LearnLab
Pittsburgh Science of Learning Center

In Vivo Study

Self-explaining in the Classroom: Learning Curve Evidence

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Abstract

Research conducted in the laboratory and classroom has repeatedly found that self-explaining is a useful, self-directed learning strategy. Although the self-explanation effect has been replicated several times, the sources for its effectiveness are still under investigation. The present study attempts to address the question: Why does self-explaining work? Two alternative proposals are contrasted. The *content account* proposes that self-explaining is effective because of the additional information to which the learner is exposed. Alternatively, the *generation account* suggests that it is the activity of producing an explanation that is effective. The evidence, taken from learning curves collected in the classroom, predominantly supports the generation account of self-explanation, which highlights the benefit of actively processing the learning material, instead of simply attending to it.

Introduction

Background

Self-explaining has been shown to be effective:

- In the laboratory (Butcher, 2006; Chi, et al., 1989)
- In the classroom (McNamara, Levinstein, & Boonthum, 2004)
- With human prompting (Chi, DeLeeuw, Chiu, & LaVancher, 1994)
- With computer prompting (Aleven & Koedinger, 2002; Conati & VanLehn, 2000; Hausmann & Chi, 2002)

Contrast is usually between self-explanation vs. none

- Not clear if the effect is due to additional *content* or the *generation* of the explanation itself.

Why does self-explanation work?

I. The content-account of self-explaining

- Additional content of instructional explanations drives (shallow) learning (Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001)
- Student-produced explanations drive (deep) learning, even when incorrect (Chi, 2000)

II. The generation-account of self-explaining

- Generation enhances an individual's memory for:
  - Simple verbal stimuli (Jacoby, 1978; Slamecka & Graf, 1978)
  - Sentences (Kane & Anderson, 1978)
  - Trivia (deWinstanley, 1995; Peynircioglu and Mungan, 1993)
  - Conceptual material (Foos, Mora, & Tkacz, 1994)

Hypotheses

- Coverage hypothesis: paraphrase = self-explaining
- Generation hypothesis: paraphrase < self-explaining

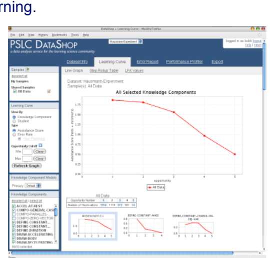
Terminology

Knowledge Components

- Abstract units of knowledge: e.g., concepts, principles, rules, declarative knowledge, and schemata.

Learning Curves

- A visualization of initial performance and the rate of learning.



Method

Participants

- Midshipmen at the U.S. Naval Academy who received course credit for their participation (N = 104).

Design:

- Complete example / paraphrase (n = 26)
- Complete example / self-explain (n = 27)
- Incomplete example / paraphrase (n = 23)
- Incomplete example / self-explain (n = 28)

Materials

- Study instructions
- Video solutions to study
- Andes homework system
- Chapter exam (1 question)
- Homework (Near n = 8; Far n = 7)
- Study domain: electrodynamics
- Transfer domain: magnetism

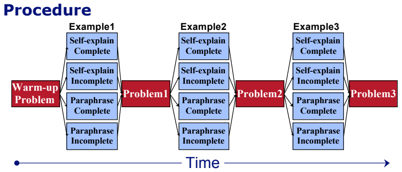
Normal Learning Measures (DV)

1. Near Transfer, Short-term Retention

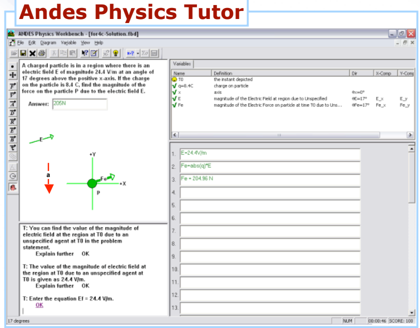
Robust Learning Measures (DVs)

