

WeBWorK: An effective online tool for assessment in Mathematics

Joseph Lo

Sandi Merchant

Costanza Piccolo

Carl Wieman Science Education Initiative
Department of Mathematics

Motivation

Issues

- Free up TA time to use it more effectively and efficiently while continuing to provide feedback on homework.
- Provide faster feedback on homework

Approach

WeBWork, an open-source online homework system supported by the Mathematical Association of America and the NSF.

What is WeBWorK?

An open-source online homework tool . . .

 **WeBWorK**

Logged in as student.
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WebWork → TestCourse → HW3

HW3

[Download a hardcopy of this homework set.](#)

Name	Attempts Remaining	Worth	Status
Problem 1	0	unlimited	1 0%
Problem 2	0	unlimited	1 0%
Problem 3	0	unlimited	1 0%
Problem 4	0	unlimited	1 0%
Problem 5	0	unlimited	1 0%
Problem 6	0	unlimited	1 0%
Problem 7	0	unlimited	1 0%

Set Info

WeBWorK assignment number HW3 is due : 05/22/2008 at 05:30am EDT.

The [main page](#) for the course contains the syllabus, grading policy and other information.

The primary purpose of WeBWorK is to let you know that you are getting the correct answer or to alert you if you are making some kind of mistake. Usually you can attempt a problem as many times as you want before the due date. However, if you are having trouble figuring out your error, you should consult the book, or ask a fellow student, one of the TA's or your professor for help. Don't spend a lot of time guessing -- it's not very efficient or effective.

Give 4 or 5 significant digits for (floating point) numerical answers. For most problems when entering numerical answers, you can if you wish enter elementary expressions such as $2 \wedge 3$ instead of 8, $\sin(3 * pi/2)$ instead of -1, $e \wedge (\ln(2))$ instead of 2, $(2 + \tan(3)) * (4 - \sin(5)) \wedge 6 - 7/8$ instead of 27620.3413, etc. Here's the [list of the functions](#) which WeBWorK understands.

You can use the Feedback button on each problem page to send e-mail to the professors.

Page generated at 10:22am on May 12, 2008
WeBWorK © 2000-2006 [The WeBWorK Project](#)

*Locally maintained by CTLT

WeBWorK offers:

- Variety of answer formats
 - Numbers (with specified error tolerance)
 - Mathematical expressions (symbolic)
 - Words
 - Multiple Choice
 - Essay (unmarked)
- Randomized parameters: can generate unique numbers and graphs for each student
- Specified number of attempts, with instant feedback
- Large existing problem database of math problems
- Quiz mode for limited-time assignments

How we use WeBWorK

Courses:

- Differential Calculus (MATH 100, 102, 104, 110, 180, 184)
- Integral Calculus (MATH 101, 103, 105)
- Multivariable Calculus (MATH 200, 253)
- Vector Calculus (MATH 264)
- Linear Algebra (MATH 152, 221)

Total of 9673
students in 2012/13

Implementation:

- Weekly assignments worth up to 10% of final grade
- Randomized numbers for each student
- Multiple attempts
- Common assignments to all sections in most courses
- Diagnostics/review assignment at start of term
- Pre-reading quizzes

How students use WeBWorK: (first year courses, self-reported)

Productive Habits

Rework a problem to correct errors either on your own or by searching for hints in your notes/textbook.

Never	Occasionally	Often	Very Often
7%	28%	38%	28%

Ask Instructor/TAs or other students for help to solve problems.

Never	Occasionally	Often	Very Often
36%	31%	21%	13%

Unproductive Habits

Use Wolfram Alpha or similar resources to obtain the solution to a problem.

