

# The Benefits of Self-Explanation

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# What is self-explanation?

- **Learners spontaneously explain the meaning of content**
  - Passages of text or other written material
  - In the context of studying a target domain
  - Initially used in conjunction with worked examples
  - Notice relevant features of problem
  - Identify gaps in knowledge about the problem
- **Quality of explanations differ**
  - High quality: Inferences about missing material, integrative statements, deeper analysis of resources
  - Low quality: Simple paraphrasing of statements found in material

# Self-explanation and learning

- High quality self-explanations are connected to learning gains
- Variety of disciplines
  - Math: algebra, geometry, logic
  - Natural science: physics, biology
  - Humanities: English, history
  - Computer science
  - Commonality: Need both ability to solve a problem and explain the underlying principles
- Variety of levels
  - Middle/high school
  - University
  - Adult learners
- What are some examples?

# Biology

## Background

- Middle-school (8<sup>th</sup> grade) students
  - Inner-city school
  - Volunteers
  - Not taken a biology course
- N = 24
  - Control group: 10
  - Experimental group: 14
  - Split equally by gender
- Problem: Read and understand a unit describing the human circulatory system
  - *Modern Biology* by Towle

## Treatment

- 101-sentence passage
- Paper with one sentence per page
- Control group
  - Read the passage twice
- Experimental group
  - General prompts
    - After reading each sentence, prompted to explain what each sentence meant
  - Specific prompts
    - At 22 places prompts about specific functions of circulatory system
- Same time for both activities -- approximately 2 hours

# Biology

## Procedure

- Phase 1: Interview session (pre-test)
  - Describe 23 terms
  - Draw blood flow
  - Answered half of test questions
- Phase 2: Treatment session
  - Randomly assigned
  - One of the two situations
- Phase 3: Interview session (post-test)
  - Same as the first phase

## Results

- Both groups of students gained significantly from the pre-test to the post-test
- The gain was greater for the prompted group (32%) than the unprompted group (22%)
  - On more difficult questions it was larger (22.6% prompted vs. 12.5% unprompted)
- High explainers (M=61) gained more (38%) than low explainers (M=14) (27%)
  - Also more pronounced for difficult questions (33% vs. 17%)

# English

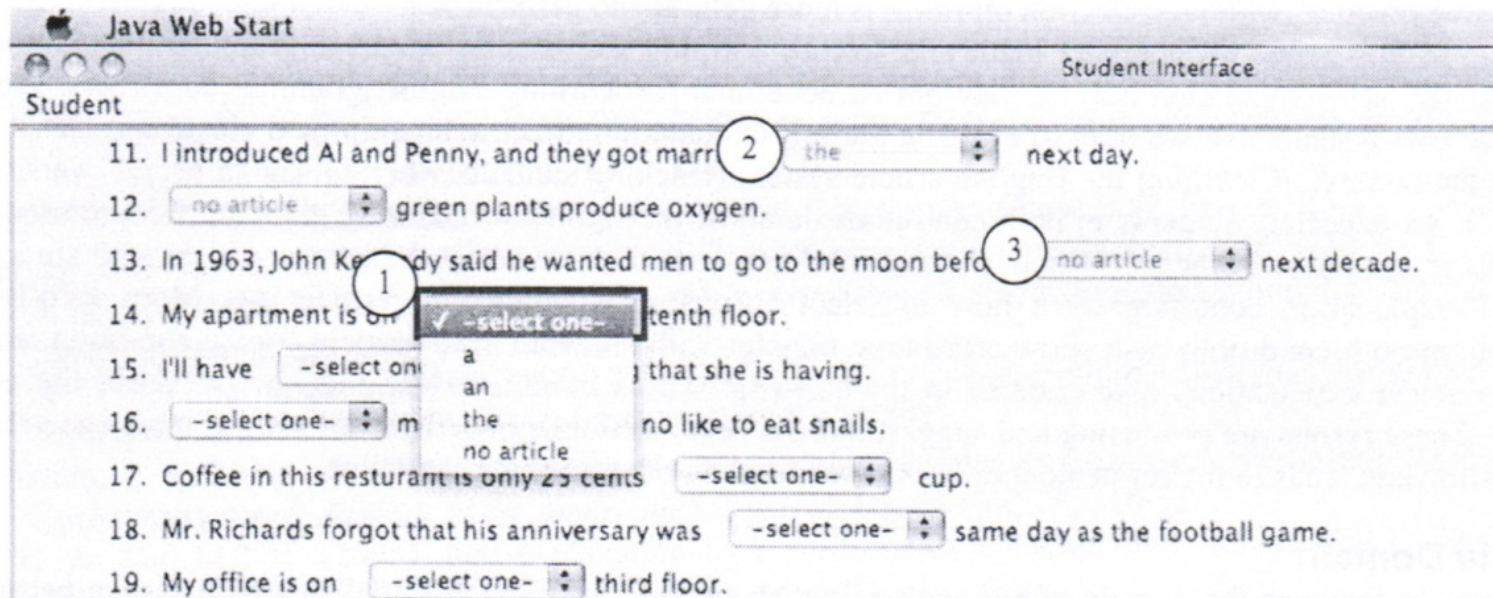
## Background

- Adult ESL learners
- N = 118
- Single class session
- Problem: Second language grammar acquisition
  - Learning correct English article to use
    - a, an, the, none
  - Rule-based situation

## Treatment

- Computerized tutoring system
  - Immediate feedback
- Article choice selection (tutored practice)
  - Choose article in a given sentence via a dropdown menu
- Explanation choice selection (self-explanation)
  - Shown the correct article, provide an explanation for it via a dropdown menu

# Article choice



**Figure 1.** In the article choice condition, students choose the article (a, an, the, no article) that best completes the sentence (1), and receive immediate feedback on their selection. If the answer is right, it turns green (2), and red if it is wrong (3).

