Using the Generation Effect to Enhance College Learning Strategies

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ABSTRACT

The generation effect occurs when students recall information successfully due to having played a role in creating, elaborating upon, or personalizing the information when attempting to learn it. This article first explores the characteristics of the generation effect and reviews its connection to learning principles. Then, the focus shifts to applying the generation effect, suggesting ways college students can learn to integrate it into active and productive study strategies. Practical applications include generating study questions, creating study tools, and engaging in dual coding. In addition to describing specific study methods, the article examines the role of tutors, academic coaches, and instructors in modeling and scaffolding effective learning.

Keywords: postsecondary literacy; reading; learning strategies; generation effect

The academic demands of college can be a major shift from what students encounter in high school, especially in terms of the pace, depth, and student-directedness of learning (Steele & McDonald, 2008). In surveys, most college students report never having learned how to study in high school (McGuire, 2015). As a result, incoming college students often do not have a strong background in using effective study strategies and understanding why they work (McGuire, 2015). Gaining these insights can help students become more self-aware and intentional in how they approach studying. An essential principle is that learners are more likely to remember information they generate than information they passively receive; this is the essence of the generation effect, first described by Slamecka and Graf (1978). Four decades of subsequent research in laboratory and practical settings have shown the benefits of the generation effect and provide insight into

why and how it enhances learning (for a review, see McCurdy et al., 2020). The purpose of this article is to introduce learning principles related to the generation effect that can be applied to students' study strategies. After presenting a theoretical foundation, the author provides examples of specific strategies and discusses ways that awareness of the generation effect can bolster efforts to support college students' learning.

Why Does the Generation Effect Occur?

The generation effect—that is, the benefit of actively generating information as part of the learning process—has been observed in a number of experiments. Researchers have documented enhanced memory for various types of information, including individual words, images, solutions to math problems, free and cued recall, recognition, and comprehension (see Bruning et al., 2004). In a meta-analysis, Bertsch et al. (2007) calculated that the generation effect added a benefit of approximately half a standard deviation above simply reading, leading the authors of the review to call the generation effect a "robust and consistent finding" (p. 203).

To understand what the generation effect is and why it occurs, it is useful to view it in the context of other principles of cognition. One explanation for the memory-enhancing properties of the generation effect is that generating material creates explicit memories; the learner is consciously aware of having been through the process of generating information, which makes remembering the information more likely (Bruning et al., 2004). A second explanation is that deep rather than shallow processing accompanies generation. Learners who generate their own mnemonic devices, rather than using mnemonic devices provided by another person, engage in deep and effortful processing that makes the content more memorable (Tullis & Qiu, 2022). Additionally, when generating information, a learner makes connections between prior knowledge and new information (Bruning et al., 2004). Linking old and new content promotes organization as well as storage, both of which are key components of memory (Ormond, 2012).

Generation can be thought of as an act of elaboration that adds meaningfulness to content, increasing how memorable it is (Schunk, 2012). This view gives further insight into why and how generation enhances learning. Generating a meaningful example, image, summary, metaphor, explanation, or other cue enhances a learner's ability to remember details about a target item (McNamara & Healy, 2000; Schindler & Richter, 2023). Also, when learners generate content, they engage in problem-solving to process relevant information. In other words, "generation should actually be thought of as enhancing the processing of whatever type of information subjects used in order to perform the required generation task" (deWinstanley et al., 1996, p. 33). Taken together, these principles explain why learners better understand and remember information when they create meaning from it rather than simply reviewing content in its original form (Schroeder et al., 2018).

A study conducted by deWinstanley and E. Bjork (2004) examined whether students would improve their memory if given the opportunity to reflect on the generation effect. In a multi-stage experiment, students took a reading comprehension test based on textual information they generated as well as textual information they read. A portion of students then learned that they had remembered a greater percentage of the information they had generated. When these students were given new reading assignments with a mix of generation and read-only tasks, they recalled a higher percentage of both types of information. The researchers attributed these outcomes to students' awareness of the generation effect, which led to improvement in overall information processing. They concluded that "not only can generating produce a memorial advantage over reading when learning new information; it can … also

lead to the spontaneous development of processing strategies for future to-be-read material that render it just as well learned as generated material" (p. 952). This finding suggests it is valuable for students to gain knowledge of the generation effect to enhance their learning. How this can be done is the focus of the remainder of the article.

How Can College Students Learn to Apply the Generation Effect?

College students' default approaches to studying often involve reviewing assigned readings and looking over notes (Callender & McDaniel, 2009). Because these activities are passive, the results are often disappointing when relied upon as study methods (McGuire, 2015). In contrast, employing the generation effect can help students actively process what they are learning and develop a range of meaningful encoding cues that can be recalled in a retrieval context, such as on an exam or when using a concept in real life.