Never	Occasionally	Often	Very Often
29%	41%	16%	13%

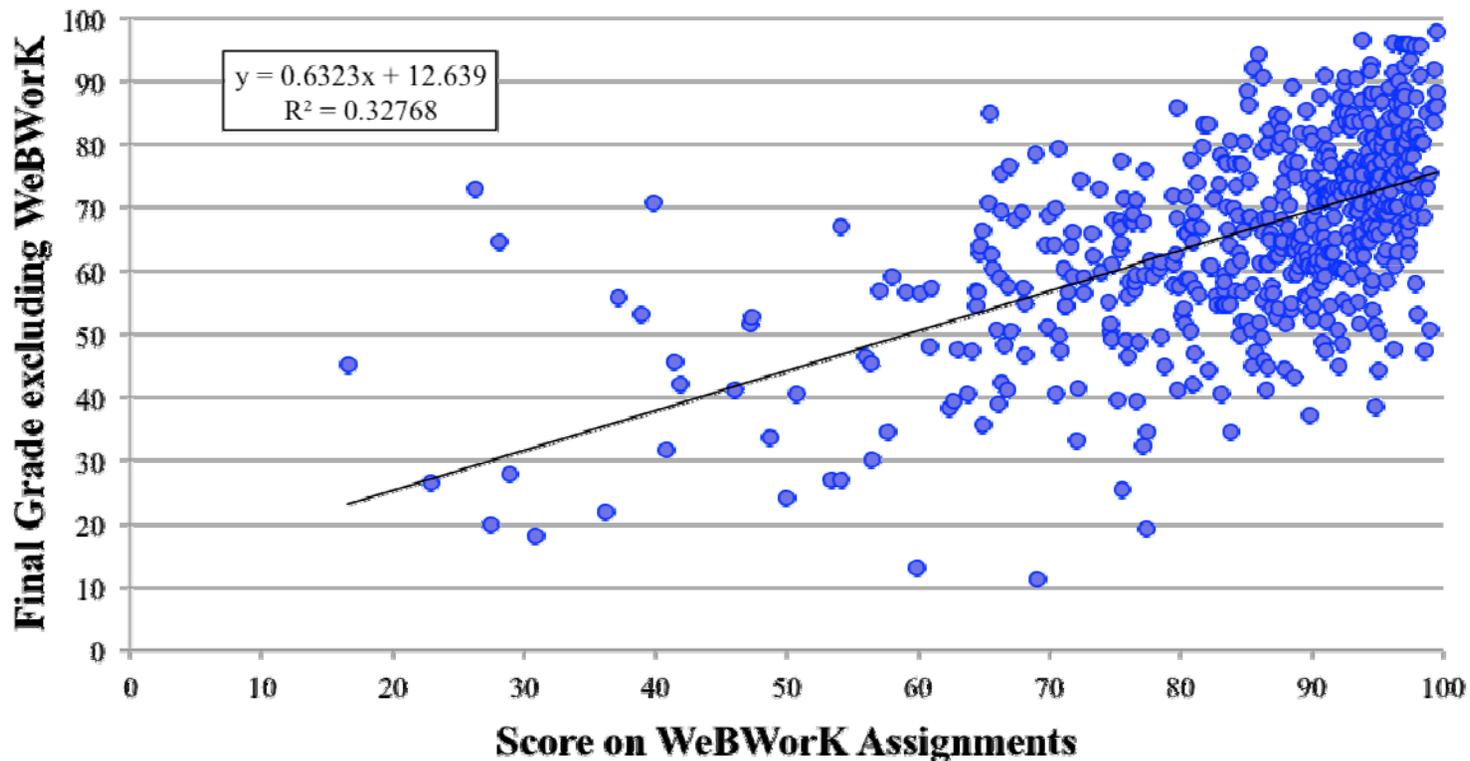
Guess the answer to a question.

Never	Occasionally	Often	Very Often
34%	47%	14%	5%

Correlation with marks

(MATH 102)

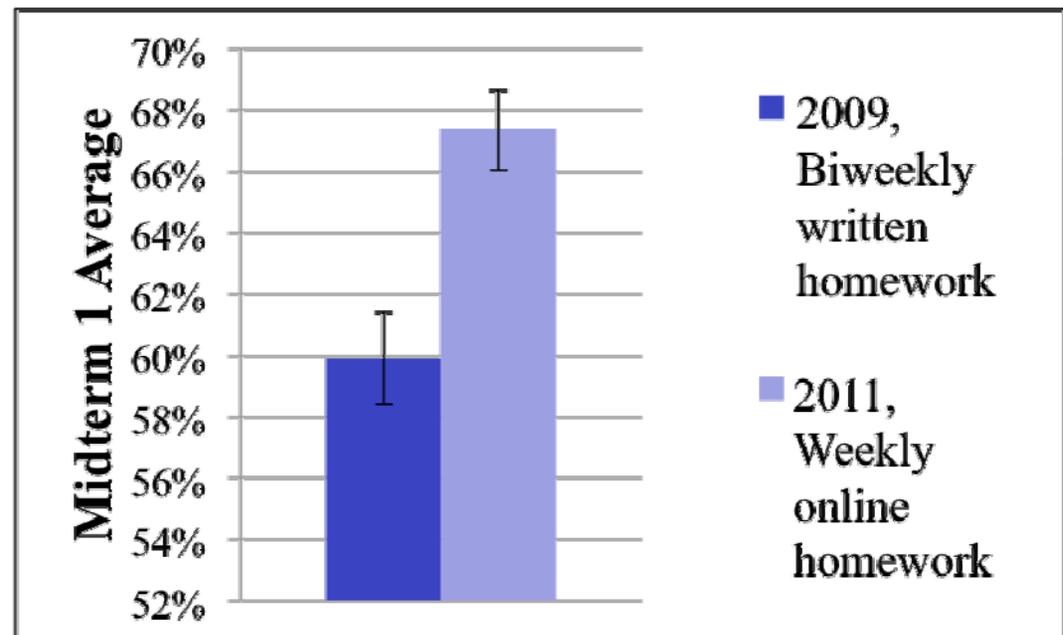
- WeBWorK consists of weekly homework and pre-lecture quizzes
- Average WeBWorK score 85.2%
- Median WeBWorK score 89.9%



