



WeBWorK

An open-source
on-line homework system
for mathematics

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<http://webwork.maa.org>

Overview: what WeBWorK is:

- WeBWorK is a web-based homework checker. (WebAssign and WeBWorK are similar)
- Originally designed at University of Rochester and now actively supported by math and science faculty nationwide.
- Supported by Math Association of America (MAA) the NSF

Overview: what it does

- The overwhelming majority of students complete all of their homework correctly -- (sometimes after several attempts).
- It is particularly adept at handling mathematics and physics problems.
- The homework is corrected and graded efficiently and completely.

Key features of WeBWorK ¹



WeBWorK's Goal:

Making homework more effective and efficient.

It increases the effectiveness of traditional homework as a learning tool by:

Providing students with **immediate feedback** on the validity of their answers and giving students the opportunity to correct mistakes while they are still thinking about the problem. As one student said, “I can fix my mistakes while [the] problem is fresh in my mind.”

Providing students with **individualized versions** of problems so instructors can encourage students to work together; yet each student must develop an answer to his or her own version of the problem.

It increases the efficiency of traditional homework by:

Providing automatic grading of assignments.

Providing information on the performance of individual students and the course (or section or recitation) as a whole.

How WeBWorK works



Screen shots:

A math question



◀ Previous ▲ Prob. List Next ▶

(1 pt) **introduction/s2_2_1_mo.pg**

If $f(x) = 3x^2 - 3x - 6$, find $f'(x)$.

Find $f'(1)$.

Find $f'(1)$ -- this time WeBWorK will not do calculations for you.

First attempt



◀ Previous ▲ Prob. List Next ▶

Entered	Answer Preview	Result	Messages
6x-(3		incorrect	Missing close parenthesis for '('
3	$6 \cdot 1 - 3$	correct	
6*1 - 3		incorrect	Can't use '*' in this context

At least one of the answers above is NOT correct.

(1 pt) introduction/s2_2_1_mo.pg

If $f(x) = 3x^2 - 3x - 6$, find $f'(x)$.

6x-(3

Find $f'(1)$.

6(1)-3

Find $f'(1)$ -- this time WeBWorK will not do calculations for you.

6*1 - 3

Now I've got it!!



◀ Previous ▲ Prob. List Next ▶

Entered	Answer Preview	Result
6*x-3	$6x - 3$	correct
3	$6 \cdot 1 - 3$	correct
3	3	correct

All of the answers above are correct.

(1 pt) introduction/s2_2_1_mo.pg

If $f(x) = 3x^2 - 3x - 6$, find $f'(x)$.

6x-3

Find $f'(1)$.

6(1)-3

Find $f'(1)$ -- this time WeBWorK will not do calculations for you.

3

interval example



Entered	Answer Preview
$(-3,7)$	$(-3, \frac{35}{5})$

The answer above is correct.

(1 pt)

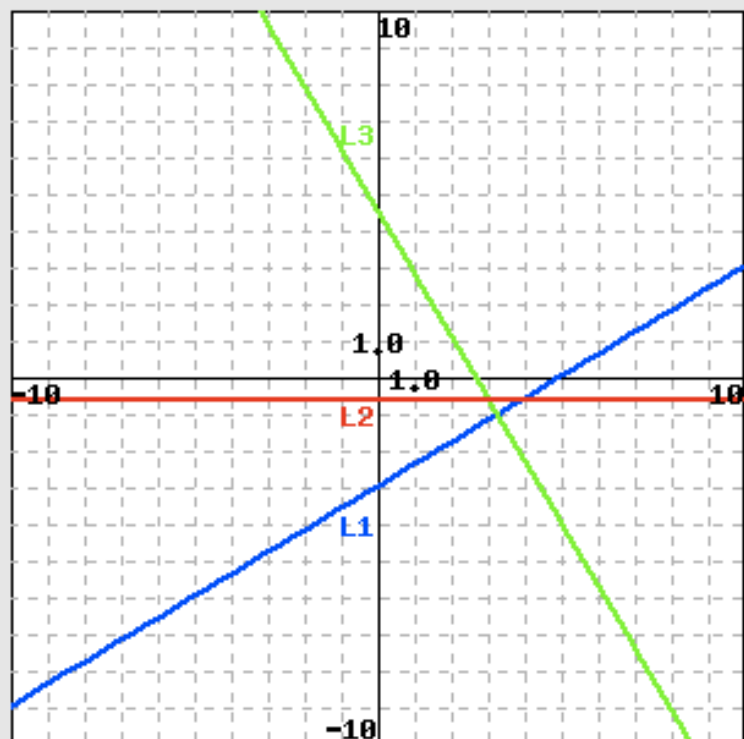
The interval described in set notation by the inequality $|5x - 10| < 25$ has interval notation:

Sample responses to incorrect answers

Entered	Answer Preview	Messages
$(-3,7]$	$(-3, 7]$	The type of interval is incorrect

Entered	Answer Preview	Messages
$(-3,35/5)$		Missing operand before '!

Graph examples



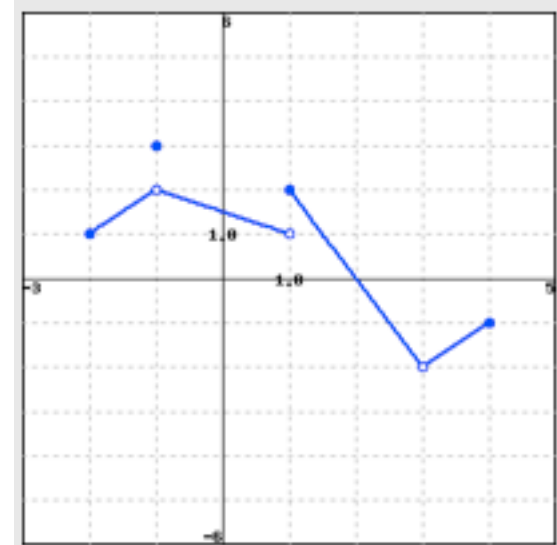
Match the Lines L1 (blue), L2 (red) and L3 (green) with the slope each set listed below:

- 1. The slope of line $L1$
- 2. The slope of line $L3$
- 3. The slope of line $L2$

- A. $m = -1.7$
- B. $m = 0.6$
- C. $m = 0$



Let F be the function below.



Evaluate each of the following expressions.

Note: Enter 'DNE' if the limit does not exist

a) $\lim_{x \rightarrow -1^-} F(x) = \square$

b) $\lim_{x \rightarrow -1^+} F(x) = \square$

c) $\lim_{x \rightarrow -1} F(x) = \square$

Using WeBWorK



Using WeBWorK, **instructors can ask most questions** typically found in mathematics and other scientific textbooks, as well as more advanced interactive questions.

WeBWorK's **National Problem Library** contains more than 20,000 questions covering trigonometry, college algebra, pre-calculus through calculus, linear algebra, differential equations, vector calculus, probability, statistics, physics, some chemistry and other subjects.

Hosting for small mathematics courses (<100 students per institution) is available through the MAA. (webwork.maa.org)

Why students like WeBWorK

- *"Yes. It was very helpful to know if I was wrong and be able to work the problem through until I knew and understood how to get it right."*
- *"I understand the problems better when given the ability to correct them."*
- *"I think it's a better way to learn."*
- *"I really like finding out right away and being able to rework a problem I got wrong."*
- *"I loved it. It helped me develop on my skills."*
- *"Significant increase in motivation [thus] giving students more confidence"*
- *"It was helpful in learning from mistakes & seeing mistakes."*
- *"Very much so. I don't have to wait for lecture to see if I'm doing it right."*
- *"Yes. It makes you want to redo it; after finding an answer, you feel accomplished, immediate feedback makes sure you have accomplished something."*

Why instructors like WeBWorK ¹



John Curran, [Eastern Michigan University](#)

“There is a great variety of technology that can be used in teaching mathematics courses.... In my opinion, the WeBWorK system provides the greatest improvement in student learning among these technologies. I have taught the same courses with and without WeBWorK. Based on this, I know that WeBWorK increases students' motivation when working on homework. In addition, it increases the amount of discussion between my students and me about an assignment. That discussion is of higher quality... and it is more conceptual and detailed than it otherwise would be.”