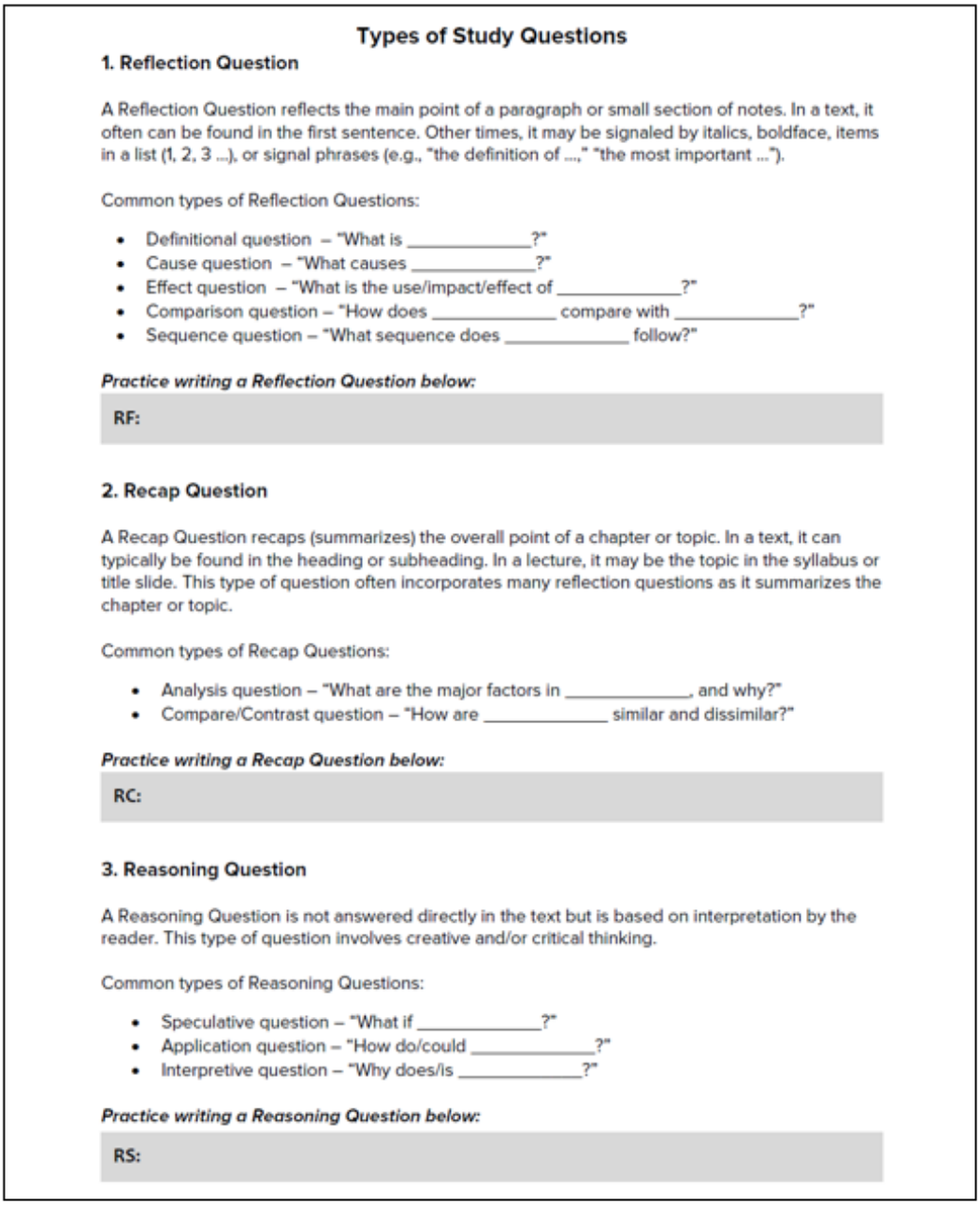
The generation effect can be introduced through both direct and embedded instruction as a simple but powerful tool to help students improve their learning strategies. Direct instruction can take place in contexts such as academic coaching, tutoring, workshops, and stand-alone academic success courses, which exist outside of a specific curricular setting (Wolters & Hoops, 2015). Embedded instruction integrates learning strategies within an existing classroom context, such as a chemistry lab or English class (Dignath & Veenman, 2021). Teaching students to employ generative learning strategies, as with other study strategies, involves providing structure that is gradually transferred over to the student until they can use the strategy independently (Azevedo & Hadwin, 2005). This process involves directly describing the strategy, modeling how to use it, providing practice using the strategy, and helping the learner assess the strategy (White & DiBenedetto, 2015).