Improved exam performance

(MATH 101: Written vs. online homework)

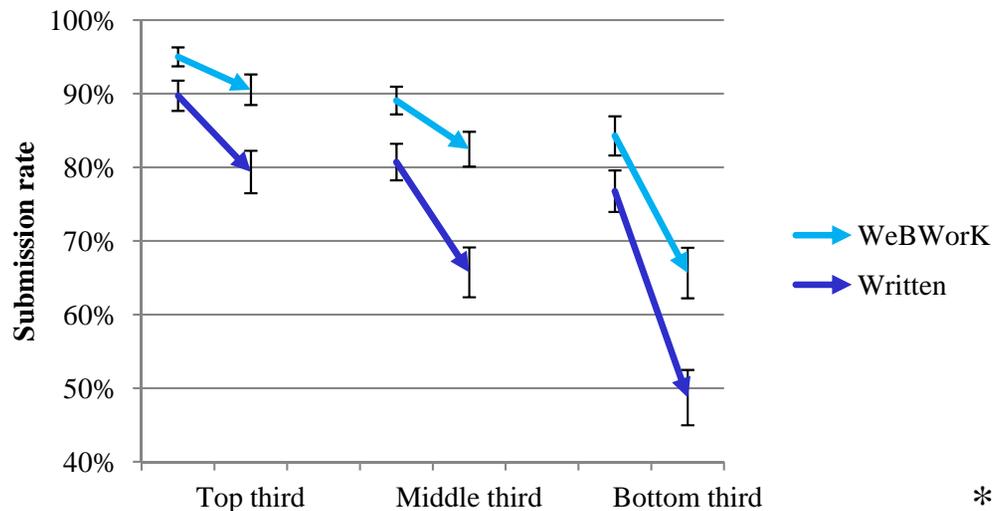
- 2009: Biweekly written assignments and in-class quizzes
- 2011: Weekly online assignments and in-class quizzes
- Same instructor



Persistence in assignment submission

(MATH 110 – A two term course)

From Term 1 to Term 2



Number of students: 238

Grouped by final exam grades:

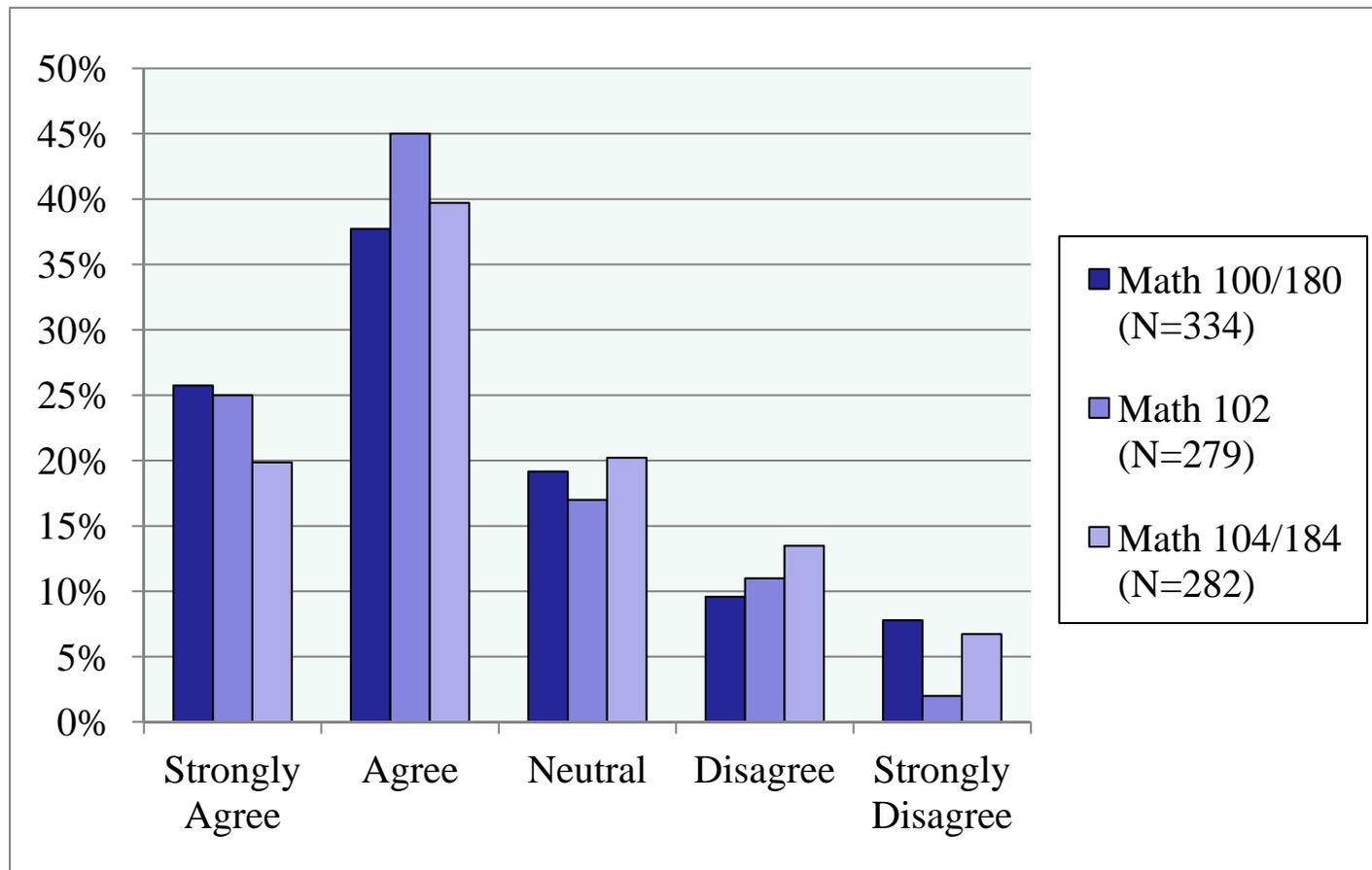
- Top third: > 59%
- Middle third: 44% to 59%
- Bottom third: < 44%

*Submitted means received a mark of >20%

The drop of submission rate from Term 1 to Term 2 is smaller for WeBWorK than for written assignments, regardless of student performance.

Students' attitudes about immediate feedback

“The immediate responses I got from WeBWorK helped me learn the course material.” (online survey)



Students' attitudes about online vs. paper-based homework

“If you were to take a similar course again, which homework program would you prefer ?”

(online survey, N = 618 respondents)

Online survey options	% responses
Only WeBWorK assignments	31%
Only hand-in assignments	8%
Only in-class quizzes based on a list of suggested problems	5%
A combination of WeBWorK and short hand-in assignments	25%
A combination of WeBWorK and short in-class quizzes	29%

Sources of students' frustration in WeBWorK

Students are often

- confused by the answer format required by WeBWorK
- frustrated by the particular syntax required by WeBWorK

Guessing behaviour on true/false questions (MATH 221, Two sections)

Many multiple true-false questions were given throughout the course:

- One section: Unlimited attempts: 7 true-false statements in a question
- Another section: Limited (7) attempts: 5 true-false statements

No indications on correct answers until all are correct.

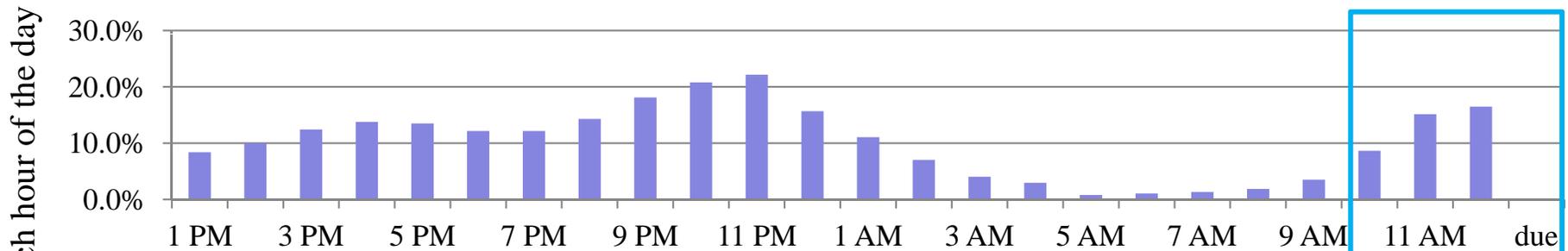
	Unlimited attempts	Limited attempts
Avg % students who got full mark in true/false questions	75.3%	79.5%
Avg % students who exhibit “guessing behaviour” when doing questions (“guessing behaviour” – 4 submissions within 30 seconds)	47.4%	9.7%

