The Weapon of Choice

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Technology doesn’t kill mathematical understanding, but it is *the weapon of choice* for some teachers.

True story

The customer wished to purchase 10 items at $1.49 each.

The cash register was out of order, but the cashier simply took out a pencil and paper...

$$
\begin{array}{r}
1.49 \\
\times\ 10 \\
\hline
000 \\
149 \\
\hline
14.90
\end{array}
$$

Harold Wenglinsky ETS Policy Information Center report (1998)

Does It Compute?
The Relationship Between Educational Technology and Student Achievement in Mathematics

http://www.ets.org/Media/Research/pdf/PICTECHNOLOG.pdf

Harold Wenglinsky report (cont'd)

“The results from this study suggest that, as technology advocates have asserted, technology does matter to academic achievement, with the important caveat that whether it matters depends upon how it is used.”

Harold Wenglinsky report (cont'd)

“The largest correlation in the study was for eighth graders who used computers for drill. Those students lagged behind the average student on the NAEP examinations by an average of 21.2 weeks (out of an average 36-week school year).”

Harold Wenglinsky report (cont'd)

“In contrast, eighth graders who used computers for applications of mathematics showed a gain of the equivalent of 15.1 weeks of instruction in their average scores.”

--CA Mathematics Framework (Chapter 9, p. 259)

Talking points

“First, the data were collected at a single point in time; the aspects of technology studied here occurred at the same time as the educational outcomes of interest.

“Thus, it may be that high-achieving students are more likely to use technology in certain ways rather than that these uses of technology promote high levels of academic achievement.”

Talking points (cont'd)

“Second, while the study takes into account some characteristics of teachers, it does not take into account their overall tendency to teach in certain ways, such as to teach higher-order thinking skills.

“It may be that computers are but one medium among many that teachers use to teach higher-order thinking skills, and that all of these media are conducive to high levels of academic achievement.”

Conclusions?

There are instances of positive association between use of computers and student achievement on the NAEP, and there are instance of negative association between use of computers and student achievement on the NAEP.

True story

After the first midterm was graded and returned, an algebra student came to office hours and asked, “Are you dropping me from the class?

“You said the first day that you would drop the lowest exam score, and I thought maybe I was the one with the lowest score!”

Pathways Through Algebra

Pathways Through Algebra was a project funded by NSF and the Lumina Foundation to study ways to improve California Community College student success in elementary algebra (Algebra 1).

The success rate in elementary algebra throughout California is probably just below 50% (1999: 46%, 2001: 47.5%, 2002: 49.7%, 2003: 49.2%) .

Pathways Through Algebra (cont'd)

Three interventions were considered: (1) a computer-assisted course, (2) a math study center, and (3) a math study skills course.

The results were “mixed but promising...”

Pathways Through Algebra (cont'd)

Success Rate for Algebra Classes

	Control	Intervention
Computer-assisted	48.6%	44.1%
Study Center	39.2%	60.3%
Study Skills	53.6%	66.7%
Total	40.9%	58.2%

Talking points

All students were given the same multiple-choice (skills) exam as the pre- and post-test.

Instructors assigned computer work (ALEKS) for drill, and used lecture time to develop conceptual understanding.

The methodology for choosing control/intervention was not specified.

Conclusion?

Student performance on standardized multiple-choice exams does not necessarily improve when the students are required to do computer drill.

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2007 Report to Congress on effectiveness of software

The Department of Education's National Center for Education Evaluation and Regional Assistance, under congressional mandate, produced a preliminary report (4/4/07) on the impact of technology on student academic achievement.

http://ies.ed.gov/ncee/pubs/20074005/

Software used in the study

Grade 6
Successmaker™, Pearson Digital Learning
SmartMath™, CompuTaught, Inc.
Achieve Now™, PLATO Learning, Inc.
Larson Pre-Algebra, Meridian Creative Group

Algebra
Cognitive Tutor©, Carnegie Learning, Inc.
Algebra, PLATO Learning, Inc.
Larson Algebra, Meridian Creative Group

2007 Report to Congress on effectiveness of software (cont'd)

“The main findings of the study are:

“1. Test Scores Were Not Significantly Higher in Classrooms Using Selected Reading and Mathematics Software Products.