The approaches in this article reinforce and build upon ways in which educators may already incorporate the generation effect into their teaching and student support practices. Specifically, three areas of focus will help students use study strategies in ways that activate the generation effect. One, students should make something of or from the content, rather than keeping it in its original version. Two, students should seek to enhance personal meaningfulness or relevance. Three, students should engage in elaboration, that is, expanding on what they are studying by generating examples, analogies, or imagery (Endres et al., 2017). These factors can be incorporated by helping students generate questions, create personalized study tools, or engage in dual processing, discussed in turn below. The section ends with final considerations for helping students see the benefits of the generation effect in order to improve their studying.

Generating Questions

Students can generate questions in multiple ways to actively engage with course content. Question-based study methods prompt generation through reflecting on course content (Tuckman, Abry, & Smith, 2008). Three effective question methods are elaborative interrogation (i.e., asking and answering why), guided peer questioning (i.e., having peers ask one another questions about content), and question-and-answer outlines (i.e., a structured approach to writing questions and answers about the most important points of a text or lecture).

Figure 1. "Types of Study Questions" Handout



Types of Study Questions

1. Reflection Question

A Reflection Question reflects the main point of a paragraph or small section of notes. In a text, it often can be found in the first sentence. Other times, it may be signaled by italics, boldface, items in a list (1, 2, 3 ...), or signal phrases (e.g., "the definition of ...," "the most important ...").

Common types of Reflection Questions:

- Definitional question – "What is _____?"
- Cause question – "What causes _____?"
- Effect question – "What is the use/impact/effect of _____?"
- Comparison question – "How does _____ compare with _____?"
- Sequence question – "What sequence does _____ follow?"

Practice writing a Reflection Question below:

RF:

2. Recap Question

A Recap Question recaps (summarizes) the overall point of a chapter or topic. In a text, it can typically be found in the heading or subheading. In a lecture, it may be the topic in the syllabus or title slide. This type of question often incorporates many reflection questions as it summarizes the chapter or topic.

Common types of Recap Questions:

- Analysis question – "What are the major factors in _____, and why?"
- Compare/Contrast question – "How are _____ similar and dissimilar?"

Practice writing a Recap Question below:

RC:

3. Reasoning Question

A Reasoning Question is not answered directly in the text but is based on interpretation by the reader. This type of question involves creative and/or critical thinking.

Common types of Reasoning Questions:

- Speculative question – "What if _____?"
- Application question – "How do/could _____?"
- Interpretive question – "Why does/is _____?"

Practice writing a Reasoning Question below:

RS:

When using these methods, learners think of the information in their readings or notes as answers and generate questions that are answered by this content. Figure 1 provides a sample handout to teach students to use the generation effect by means of study questions.

By reflecting on the source material, creating questions, and writing (or speaking) the answers, students add something to the material they are seeking to learn. As a result of engaging in this process, known as elaboration (Endres et al., 2017), they have generated content, rather than merely having received it. This effortful interaction with to-be-memorized material enhances its memorability. In most testing situations, students are asked

questions and must provide the answers. If students study by generating questions and answers, they are likely to find that the retrieval cues match the encoding cues. Transfer-appropriate processing will thus take place, enhancing students' ability to both recognize and recall material (e.g., McNamara & Healy, 2000).

Creating Study Tools

Students can create a variety of study tools to produce the generation effect. These methods can include creating summaries of major topics, flash cards of key concepts, and mnemonic devices for difficult-to-remember lists. Several popular websites and apps provide students with the option of studying with a bank of content summaries, flash cards, or mnemonic devices (e.g., acronyms based on the first letter of each word to be memorized). When study tools are developed by others, however, they lose some of their potency. Externally created tools place students in the position of receiving rather than generating material. For example, after an exam a student might find that they remembered the mnemonic device but not what it meant. The tool lacked personal meaningfulness and the student did not have explicit memories of creating it. Therefore, it was difficult to translate the mnemonic back into its component parts.

Preparing students to generate their own study tools is a process. To begin, tutors or academic coaches can describe the steps involved in creating an effective summary, flash card, or mnemonic device and externalize their thought processes as they walk through an example. This method, known as metacognitive modeling, provides a foundation for students who are developing effective learning strategies (Tanner, 2012). Students can then practice creating their own study tools using these principles. These efforts can be supported by templates or instructional handouts until students make the study tools their own (Caprara et al., 2008). Instructors also can allocate a few minutes of class time for these activities, a practice known as "small teaching" that enhances students' learning (Lang, 2016). Once students understand how and why to make their own study tools, instructors can reinforce the new strategies by having students create and turn in study tools for homework or extra credit. When students construct their own study tools, personal meaningfulness is enhanced and the generation effect occurs. See Figure 2 for a sample handout that could help students create useful flashcards based on these principles.

