

# Effects of Adaptive Prompted Self-explanation on Robust Learning of Second Language Grammar

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**Abstract.** Prompted self-explanation is a successful intervention for many domains. However, in our previous work within the domain of second language grammar learning, we found no advantage for self-explanation over practice alone. Here, we continue testing the generality of self-explanation through the development of an adaptive self-explanation tutor and report on results of a classroom evaluation (N=92) in which we compare the adaptive tutor to a practice-only tutor. We investigate both procedural and declarative knowledge acquisition as well as long-term retention. Results show that while self-explanation takes more time than practice alone, it leads to greater learning of declarative knowledge. However, there are no differences between conditions on immediate or long-term retention measures of procedural knowledge.

**Keywords:** Self-explanation, Second Language Learning, Long-term Retention.

## 1 Introduction

Prompted self-explanation is an instructional strategy in which students provide rationales for steps on solved problems or worked examples. It has been shown to be highly effective for increasing learning in STEM domains [1,2,3]. However, little work has been done in non-STEM domains, and thus, the goal of this work is to test the generalizability of self-explanation. In previous studies on teaching students the English article system, we found that self-explanation led to learning gains, but there was no advantage over a practice-only condition [4]. We also found self-explanation to be relatively inefficient for this domain, but a limitation was a lack of robust learning measures such as long-term retention and declarative knowledge acquisition.

To address these gaps, we built two tutoring systems to teach the English article system (teaching students when to use *a*, *an*, *the*, or *no article*): a practice-only tutor and an adaptive self-explanation tutor. In the practice-only tutor, students see one sentence at a time and select the article that best completes the sentence from the provided menu. In an attempt to make a more efficient tutor, we built an adaptive self-explanation tutor that prompts students to self-explain only when estimates of their prior knowledge for a given article rule are low. Namely, if a student chooses the correct article on their first attempt, they move to the next sentence. If they make an

error or ask for a hint on their first attempt, after eventually selecting the correct article, they are prompted to self-explain. In both tutors, students receive immediate feedback and have access to hints.

## 2 Methodology

Participants were adult English language learners ( $M=25.5$  years,  $SD=5.3$ ) enrolled in an intensive language program. Instruction and assessments were incorporated into normal classroom activities. We assessed both procedural knowledge and declarative knowledge. The procedural knowledge assessment consisted of problems similar to the tasks students completed as part of tutoring (e.g. *Yesterday, I bought a new car. \_\_\_\_ car is red.*). The declarative knowledge assessment presented students with a feature and asked them to select the corresponding article (e.g. *If a noun has already been mentioned, which article do you use?*). In addition, we also computed instruction time to compare tutor efficiency.

On the day of instruction, students met in the computer lab and began by taking the declarative knowledge pretest. Students were then given a five-minute introduction to both tutoring systems. Students next took the procedural knowledge pretest and were randomly assigned to a tutoring condition. Students then completed both immediate posttests (procedural and declarative knowledge) as well as a demographic survey. Long-term retention procedural knowledge assessments were administered in class one-week and two-months after tutoring.

## 3 Results

A repeated measures ANOVA on the procedural knowledge (article selection) assessment using the pretest and immediate posttest replicates our previous findings and shows that students in both conditions demonstrate significant pretest to posttest learning gains ( $F(1,88)=13.1$ ,  $p=0.001$ ,  $\eta^2=0.13$ ). However, there is no difference between conditions ( $F(1,88)=0.30$ ,  $p=0.58$ ) (Table 1). Efficiency results also replicate our previous findings and show that the practice-only tutor is more efficient than the adaptive self-explanation tutor. Students using the practice-only tutor complete the instruction significantly faster ( $M=15.0$  minutes,  $SD=4.9$ ) than students using the adaptive tutor ( $M=17.7$  minutes,  $SD=4.3$ ,  $F(1,90)=7.8$ ,  $p=0.006$ ,  $\eta^2=0.08$ ).

To test whether the adaptive self-explanation condition leads to more declarative knowledge gain, we conducted a repeated-measures ANOVA on the declarative knowledge assessment. Again, both conditions led to significant pretest to posttest improvement ( $F(1,77)=86.2$ ,  $p<0.001$ ,  $\eta^2=0.53$ ). Furthermore, results show that the adaptive self-explanation tutor led to greater declarative knowledge gains than the practice-only tutor ( $F(1,77)=4.39$ ,  $p=0.04$ ,  $\eta^2=0.05$ ) (Table 1).

Finally, we tested whether self-explanation led to better long-term retention. We did a repeated-measures ANOVA using all four instances of the procedural knowledge assessment and found no evidence that self-explanation is better for long-term retention than practice alone ( $F(3,86)=0.56$ ,  $p=0.64$ ).

**Table 1.** Learning gains by condition for the procedural and declarative assessments. Both conditions lead to learning on both assessments, and those using the adaptive tutor make greater gains on the declarative assessment than those using the practice-only tutor.

	Proc. Pretest (SD)	Proc. Posttest (SD)	One-week Retention (SD)	Two-month Retention (SD)	Declarative Pretest (SD)	Declarative Posttest (SD)
Adaptive SE n=47	68.8% (14.2)	78.0% (12.9)	82.6% (14.8)	81.8% (17.5)	55.8% (22.5)	90.3% (14.3)
Practice-only n=45	71.3% (16.2)	77.8% (16.3)	86.2% (11.0)	83.8% (14.8)	62.8% (22.1)	84.6% (26.6)

4 Discussion

One of the primary goals of the learning sciences is to understand when and why instructional manipulations succeed. While self-explanation has been called a “domain general” strategy [5], these results suggest that there may be limits to its generalizability depending on the goals of instruction and the nature of the targeted knowledge. Specifically, these results show that self-explanation is generalizable in that it leads to an increase in declarative knowledge over a comparable practice-only condition. However, this additional knowledge does not transfer to better procedural performance, which, for this domain, is the primary goal of instruction. To conclude, this study suggests practical differences between the effects of self-explanation on language learning compared to math and science, and highlights the importance of replicating findings across multiple domains.

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