“Test scores in treatment classrooms that were randomly assigned to use products did not differ from test scores in control classrooms by statistically significant margins.

2007 Report to Congress on effectiveness of software (cont'd)

"2. Effects Were Correlated With Some Classroom and School Characteristics.

"For reading products, effects on overall test scores were correlated with the student-teacher ratio in first grade classrooms and with the amount of time that products were used in fourth grade classrooms.

"For math products, effects were uncorrelated with classroom and school characteristics."

2007 Report to Congress on effectiveness of software (cont'd)

The study involved 33 districts, 132 schools, and 439 teachers.

In mathematics grade 6, there were 10 districts, 28 schools, 81 teachers and 3,136 students, and

for algebra, 10 districts, 23 schools, 71 teachers and 1,404 students.

Some talking points about the study:

The results reflect findings after a single year, and none of the teachers had used the software before that year. 50% of the teachers indicated that they needed more support/training.

The software was assigned to (not selected by) instructors, who were not required to use the software in any specified fashion.

Some talking points about the study (cont'd):

The findings are averaged over all the software products. This method of reporting could mask the positive results of one product if there were offsetting negative results from other products.

Student achievement was measured using SAT-10 and the ETS End-of-Course Algebra Assessment (1997).

Some talking points about the study (cont'd):

90% of the teachers found the software useful and planned to continue using it.

The schools involved did not necessarily have an adequate technology infrastructure to accommodate the classes.

Conclusion?

The presence of software in the classroom does not guarantee that students in those classrooms will perform significantly better on standardized tests than students in other classrooms.

True story

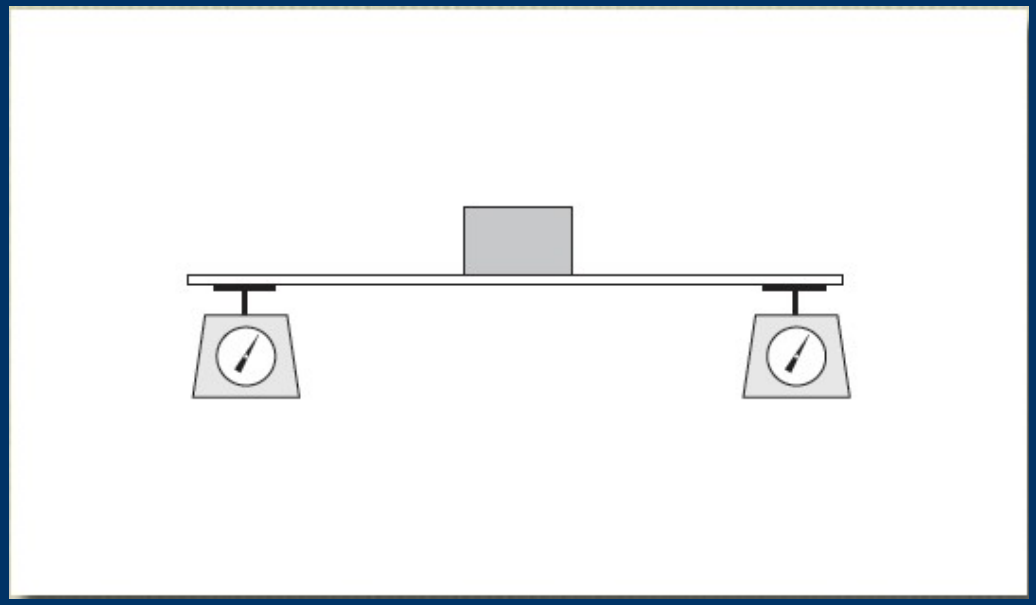
Students complained that the exam had a specific problem unlike anything they had seen in their homework.

The instructor pointed out that the problem in question was identical to one assigned in homework.

