

Research Results

Pittsburgh Public Schools, Pittsburgh, PA, 1995

Abstract

Students at three Pittsburgh Public High Schools were given post-tests to assess their performance on both standardized tests (Math SAT and Iowa) and complex mathematical problem solving (a multiple-representations test and a real-world problem solving test developed at Carnegie Mellon University). Experimental classes used Cognitive Tutor Algebra I, while comparison classes used a traditional curriculum. Results showed advantages for the Cognitive Tutor Algebra I group on the problem-solving and multiple representations measures. The study design and results are comparable to those reported in Koedinger, Anderson, Hadley, and Mark (1997).

Study Design:

Matched control group

Measures:

Standardized exam; Math SAT, Iowa Algebra Aptitude Test

Other exam: Problem Situations Test, Multiple Representations Test

Study location:

Pittsburgh Public Schools, High Schools, Pittsburgh, PA (urban)

Study conducted by:

Carnegie Mellon University

Data analyzed by:

Carnegie Mellon University

Course assessed:

Cognitive Tutor Algebra I

Data collection date:

1994 – 1995

District Information:

Type: Public, urban
Students Enrolled: 46,700
% of Students Qualifying for Reduced Lunch: 22%

Ethnic Breakdown:

African American: 56%
Asian: 1%
Caucasian: 42%

Participants

Participants were students in 3 Pittsburgh Public High Schools (Langley, Brashear and Carrick). The three schools have similar demographics: about 50% African-American, 50% from single-parent families, 15% go on to college.

With the exception of students who took algebra in 8th grade (prior to high school), all students at Langley High School used Cognitive Tutor Algebra I as their algebra curriculum. Langley had also moved to an "Algebra for everyone" policy, meaning that all students were required to take Algebra.

At Carrick and Brashear, some teachers used Cognitive Tutor Algebra I and some did not, so some students in these schools were in the CTAl group, and some were in the matched control group.

Method

Students were administered exams during two (approx. 44-minute) class periods near the end of the school year. Four exams were used:

- A subset of the Math SAT (comprising questions pre-selected to emphasize Algebra)
- The Iowa Algebra Aptitude Test
- A Problem Situations test (see Appendix A)
- A Multiple Representations test (see Appendix B)

Results

Due to student absences on the test days, fewer students completed the tests than took the classes. As shown in Table 1, the scores favor the Cognitive Tutor students on all measures except the Iowa test. Reporting of inferential statistics awaits a more complete and formal analysis of the data.

	Cognitive Tutor Algebra I	Control
Iowa Algebra Aptitude	.42	.43
Math SAT subset	.27	.23
Problem Situation Test	.20	.13
Representations Test	.21	.09

Table 1: Student performance (proportion correct) by condition and measure.

Discussion

The results favor the Cognitive Tutor students over the control group on all measures, except for the Iowa test. On that test, the groups are nearly equal in performance.

As would be expected, the differences are largest on the Problem Situation and Representations tests, since those tests are better aligned with the Cognitive Tutor curriculum. The fact that Cognitive Tutor classes did at least as well on the Math SAT subset support the applicability of Cognitive Tutor course's instruction to the more basic skills covered in those tests.

Although the differences between the Cognitive Tutor classes and the control classes are substantial, the absolute proportions correct for both groups leave much to be improved. In part, the low levels of absolute performance reflect the fact that students knew that these were low-stakes tests (administered as part of a research study).

Reference:

Koedinger, K. R., Anderson, J.R., Hadley, W. H., & Mark, M. A. (1997). Intelligent tutoring goes to school in the big city. *International Journal of Artificial Intelligence in Education*, 8, 30-43.

For more information or for additional copies of this report, please go to <http://www.carnegielearning.com/results/reports> or send email to researchpartner@carnegielearning.com

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Appendix A: Problem Situation Test

This is an example of the Problem Situation Test. Several different variants were administered to students, in order to minimize cheating, to sample a wider variety of problems, and to assess what features of problems are most difficult for students.

Currently I have \$1125 in my savings account and I am spending at a rate of \$17 per week. 015

Answer the following questions by filling in the TABLE below.

