea levels are a consequence of higher levels of carbon dioxide in the atmosphere. On a post-test given after the reading, the students who received factual prequestions

showed the usual specific benefit of prequestions, in that they scored significantly higher than the control group on prequestioned information but not on non-prequestioned information. In contrast, the students who received conceptual prequestions showed no advantage at all over the control group.

Thus, prequestions are beneficial when applied to material in the lesson that can be directly noticed by students. As we have seen, these benefits often tend to be specific to the prequestioned information. However, under some circumstances prequestions can produce general benefits as well. Little and Bjork (2016) had students read a text about geysers, either receiving multiple-choice prequestions ahead of time (e.g., “What is the tallest geyser in Yellowstone National Park? (a) Old Faithful, (b) Steamboat Geyser, (c) Castle Geyser, (d) Daisy Geyser”) or no prequestions. Although only one answer is correct (Steamboat), information about each of the other geysers was included in the reading as well. Post-test performance showed that students who received prequestions (compared to the control group) not only performed better on those same questions again, but they also performed better on never-before-seen questions about the other geysers (e.g., a question about Castle Geyser or Daisy Geyser). By requiring students to consider each answer option during the reading, these multiple-choice prequestions served to enhance attention not only to the specific correct answer in the prequestion, but to the other answer options as well, resulting in both specific and general benefits. Along similar lines, St. Hilaire et al. (2019) found both specific and general benefits of prequestions when the prequestions were designed to enhance attention to multiple parts of a reading passage about brakes (e.g., “What is the primary difference between mechanical brakes and hydraulic brakes?”), compared to prequestions that targeted a more isolated fact within the reading (e.g., “What type of machine relies on caliper brakes?”). If prequestions are designed in a way that encourages students to focus their attention beyond the prequestioned information, then they can produce both specific and general benefits.

Prequestions can be applied to a variety of learning situations. They can benefit students’ learning of reading material, video presentations, and class lectures. Studies exploring prequestions have also utilized diverse learning material, including readings or lectures over scientific topics (de Lima & Jaeger, 2020; Hausman & Rhodes, 2018; McDaniel et al., 2011; Richland et al., 2009), history (Carpenter & Toftness, 2017; James & Storm, 2019), geography (Little & Bjork, 2016), signal detection theory (Pan et al., 2020; Toftness et al., 2018), engineering (Geller et al., 2017), and psychology (Carpenter et al., 2018). The benefits of prequestions occur across educational levels, from elementary school children to college students. Researchers have also observed benefits for different types of prequestions, including multiple-choice, fill-in-the-blank, and short answer. Prequestions are thus a flexible learning tool that can be adapted to a number of different lessons and contexts.

Recommendations for Teachers

Prequestions are a straightforward tool that teachers can utilize in a number of ways. The first step is to create questions over the learning material that is in a given lesson. Such questions can pertain to fairly discrete facts (e.g., “In what year was the U. S. Declaration of Independence drafted?”), or to more complex information (e.g., “How does a neurotransmitter enable communication between neurons?”), so long as the information needed to answer the questions is directly provided in the lesson.

Teachers can then provide these questions to students right before the lesson. Because many students may not have full knowledge of the answers at this point, the prequestions can be used as a low-stakes pre-learning activity that encourages students to think about what the answers to the prequestions may be but does not require them to answer the questions correctly. Knowing that the answers will be provided in the upcoming lesson, students are then prepared to direct their attention to the lesson, and in particular to the information that is relevant to the prequestions. Although no direct feedback of the answers need be provided at the time of the prequestions, teachers may find it useful to re-visit these

questions again at the end of the lesson and provide feedback at that time. This helps ensure that students have fully grasped the concepts and provides an opportunity to resolve any potential confusions or misconceptions.

The most straightforward way to incorporate prequestions likely depends on how a lesson is delivered. For an in-class learning opportunity, prior to immersing in the activities teachers can introduce the topic and present the prequestions at that time. Exactly how the prequestions are presented can vary. For example, teachers could display the prequestions in a presentation, or write them on a whiteboard and ask students to write down their answers. Teachers could also distribute sheets of paper with the prequestions printed on them and ask students to work on these questions at the beginning of class. If resources are available, teachers could also use “clicker” devices to present the prequestions and collect students’ responses electronically.

Other times, a lesson could take the form of a reading assignment or a video that students complete outside of class. In these cases, prequestions could be assigned ahead of time to be completed just prior to the reading assignment or video. If the reading or video is available in an online course management system, teachers could include the prequestions in the form of a short online quiz that students complete before opening the link to the reading or video.

In summary, prequestions can be incorporated as learning activities in a number of different ways. The exact way that prequestions are delivered can be flexible and could include either high-tech options (online quizzes or clicker questions) or low-tech options (on the whiteboard or on paper). Whatever the method that teachers use, “pretrieval” practice is a simple and effective way to engage students in what they are about to learn.

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