



Role of expectations and explanations in learning by teaching



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ABSTRACT

The present study examined the role of preparing to teach (i.e., teaching expectancy) and actually teaching (i.e., explaining to others) on immediate and long-term learning. In Experiment 1, participants studied a base version or an enhanced version of a paper-based lesson on how the Doppler Effect works with the expectation of taking a test on the material or with the expectation of teaching the material by providing a video-recorded lecture. Results indicated that those who prepared to teach (without actually teaching) outperformed those who prepared for a test on an immediate comprehension test (i.e., a teaching expectancy effect; $d = .55$), regardless of the format of the lesson. In Experiment 2, participants studied while expecting to be tested or expecting to teach the material; some then actually did teach the material by providing a video-recorded lecture, whereas others received additional study time. Results indicated that those who actually taught the material outperformed those who did not teach on a delayed comprehension test (i.e., a teaching effect; $d = .56$), though this effect was strongest for those who also prepared to teach. Overall, these findings are consistent with the idea that preparing to teach results in short-term learning gains, whereas the act of teaching (i.e., by explaining the material to others) coupled with preparing to teach is important for long-term learning.

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1. Introduction

It is often said that the best way to learn something new is to teach it to someone else. Thus, it is not surprising that *learning by teaching* is prevalent among contemporary educational practices, including peer tutoring (e.g., [Palincsar & Brown, 1984](#)), cooperative learning environments (e.g., [Slavin, 1983](#)), and even interacting with computer-based pedagogical agents (e.g., [Biswas, Leelawong, Schwartz, Vye, & The Teachable Agents Group at Vanderbilt, 2005](#)). Although there is considerable evidence that teaching can enhance one's own learning (e.g., [Allen & Feldman, 1973](#); [Cohen, Kulik, & Kulik, 1982](#); [Gartner, Kohler, & Riessman, 1971](#); [King, Staffieri, & Adelgais, 1998](#); [Morgan & Toy, 1970](#); [Robinson, Schoefeld, & Steers-Wentzell, 2005](#); [Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003](#); [Roscoe & Chi, 2007](#)), it is largely unclear how different components of the teaching process influence learning ([Galbraith & Winterbottom, 2011](#); [Rohrbeck et al., 2003](#); [Roscoe & Chi, 2007](#)). This ambiguity is likely due to the diversity of learning by teaching programs available (e.g., cross-age tutoring, reciprocal tutoring, teachable agents), the many teaching-related activities

potentially responsible for learning (e.g., preparing to teach, explaining to others, providing feedback), as well as other interactions between students that may or may not be unique to teaching (e.g., answering questions), but that still may contribute to learning. In addition, much of the evidence for learning by teaching is derived from research evaluating the effectiveness of peer tutoring programs over conventional instruction ([Roscoe & Chi, 2007](#)). Although this program-based approach may offer important practical implications for implementing specific learning by teaching programs into the classroom, it is limited in its ability to explain how distinct features of learning by teaching differentially influence student learning (such as preparing to teach versus explaining to others).

An alternative approach is to break down the teaching process into distinct stages and to systematically test how each stage uniquely contributes to learning. For example, [Bargh and Schul \(1980\)](#) offered an early framework that proposed three distinct stages of teaching: preparing to teach, explaining to others, and interacting with others. First, preparing to teach (without actually teaching) may improve learning because the expectation of teaching encourages learners to better select and organize to-be-learned material during learning. Second, explaining the material to others (without interacting with others) may offer additional benefits because it encourages learners to elaborate on the material presented and to make connections between the to-be-learned material and their existing knowledge. Finally, interacting with others—by

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answering questions or providing feedback—may offer metacognitive benefits by encouraging learners to reflect on their own understanding of the material and to identify gaps in their knowledge. Yet relatively little research has followed this stage-based approach (e.g., Annis, 1983; Fiorella & Mayer, 2013; Coleman, Brown, & Rivkin, 1997; Roscoe & Chi, 2008), and as a result, it is largely unclear the extent to which effects of learning by teaching can be attributed to the mere expectation of teaching (i.e., preparing to teach), the act of teaching (i.e., explaining to others), or interactions between students that may or may not be unique to teaching (e.g., answering questions and receiving feedback).

The current study focused on contributing toward a better understanding of the first two stages of learning by teaching—preparing to teach and explaining to others. In Experiment 1, participants studied two versions of a paper-based lesson on how the Doppler Effect works with instructions that they would later be tested on the material or asked to teach the material by providing a short video-recorded lecture. Those expecting to teach did not actually teach, but instead all participants were given an immediate comprehension test on the material. In Experiment 2, participants were given the same instructions (i.e., prepare for a test or prepare to teach) but some actually did teach the material by providing a video-recorded lecture, whereas others only restudied the material. All participants were then assessed on a delayed comprehension test of the material. Overall, the goal of the current study was to examine the effects of preparing to teach and the effects of explaining to others on immediate and long-term learning.