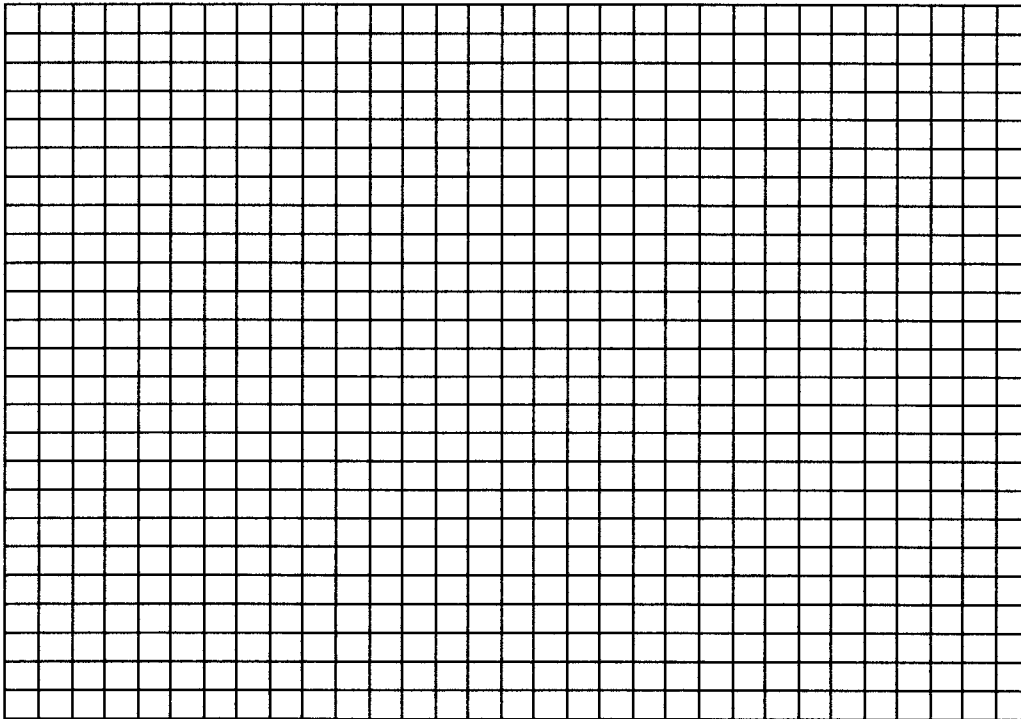
1. How much money do I have after 6 weeks?
2. How much money do I have after 364 days?
3. How many weeks before I have a total of \$3?

TABLE:

	Time (weeks)	Savings
1		
2		
3		

4. Define two variables for time and savings and write an equation that expresses the relationship between them:

5. Create a graph of the relationship between time and savings and plot the 3 points in the Table above. Be sure to label which axis is time and which is savings. Also put numbers on the axes to indicate the scale.



Problem Situation test, page 1

There are 2 Mediterranean Fruit Flies and each minute 3 more are born.

Answer the following questions by filling in the TABLE below.

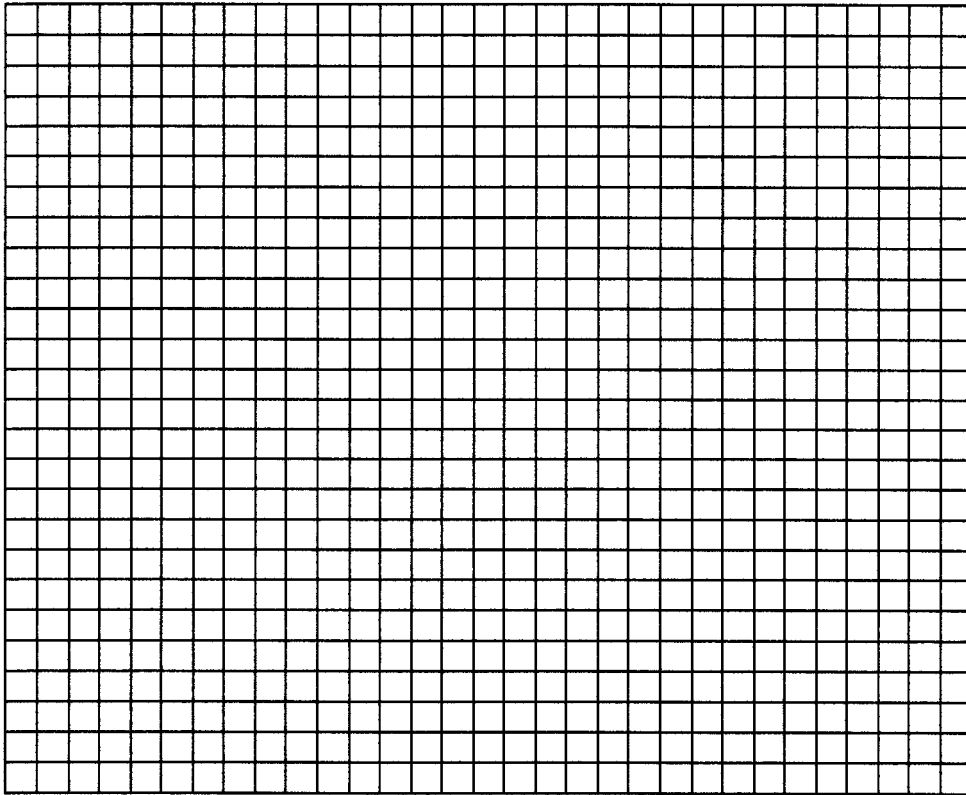
1. How many Fruit Flies are there after 2 minutes?
2. How many Fruit Flies are there after 1/10 of an hour?
3. How long before there are 17 Fruit Flies?

