A Test of the Interaction Hypothesis: Joint-explaining vs. Self-explaining

Robert G.M. Hausmann & Kurt VanLehn

Department of Psychology, University of Pittsburgh, Pittsburgh, Pennsylvania 15260

Introduction

I. Background Literature

Self-explaining has been shown to be effective: • In the laboratory & classroom (Bielaczyc, 2000; Chi, Weger, Lew, Stern, & Glaser, 1989; Hausmann, Levison, & Feil, 1998; Rummel, Koedinger, & Pelletier, 2003). • With human & computer prompting (Chi, DeLova, Liu, & Lebowitz, 1999; Hausmann & Koenig, 2002; Hausmann & VanLehn, 2003; Levison & Chi, 2002). • The effect sizes are estimated to be d = .74 – 1.12.

Collaboration has been shown to be effective under the following conditions: • When the dialog is scripted (Hausmann, 2006; Rummel & Koedinger, 2002). • When students collaboratively develop explanations (Coleman, 1998). • When students provide elaborated help (Hausmann, 2002). • The effect sizes are estimated to be d = .21 – .88.

II. Research Question

Will we observe learning gains from jointly produced explanations that are over and above the beneficial effects of self-explanation while studying worked-out examples and solving problems with an Intelligent Tutoring System (ITS)?

Confirmatory Evidence

- Hypothesis Testing Micro-world (Toskey, 1995)
- Talk Dyad vs. No-talk Alone
- LISBP tutor (Balinsky, Prok, & Brown, 1994)
- Dyad Explaining vs. Individual Self-explaining

Disconfirmatory Evidence

- Geometry Tutor (Anderson, Corbett, Kolenkog, & Pelletier, 1995)
- Dyads = Individuals
- Cognitive Tutor Algebra (Rummel, Dinsen, McLauren, Spada, 2007)
- Dyads = Individuals

How do we account for the discrepant findings?

III. The Interaction Hypothesis

- Explanation is a powerful learning strategy.
  - Individuals will interact with the intelligent tutoring system (i.e., Andes).
  - Andes dyads interact with each other first, then Andes if they are unable to resolve their error.

Predicted Findings

The interaction hypothesis is agnostic about the number of errors made by individuals and dyads. How the errors are resolved will differ. Individuals will use the Andes Help System. Dyads will primarily rely on each other as a resource.

IV. Terminology

Interactive

The mutual exchange of conditionally relevant information (Clark & Schieffler, 1989).

Elaborated Help

Providing more information than just the answer.

Knowledge Components (KCs)

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

Joint-explaining

A complete articulation of a problem-solving step.

Method

Participants

Undergraduates at the University of Pittsburgh who were paid for their participation (N = 38).

Design:

- Self-explanation (individuals; n = 11)
- Joint-explanation (dyads; n = 14)

Materials

- Study instructions
- Video solutions to study
- Andes homework system
- Study domain: electrodynamic

Normal Learning Measures (DV)

1. Transfer, Short-term Retention

Procedure

- Warm-up
- Example
- Problem
- Feedback

Results 1: Assistance Score

The joint-explanation condition demonstrated lower normalized assistance scores than the self-explanation condition. F(1, 23) = 7.33, p = .01, d = 1.14. Moreover, this pattern replicated when Problem was entered as a within-subjects factor in a repeated measures ANOVA, F(3, 19) = 3.51, p = .04, n² = .36

Results 2: Bottom-out Hints

The joint-explanation condition requested fewer bottom-out hints than the self-explanation condition, F(1, 23) = 4.34, p = .05, d = .88. Moreover, this pattern replicated when Problem was entered as a within-subjects factor in a repeated measures ANOVA, F(3, 21) = 2.37, p = .10, n² = .25

Results 3: Errors

There were no significant differences between the two conditions for the number of errors committed while solving problems, F(1, 23) < 1. This pattern also replicated for each individual problem (ps = .15 - .50).

Conclusions

Joint Explanation

- The results suggest collaboratively developing an explanation enhances problem solving and learning over and above the effects of self-explanation, which supports the interaction hypothesis.

Peer vs. ITS Help

- Both individuals and dyads make the same number of errors.
- Yet, the dyads ask for fewer hints.

Hypothesis: help from a peer has a higher utility function (i.e., it is cheaper and easier to understand) than the hints from Andes.

Social Accountability => KC Coverage

- A communicative partner provides a social cue to avoid glossing over the material, which then leads to explanations of higher quality than those produced individually.

Future Analyses

- Qualitatively code the quality of explanations produced by each condition.

Acknowledgements

Funding for this research is provided by the National Science Foundation, Grant Number 081-364420 to the Pittsburgh Science of Learning Center (PSLC, http://www.learnlab.org). The author is indebted to the Andes team, Brett van de Sande, Donald J. Treacy, & Robert Shelby for their assistance in developing the materials.

For further information

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