True story (cont'd)

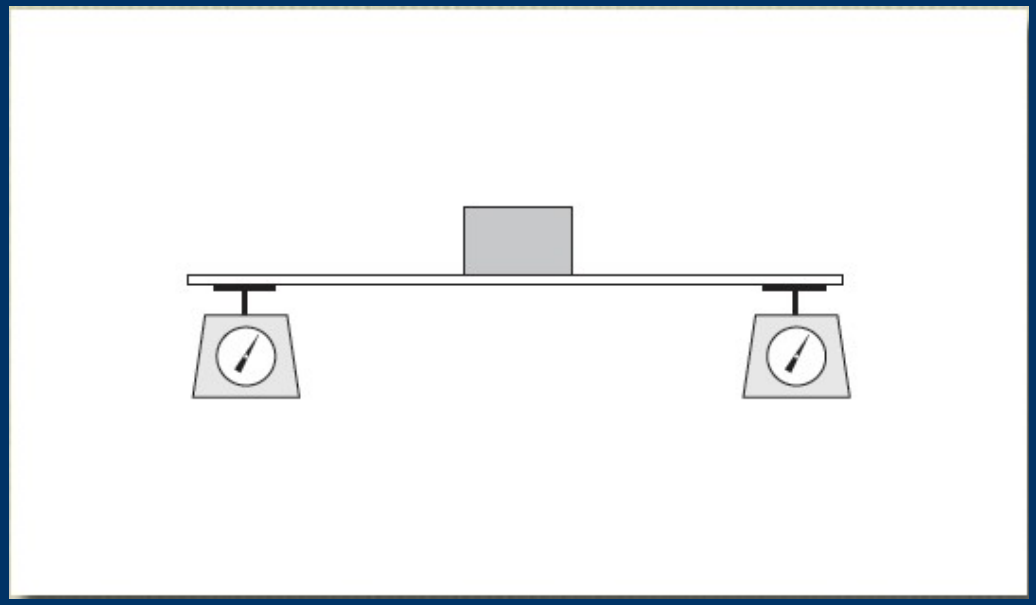
“But you used a different font!”

Computer animation and engagement



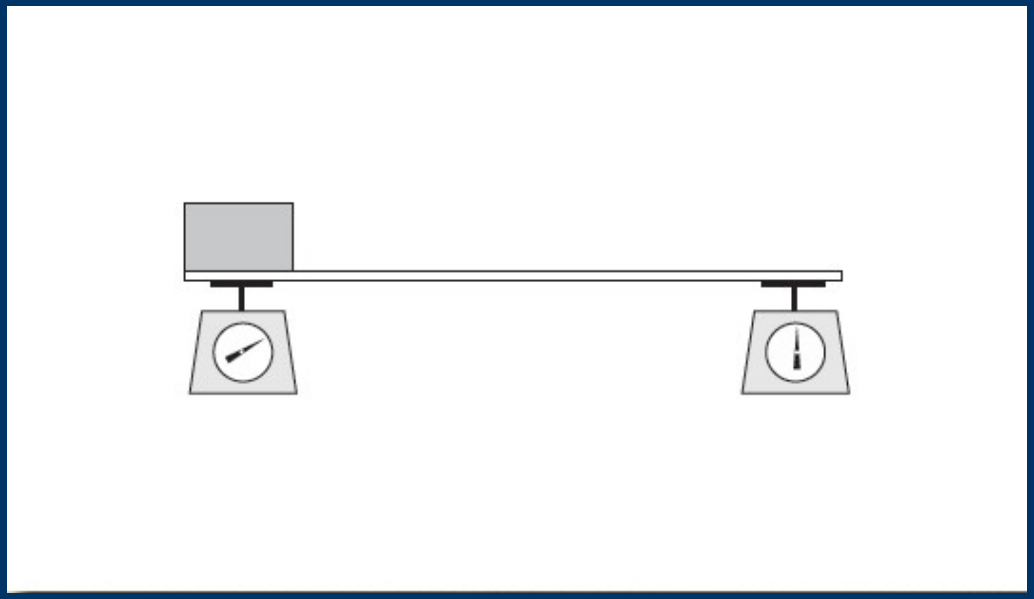
Common misconception: The plank evens out the load, so scale readings don’t change even if the mass is moved.