# Explanation choice

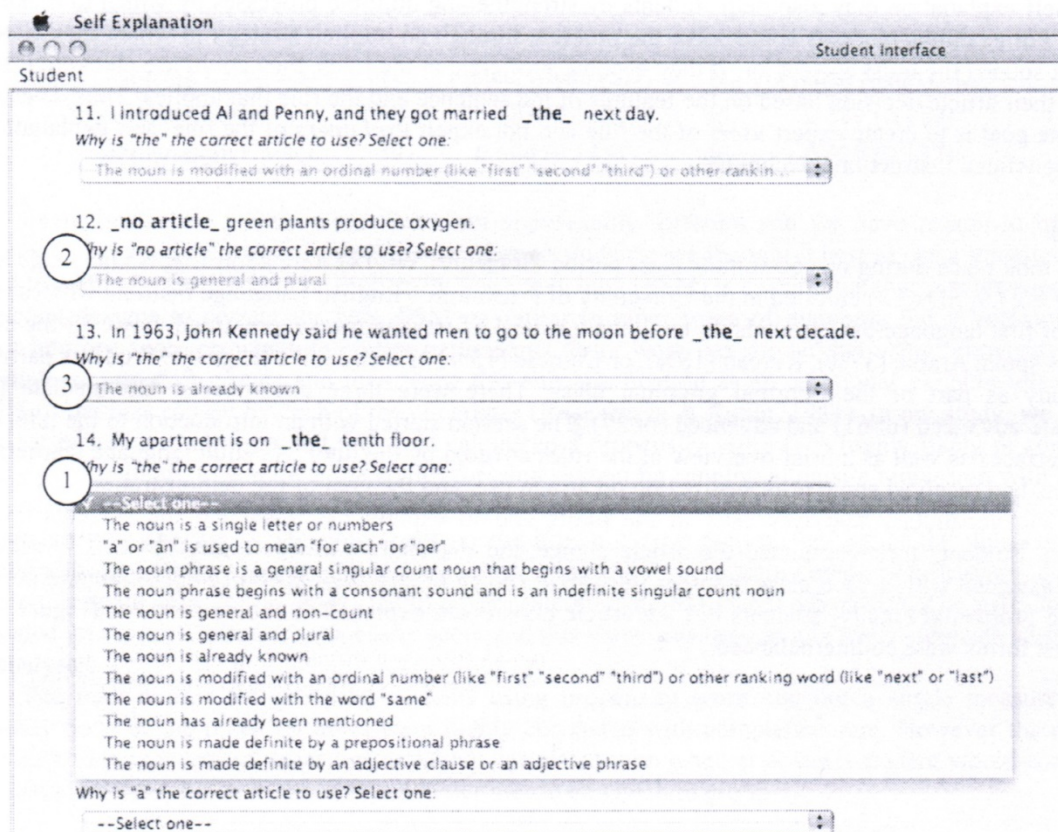


Figure 2. In the explanation choice condition, students choose the feature of the sentence that best explains the article use (1). Identical to the article choice condition, students receive immediate feedback on their selection. If the answer is right, it turns green (2), and red if it is wrong (3).



# English

## Procedure

- Pre-test
  - On both type of exercises
- Tutoring session
  - One type of activity only
    - Article choice exercises
    - or
    - Explanation choice exercises
  - Randomized assignment
- Post-test
  - On both types of exercises

## Results

- Students improved on the type of problem they studied
- Students improved on the other type of problem (transfer)
- Effects of prompted self-explanation were somewhat stronger
- No reduction in speed for self-explanation group
  - Important for fluency

# Computer science

## Background

- **Open University**
  - Helsinki, Finland
  - Open enrollment for nominal fee (~\$50)
  - Summer 2013 and 2014
- **N = 51**
  - Initially N = 110
  - Typical dropout rate
- **Problem: Java programming**
  - Self-explanation exercises embedded into weekly course assignments
  - Longer-term than any previous study

## Treatment

- **Three weekly self-explanation exercises**
- **Two subgroups**
  - Motivational text + code + self-explanation
  - Motivational text + code + multiple-choice question + self-explanation
  - Randomly assigned
- **Self-explanations were not assessed for quality**
  - Students knew this in advance

# Computer science

## Procedure

- Weekly course assignments
  - Between subjects design
- Final exam
  - Three self-explanation questions (0-2 points each for total of 0-6 points)
    - Compare Summer 2013 (no self-explanation) to Summer 2014 (with self-explanation)
  - Two of the three problem-based questions (0-11 points)
    - Ones with highest completion rate
    - Compare two Summer 2014 populations (with multiple-choice or without)

## Results

- Students with self-explanation exercises ( $M = 4.6$ ) performed better on self-explanation exam questions than previous year ( $M = 3.7$ )
  - Statistically significant
  - No evaluation of quality of explanations
- Students with supporting questions ( $M = 8.4$ ) outperformed students without them ( $M=6.7$ )
  - Marginally significant
  - Focused students on relevant aspects of the question

# Summary

- **High quality self-explanations are connected to learning gains**
- **Subjects**
  - **Biology**
  - **English**
  - **Computer science**
- **Variety of levels**
  - **Middle school**
  - **University**
  - **Adult learners**

# References

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