Who guessed? Both high- and low-performing students did.

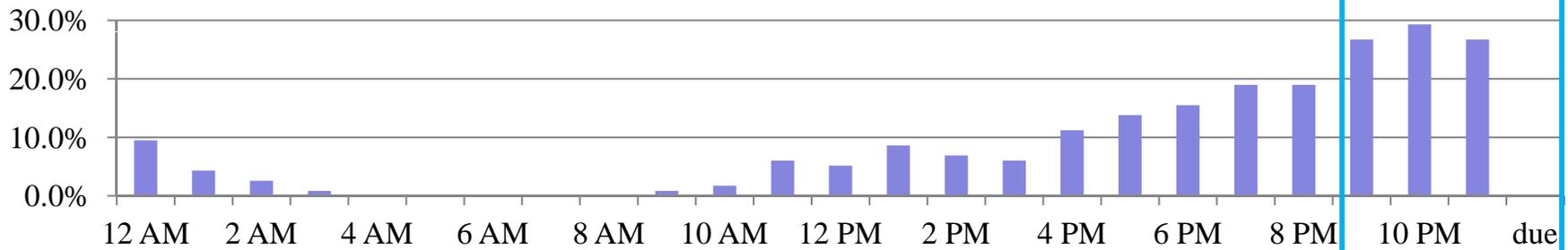
	% students who exhibited “guessing behaviour”
Top third (final grade > 77)	40.4%
Middle third (final grade from 64 to 77)	52.8%
Bottom third (final grade < 64)	51.4%

Due time and last-minute working trend (3 different first/second year course)

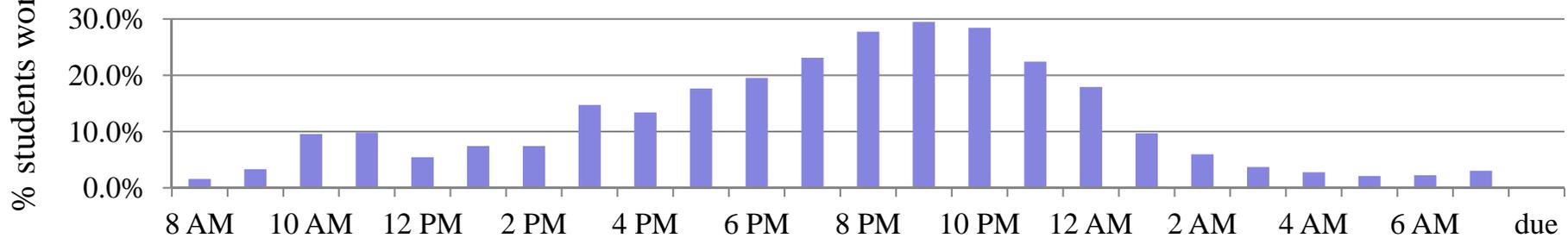
Due Time at 1:00 PM



Due Time at 12:00 midnight



Due Time at 8:00 AM



24 hours before due time

Summary

- WeBWorK has now been implemented in most of our large undergraduate math courses.
- Students report in surveys that they:
 - find the immediate feedback provided to be helpful for learning
 - prefer a homework structure that includes some WeBWorK over one that consists only of traditional written assignments
 - use the system primarily in ways that are productive for learning
- Evidence that WeBWorK is an effective online assessment tool:
 - performance on WeBWorK assignments correlates well with overall course performance
 - submission rates are higher and decrease more slowly over the term than with written homework.
 - there are indications that exam performance increases with the introduction of WeBWorK

Future work

- Analyse types of errors (i.e. guessing vs. syntax/format errors)
- Improve specific assignments and problems to reduce student frustration with syntax and answer formats.
- Develop custom remedial assignments based on diagnostic results