Computer animation and engagement (cont'd)



Students are shown a simulated laboratory experiment demonstrating that scale readings depend on the position of the mass.

Computer animation and engagement (cont'd)



One student's conclusion weeks later:

“As demonstrated in lecture both scales will read 10 N regardless of where the center of mass is located. The platform and the metal block form one unit that is being measured, so the scales show two evenly distributed readings, no matter where the metal block is placed along the platform.”

Eric Mazur's conclusion:

If a student has internalized an incorrect mental model, observation can reinforce misconceptions.

To replace the incorrect model, the student needs to predict an outcome before making an observation, record the observation, and reconcile prediction with observation.

http://mazur-www.harvard.edu/

True story

The unit circle

(Not drawn to scale)

Best practices

What are the best ways of using technology to help students learn mathematics?

Best Practices for Math on the Web

July 25-29, 2007 twenty people gathered at the MAA's Carriage House to consider desirable attributes of Web-based resources for mathematical learning.

Kansans outnumbered Californians 2 to 1.

The organizers thought the title “Best Practices” was too arrogant, and called the workshop “Better Practices for Math on the Web”.

http://www.mathonweb.org/wiki/index.php/Better_Practices_for_Math_on_the_Web

Better Practices (cont'd)

Goals of Better Practices (abridged list)

Both the tools and content should be open source. The underlying goals here are accessibility to users, ease of authoring, and extensibility or customizability.

Better practices should not be restrictive...This goal and the preceding goal are sources of great conflict. Much of the best software is proprietary.

Frank Wattenberg
http://www.mathonweb.org/wiki/index.php/Goals_of_Better_Practices

Better Practices for Math on the Web

Issues: Access and reusability

The World Wide Web Consortium (W3C) has approved standards for MathML, an extension of HTML for display of mathematical expressions on the Web.

Observing standards allows compatibility not with only different browsers, but also with electronic readers for visually impaired, search engines, hand-held devices, printers, projectors, and computer algebra systems.

Better Practices (cont'd)

Issues: Access and reusability

The syntax for MathML is NOT TeX, and it is unwieldy.

(But there are translators available.)

Microsoft does NOT support MathML.

(But there is a free plugin available from Design Science.)

Better Practices (cont'd)

Issues: Access and reusability

We should design web pages to “degrade gracefully”:

Use the simplest technology appropriate.

Provide alternate descriptions.

Kyle Siegrist
http://www.mathonweb.org/wiki/index.php/Web-documents

Better Practices (cont'd)

What I learned:

Style sheets can help to separate content from presentation.

Current means of displaying mathematical expressions have strengths and weaknesses.

Flash has advantages and disadvantages compared with Java for creating applets.

Where can a math instructor get started?

One possibility:
the MAA Mathematics Digital Library

MathDL Partners

- *Loci*
- *MAA Writing Awards*
- *MathResources, Inc*
- *Math Forum*
- *PlanetMath*
- *MathWorld*
- *Connected Curriculum Project*
- *iLumina Digital Library*

MathDL Partners (cont.)

- The Mathematics Survey
- Virtual Libraries in Probability and Statistics
- National Curve Bank
- causeweb.org
- Demos with Positive Impact
- NSDL Middle School Portal
- WeBWorK
- Eduworks
- webODE (getting underway)

MathDL examples

- MAA Writing Awards
- *Loci*
- *Loci Convergence*
- *On This Day*
- *Loci Resources*
- *JOMA*

True story

During an exam, the student came up to the teacher and complained that not enough information was given for one of the problems...

“You gave us the radius of a circle, and we have to figure out the diameter.

“I know that $d = rt$, but I don't know what the time is.”

True story (cont'd)

“It's two o'clock!”

Thank you!

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http://faculty.piercecollege.edu/yoshibw