1.1. Learning by preparing to teach

An often-overlooked factor in learning by teaching is the unique effect of preparing to teach on learning. Indeed, research on the teaching expectancy effect suggests that studying with the mere expectation of later teaching can enhance learning beyond studying normally for a test (e.g., Fiorella & Mayer, 2013; Bargh & Schul, 1980; Benware & Deci, 1984). For example, in a classic study by Bargh and Schul (1980), students were given verbal material to study with the expectation of either answering questions afterwards or teaching the material to another student. Those who prepared to teach outperformed those who prepared to be tested on subsequent recall and recognition tests. Benware and Deci (1984) replicated this finding with more meaningful learning materials when they asked students to study an article on brain functioning with the expectation of teaching or being tested on the material. Those who expected to teach performed better on a conceptual knowledge test than those who expected to be tested. These studies indicate that preparing to teach plays an important role in learning by teaching.

At the same time, preparing to teach may not result in improved learning under some conditions (Fiorella & Mayer, 2013; Ehly, Keith, & Bratton, 1987; Renkl, 1995). For example, in a study by Renkl (1995), students prepared to teach others about probability while studying worked-out examples on a computer. The results showed no evidence for a teaching expectancy effect, likely due to the fact that students may have experienced excessive stress and anxiety at the prospect of teaching others. Further, a recent study by Fiorella and Mayer (2013) suggests that the teaching expectancy effect may also be limited to short-term learning benefits. In their study, participants studied a lesson on the Doppler Effect with the expectation of later teaching or being tested on the material. Those who prepared to teach (without actually teaching) significantly outperformed those who prepared to be tested on an immediate comprehension test ($d = .59$); however, this effect did not reach statistical significance when students were assessed following a 1-week delay ($d = .24$). These findings are also similar to those reported by Annis (1983), which indicated only mixed evi-

dence for a teaching expectancy effect when learning was assessed after a delay.

1.2. Learning by explaining to others

Explaining material to others may offer unique learning benefits beyond only preparing to teach (Fiorella & Mayer, 2013; Bargh & Schul, 1980). This is because generating explanations requires learners to go beyond the information presented and make connections between to-be-learned material and their existing knowledge (Chi, 2000). In other words, learning by explaining depends on the extent to which learners reflect on their own understanding and integrate the material with their prior knowledge—what is sometimes referred to as *reflective knowledge building* (Roscoe & Chi, 2007). On the other hand, learners are unlikely to benefit from engaging in *knowledge telling*—that is, simply summarizing the material and making only minor inferences. In short, generating quality explanations for others is likely to result in deep learning.

Although there is much research on the benefits of self-explanation (Fonseca & Chi, 2011; Roy & Chi, 2005), relatively few studies have systematically investigated the effects of explaining to others (Annis, 1983; Coleman, Brown, & Rivkin, 1997; Roscoe & Chi, 2008). Further, one important limitation of this research is that the effects of explaining to others are often not isolated from potential effects of other stages of learning by teaching (e.g., preparing to teach or interacting with others). For example, in the study by Annis (1983), participants studied a history lesson either with the expectation of later teaching another student or with the expectation of being tested on the material. Of those expecting to teach, some actually did teach another student, whereas others only prepared to teach. Results indicated that students who taught generally outperformed those who only prepared to teach on delayed measures of learning. However, the students who taught did so by *interacting* with a peer who was encouraged to ask questions throughout the teaching session. According to Bargh and Schul's (1980) framework, interacting with others represents a distinct stage of the teaching process; thus, it is unclear whether the added benefit of teaching was due to explaining the material to another person, interacting with another person, or some combination between the two.

In a study by Coleman, Brown, and Rivkin (1997), students learned about evolution by natural selection and then either self-explained the material or explained the material to another student (without interacting with the other student). Results indicated that students who explained to a peer generally outperformed students who self-explained on measures of deep learning. However, one limitation of this study is that the groups studied the material with different expectations—that is, the self-explain group studied with the expectation of later self-explaining, whereas the explain-to-other group studied with the expectation that they would explain the material to another student. Thus, it is unclear the extent to which the potential benefits of preparing to teach may have influenced the results.

One approach to isolate the effects of explaining to others is to not inform participants that they will later teach the material. For example, in a study by Roscoe and Chi (2008), students learned about the human circulatory system by studying a lesson normally. They were then asked to explain the material to themselves, explain the material by giving a video-recorded lecture, or explain the material to another student while also interacting with the student (e.g., by answering questions). Results indicated that those who self-explained generally outperformed those who explained to others on measures of deep learning. Self-explainers also showed more evidence of reflective knowledge building than the explain-to-other groups. However, it may be that the benefits of explaining to others depend on also having studied the material with the expectation of later teaching.

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