TABLE:

	Time (minutes)	Fruit Flies
1		
2		
3		

4. Define two variables for time and fruit flies and write an equation that expresses the relationship between them:

5. Create a graph of the relationship between time and fruit flies and plot the 3 points in the Table above. Be sure to label which axis is time and which is fruit flies. Also put numbers on the axes to indicate the scale.

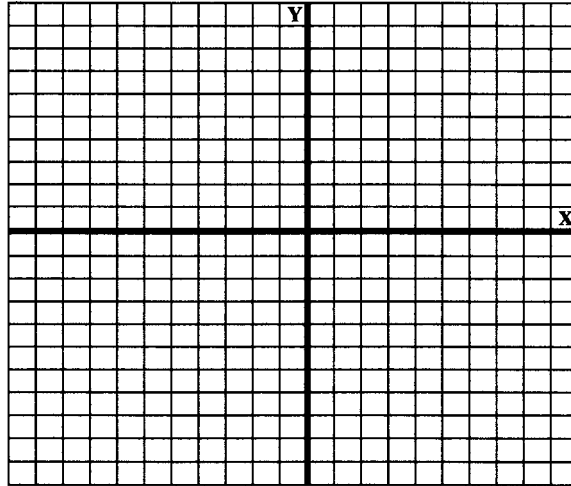


Problem Situation Test, page 2

Appendix B: Multiple Representations Test

ST-1

- 1) Sketch the graph of $Y = 3X - 5$.

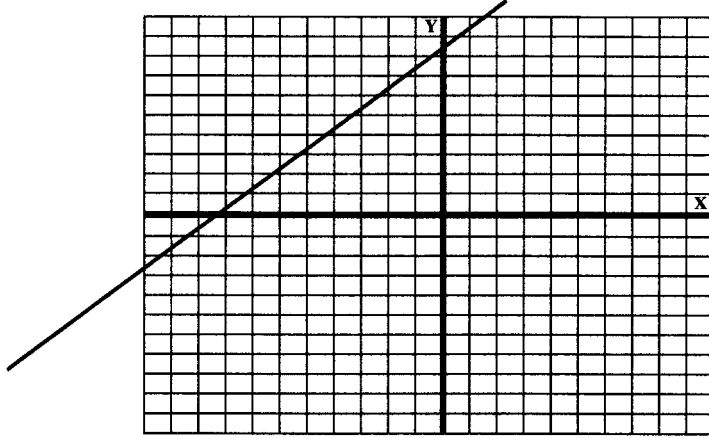


- 2) What is the y-intercept of this graph?
- 3) What is the slope of this graph?
- 4) How would the graph of this equation change if the slope was -2?
- 5) How would the graph of this equation change if the y-intercept was 2?
- 6) Write a situation that could be modeled by the following equation:

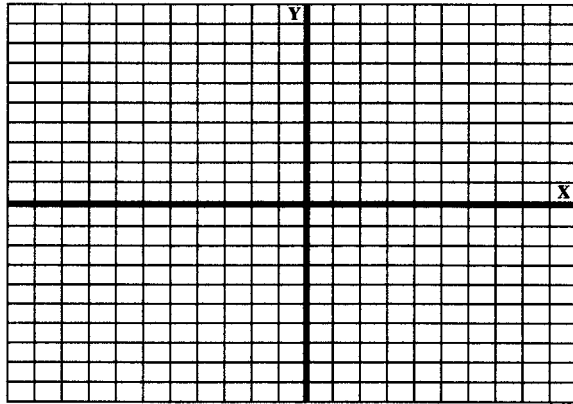
$$Y = 3x + 2$$

Multiple Representations Test, page 1

- 7) Find the equation of the line graphed below:



- 8) Draw the graph of the line parallel to the graph of the line, $Y = 2X + 5$ that passes through the origin.



Multiple Representations Test, page 2