Enhancing Learning through Worked Examples with Interactive Graphics
(Tentative Design)

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QUESTION: Do worked examples accompanied by graphical representations help prepare students for problem solving?

The proposed study will evaluate whether introducing worked examples with either static or interactive bar graphs facilitate learning in Algebra Cognitive Tutor problem solving.

DOMAIN: Four types of mixture problems (see Table 2) that can be represented by General Linear Form Models. (Units 5 and 6 in the Algebra II Cognitive Tutor).

> Example: You have a MasterCard with a balance of $532 at a 21% interest rate. You also have a Visa credit card with a balance of $841 at a 16% interest rate. How much money are you paying in total interest?

GENERAL DESIGN: Alternate Worked Examples and Cognitive Tutor Problems in learning.

- Four Learning Conditions:
  (1) Worked Examples with Interactive Graphics (see Figure 1a)
  (2) Worked Examples with Static Graphics (see Figure 1a)
  (3) Text-Only Worked Examples (Figure 1b)
  (4) Control – No Worked Examples

- Six Algebra Classes: Random Assignment of students to 1 of 4 conditions (approximately 40 students per condition)

- Procedure: 3 successive class periods:

Table 1. Procedure Specifics

	Day 1: Learning	Day 2: Learning	Day 3: Test/Learning
Groups 1, 2 & 3 (worked examples)	2 pretest problems 4 Worked Examples 4 Cognitive Tutor Problems 2 posttest problems	2 pretest problems 4 Worked Examples 4 Cognitive Tutor Problems 2 posttest problems	6 Test Problems 4 Model Analysis Problems
Group 4 (control)	2 pretest problems 8 Cognitive Tutor Problems 2 posttest problems	2 pretest problems 8 Cognitive Tutor Problems 2 posttest problems	6 Test Problems 4 Model Analysis Problems

Table 2. Four mixture problems that can be represented by General Linear Form Models.

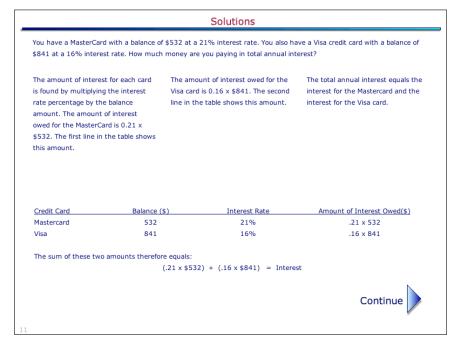| You have a MasterCard with a balance of $532 at a 21% interest rate. You also have a Visa credit card with a balance of $841 at a 16% interest rate. How much money are you paying in total interest?	Shelly owed $475 in total interest on her MasterCard and Visa accounts. Her MasterCard charges 19% interest and her Visa Card charges 22% interest. She paid the interest on her Visa Card debt of $1100. How much interest does she still owe on her MasterCard?	You have an American Express credit card with a balance of $715 at an 11% interest rate and a Visa credit card with a 15% interest rate. If you pay a total of $165 in annual interest, what is the balance on your Visa card?	You have a total balance of $1405 on two different credit cards— an American Express credit card with a 12% interest rate and a Discover credit card with a 24% interest rate. If you owe a total of $224 in annual interest, what is your balance on the Discover card?
(.21 x $532) + (.16 x $841)=TI	$475 - (.22 x $1100) = MI	(.11 x $715) + (.15 x V) = $165	(.24 x D)+(.12 x [$1405 - D]) = $224

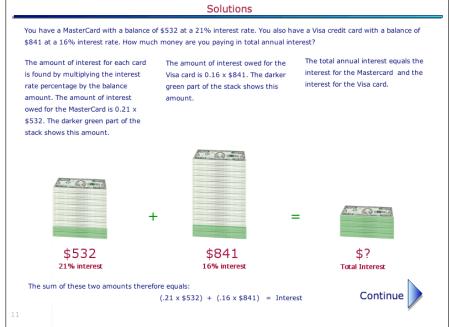Figure 1a. Text-Only Worked example for the first interest problem.

Figure 1b. Worked example with Static Graphics for the first interest problem. In the dynamic graphics group, students construct the stack on the right.

Cognitive Tutor Model Generation Problem (Days 1 and 2)	Model Analysis Problem (Day 3)

You have a MasterCard with a balance of $532 at a 21% interest rate. You also have a Visa credit card with a balance of $841 at a 16% interest rate. How much money are you paying in total interest?	You have a MasterCard with a balance of $532 at a 21% interest rate. You also have a Visa credit card with a balance of $841 at a 16% interest rate. How much money are you paying in total interest? (.21 x $532) + (.16 x $841) = T

	Balance	Interest Rate	Interest Owed
MasterCard	532	21%	.21*532
Visa	841	16%	.16*841
Total	1373		Total Interest

Equation: | .21*532 + .16*841 = Total Interest |

0.21	MasterCard interest rate
532	MasterCard balance
0.21*532	Interest owed for MasterCard
0.16	Visa interest rate
841	Visa balance
0.16*841	Interest owed for Visa
T	Total interest

Figure 2a & 2b. The initial problem text is shown in regular font and example student answers are shown in italics.