1. Far Transfer (*Electric Field Homework*)
2. Long-term Retention
3. Accelerated Future Learning (*Magnetic Homework*)

Procedure



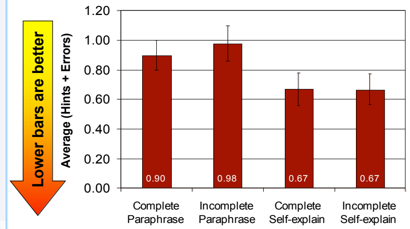
Andes Physics Tutor



Transcript Example

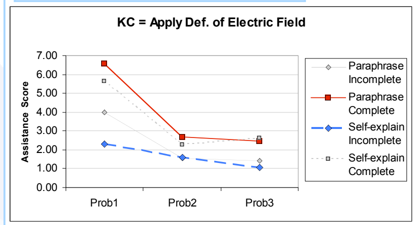
Speaker	Contribution	Code
Video:	The direction of the electric force is in the opposite direction as the electric field **because the charge on the particle is negative.**	Complete example
AB2438:	...because the charge on the particle is negative, then the force will be in the opposite direction of the electric field vector.	Paraphrase

Results: *Aggregate Results*



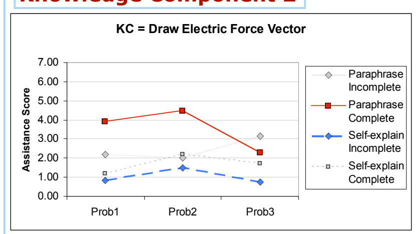
Using a repeated-measures Analysis of Variance, a main effect for Study Strategy was observed, with the self-explanation condition demonstrating lower normalized assistance scores than the paraphrase condition, $F(1, 73) = 6.19$, $p = .02$, $\eta_p^2 = .08$.

Knowledge Component 1



No significant main effects or an interaction; however, a post-hoc comparison between the incomplete self-explanation and complete paraphrase condition revealed a marginal difference, $F(1, 58) = 3.73$, $p = .06$, $\eta_p^2 = .06$.

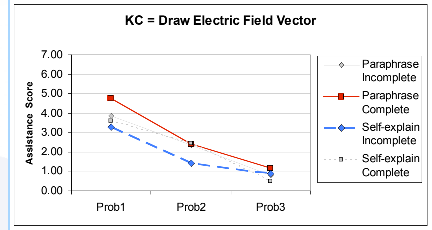
Knowledge Component 2



There was a between-subjects main effect for Activity, with the self-explaining conditions demonstrating lower assistance scores than the paraphrasing conditions, $F(1,54) = 4.36$, $p = 0.04$, $\eta_p^2 = .08$.

A post-hoc comparison between the incomplete self-explanation and complete paraphrase condition also revealed a reliable difference, $F(1, 54) = 4.93$, $p = .03$, $\eta_p^2 = .08$.

Knowledge Component 3



There was a trend for self-explainers committing fewer errors and asking for fewer hints than the paraphrasing condition, $F(1, 71) = 2.10$, p = 0.15, $\eta_p^2 = .03$.

A post-hoc comparison between the incomplete self-explanation and complete paraphrase condition revealed a marginally significant difference, $F(1, 54) = 3.27$, $p = .08$, $\eta_p^2 = .04$.

Conclusions

1. At Knowledge Component

- The Incomplete Self-explanation condition had lower assistance scores for all three knowledge components.
- Replicates findings from the aggregate level.
- Supports the *generation account* of self-explanation.

2. Most Knowledge Components demonstrated decelerating curves.

- According to most learning theories, errors and requests for assistance should decrease over time.
- This was evident in 2/3 knowledge components.

3. Knowledge Component Anomaly (KC2)

- Drawing an electric-force vector did not conform to the decelerating curve.
- *Hypothesis*: skill decomposition is wrong.
  - Some KCs may be nested within others
  - Therefore, the assignment of blame is incorrect.

Acknowledgements

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For further information

Please contact bobhaus@pitt.edu for more information on this and related projects. A copy of the poster is located on http://www.pitt.edu/~bobhaus/pubs.html