Engaging in Dual Coding

A cognitive strategy that can further enhance students' study tools is dual coding. Students who engage in dual coding by processing information both verbally and non-verbally have stronger retention of information than those who encode information with a single cue (Dogomeo & Aliazas, 2022). Dual coding is the cognitive process at play when students organize information through charts, diagrams, and concept maps (e.g., Bauer, 2014). Through direct or embedded instruction, students can learn basic procedures for generating charts, diagrams, figures, images, mind maps, or cartoons. As with teaching other study methods, the key is to model dual coding methods and then provide guided practice to help students create their own. As Ormond (2012) advises, "learning something by constructing it on one's own makes it more memorable than having someone present it in a prepackaged format" (p. 196).

Figure 2. "Creating Useful Flashcards" Handout

Creating Useful Flash Cards

General Tips

- Create flash cards based on class notes, textbooks, additional readings, etc.
- Include only *one* major point per flash card. Too much information on any one card can be distracting.
- Use different colored flash cards to designate relationships among flash cards. For example, in creating history note cards, you could use yellow to represent the Civil War, blue to represent the Revolutionary War, and red to represent World War I.

Types of Flash Cards

- **Q&A:** On one side, write a question; on the other side, write the answer.

Front	*Back*
What are the components of the hydrosphere?	ocean, streams, lakes, glaciers, underground water sources

- **Word pictures:** On one side, write the word or concept; on the other side, draw a picture to illustrate its meaning.

Front	*Back*
Acute	 1. angle measuring less than 90 degrees 2. sharp or severe in effect

- **Mnemonic devices:** On one side, write the mnemonic device you've created; on the other side, write out the concepts that relate to the mnemonic device.

Front	*Back*
Order of operations (PEMDAS)	• Parentheses • Exponents • Multiplication • Division • Addition • Subtraction

How to Use Flash Cards

- Separate the cards into two groups as you review the entire pile: Do Know and Don't Know.
- Review the Don't Know pile until you can place all the cards into the Do Know pile.
- Test yourself on flashcards a bit at a time, spaced out over a few days or weeks. Keep track of which concepts tend to fall into the Don't Know pile. Pay extra attention to this pile, and change the information/format for any cards that are especially difficult to memorize.
- Flip the flash cards over and try to anticipate questions when reviewing the answers (like Jeopardy).
- Visualize the big picture by organizing flash cards into categories (similar topics, opposites, cause and effect, steps in a process).

Dual coding is at play in the word picture example in Figure 2 and can also be employed through creating mental imagery or visual organizers.

Helping Students Assess Their Learning

That students can adapt how they process to-be-learned information has important implications for teaching them to engage in more powerful studying (deWinstanley & Bjork, 2004). Many educators have experienced firsthand that metacognition enhances engagement and learning. Building upon this effective practice, it is advisable to teach about the generation effect from a metacognitive perspective in which students reflect on their learning processes (Sears, 2004). Individuals in a position to help college students enhance their learning strategies—whether instructors, tutors, or academic coaches—can explain to students why and how methods involving generation are effective and then work with students to assess the impact. Setting goals and tracking progress during study sessions can help students understand how and when learning is taking place (e.g., how many terms could I remember this time?). To expand the learning opportunities provided by tests and quizzes, instructors can have students complete a set of questions to reflect on the study tools they used and how effective they were (Lovett, 2013). Academic coaching and tutoring sessions can also provide a context to check in on how students are applying generative study strategies, assess their effectiveness, and make enhancements. If students have tangible evidence that the generation effect is having a positive impact on their learning, this improvement acts as an incentive to continue using these methods. Alternatively, guided self-assessment can help students monitor and reflect on their studying in order to improve the when, where, and how of their approaches (McCabe, 2011).

Conclusion

Helping students learn how to learn is just as valuable as—and sometimes more valuable than—simply conveying content. Effective learning can be taught in the context of a tutoring or coaching session, academic success courses or workshops, or incorporated into small teachable moments across the curriculum (McGuire, 2005; Weinstein et al., 2000). The generation effect draws on how memory works and can be incorporated into a variety of teaching and study methods. Rather than adding an isolated set of practices, the generation effect complements efforts to enhance metacognition, active reading, and strategic learning. With explanation, modeling, practice, and reflection, students can become experts in using the generation effect for enhanced learning.

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