GENERATION EFFECT

Definition and Background

Learners are more likely to retain information when asked to produce (generate) an answer, compared to having that same information provided. (Slameka & Graf, 1978). However, students are unlikely to engage in generative learning on their own (King, 1992; Wittrock, 1989); they need to be prompted and guided to do so through providing learning activities that are consistent with generative learning (see Bertsch & Pesta, 2014) for a review.

Generating answers increases the likelihood a learner will recall or recognize information later (Bertsch, Pesta, Wiscott, & McDaniel, 2007; McNamara & Healy, 1995, 2000). When compared to passive activities such as reading, generative activities encourage learners to use methods during learning (or encoding) that can be evoked during retrieval of the learned information (McNamara & Healy, 2000). The learning benefits of actively constructing knowledge have been noted in several areas, including mathematics (Lawson & Chinnappan, 1994; McNamara & Healy, 2000; Pesta, Sanders, & Murphy, 1999), reading comprehension (Doctorow, Wittrock, & Marks, 1978; Wittrock, 1990), and trivia questions (deWinstanley, 1995).

Generation activities can vary in form, resulting in differing levels of cognitive processing:

- **Surface processing:**
  - Rearranging letters or filling in missing letters in a word
  - Recognition tests

- **Deep processing:**
  - Relating two concepts to one another
  - Creating a hierarchy of relationships between items
  - Creating and answering questions on the material
  - Summarizing a reading passage

Self-questioning during a lecture is somewhat more beneficial than generating summaries where learners use their own words to connect their prior knowledge to the material they are learning (King, 1992). Both strategies, however, are more beneficial than more passive strategies such as taking notes during lecture and reviewing them for a test. Although students report that generation methods are helpful, when comparing generation techniques to retrieval (testing), retrieval appears to offer more benefits for later retention (Karpicke & Zaromb, 2009).

Limitations and considerations:
Learning objectives and learning activities

- Generation activities during learning are optimal when the activities students engage in during learning resemble the retrieval or product that will be required during learning assessments. This is referred to as transfer-appropriate processing (deWinstanley, Bjork, & Bjork, 1996; Foos, Mora, & Tkacz, 1994; McDaniel, Waddill, & Einstein, 1988; McNamara & Healy, 2000; Morris, Bransford, & Franks, 1977; Thomas & McDaniel, 2007).
  - Reading with general instruction allows the learner to focus more broadly on all aspects of the material. Deep generative activities, however, may be indicated when assessments require students to:
    - make connections between concepts
    - work to provide specific solutions
- Placing minimal constraints on the generating activity, such as a free-recall exercise, will yield better learning than placing constraints to what the students generate (McCurdy, Leach, & Leshikar, 2017).

Low-skill versus high-skill learners:
- Learners who are low in comprehension skills might benefit more from instruction on generative activities, such as self-questioning, than high-skill learners, (King, 1992).

Novice versus expert learners:
- Generative activities, such as fill-in-the-blank questions, for material that is unfamiliar to learners (such as vocabulary words) may not be beneficial for students who have no pre-existing mental representation of the topic (Lutz, Briggs, & Cain, 2003).
- As expertise in an area increases, the benefits of generation decreases; those with high prior domain knowledge may not benefit from generation to the extent that those with low prior knowledge (Lutz, Briggs, & Cain, 2003; Rittle-Johnson & Kmicikewycz, 2008).
- Generating an incorrect answer in a problem-solving activity may not yield the benefits of the generation effect described above. This is true when the activity requires the construction of knowledge, rather than the retrieval of existing knowledge (Kizilirmak, Wiegmann, & Richardson-Klavehn, 2016).
  - However, generation can be beneficial when an incorrect response is accompanied by corrective feedback (Metcalfe and Kornell, 2007).
- As the cognitive load necessary to complete a learning task increases, the efficacy of the generation effect decreases.
  - Providing worked worked-examples may prove to be more beneficial (Chen, Kalyuga, & Sweller, 2016).
Educational Implications

- Preparing for exams
  - students first generate potential exam items and then answer them
  - students generate study outlines from course materials
- Transfer appropriate processing
  - Assign generative activities that focus on the elements important to future testing
  - Ensure that the generative practice resembles the actual testing situation. For example:
    - Essay exam questions: short essay generative-study activities
    - Multiple-choice exam questions: quizzing activities, matching future testing, that align with Bloom’s Taxonomy generative-learning activities
- Provide corrective feedback, when indicated, to generative activities
- Finally, Metcalfe and Kornell (2007) suggest, “. . . pause from time to time, asking questions that encourage the students to generate the answers themselves, Socratic style. It would seem important not to immediately jump to the answer. A short pause or, even better, a seemingly interminable pause of several seconds may greatly enhance learning. It may also be beneficial for the whole class, and not just for the students who answer, if the instructor asks individuals to answer aloud, but without saying in advance who the victim will be” (p. 228).

Bibliography


Chen, O., Kalyuga, S., & Sweller, J. (2016). Relations between the worked example and generation effects on immediate and delayed tests. Learning and Instruction, 45, 20-30.