WeBWorK sites



Reference URLs

- Information:

- <https://webwork.maa.org>
- <https://webwork.maa.org/wiki>

- Demo

- <https://test.webwork.maa.org/webwork2/maa101>, maa102, etc.
- Login: profa Password: profa -- instructor version OR
Login: jdoe Password:jdoe -- student version

- Video and full presentation at Sage3 I

- <http://wiki.sagemath.org/days3I> (see Wednesday's presentation)

End

- Thanks


Who is using WeBWorK?

- 151 universities known to be serving WeBWorK homework from their own servers.
- 103 courses hosted at the MAA for small courses at colleges and high schools and for first timers.
- We estimate in total there are more than 300 institutions using WW.



American Institute of Mathematics (AIM)
WeBWorK Workshop
August 2007
and
100's of instructors writing questions
(more than 12,000 collected in the national library)

Timeline

- Fall 1996 - WeBWorK first used in classes at U of R
- Spring 1999 - NSF support for WeBWorK at U of R NSF 
- Fall 1999 - WeBWorK received ICTCM award for Excellence and Innovation with the Use of Technology in Collegiate Mathematics
ICTCM 
- Spring 2003 - WeBWorK2 is first released
- Summer 2004 - MSRI sponsors WeBWorK programming workshop
- 2007 - More than 100 universities and colleges serving WeBWorK and more than 150 courses hosted on U of R server
- August 2007 - American Institute of Mathematics sponsors workshop on WeBWorK development and outreach
- August 2008 - WeBWorK 2.4.5 released.
- August 2008 - Moodle interactivity in beta. (6-12 installations)

Features to look for in demo:

- Download a typeset copy of the entire homework set
- Use gateway quiz or homework set mode
- Each student's homework set is different
- 'Email instructor' button aids communication
- Create homework sets from library with more than 12,000 problems.
- Precalculus, calculus I and II, multivariable calculus
- Linear algebra, differential equations, statistics, classical physics

- A partial list of answer types that can be checked with current response evaluators.
 - Real and complex numbers - to specified accuracy
 - Functions - of one or more variables: ($x^3+5x-4+\sin x$)
 - Numbers or functions with units (500 cm or 5 m)
 - Antiderivatives -- up to a constant
 - True-False, multiple choice, short answer
 - Solutions to non-homogeneous ODE up to a solution of the homogeneous ODE
 - Eigenvectors, parallel vectors, vectors lying in a given span
 - Independence of a set of vectors

Some demo courses

- Demonstration
- first semester calculus
- Applets
- <https://hosted2.webwork.rochester.edu/webwork2/maa101>, maa102, maa103, etc.

Why instructors like WeBWorK ²



Alan Tucker, [SUNY Stony Brook](#):

“...Without instant grading of math homework, even if students do math homework assignments, they do not know if they have done them correctly-- unless the answer is in the back of the book (in which case it is tempting to copy the answer and work backward from it). Being told immediately that their answer is wrong is a strong motivation for students to keep working on a problem. Engaging students to stick with a problem until they get it right is an extremely powerful strategy for good learning...”

What students think of WeBWorK: survey results

- Positive – the top of the list
 - Immediate feedback
 - Prefer WeBWorK to paper & pencil homework
 - Structured system supports homework completion

- Negative – the top of the list
 - Syntax--difficult to type in long answers
 - No partial grade
 - No way to tell if answer is almost correct

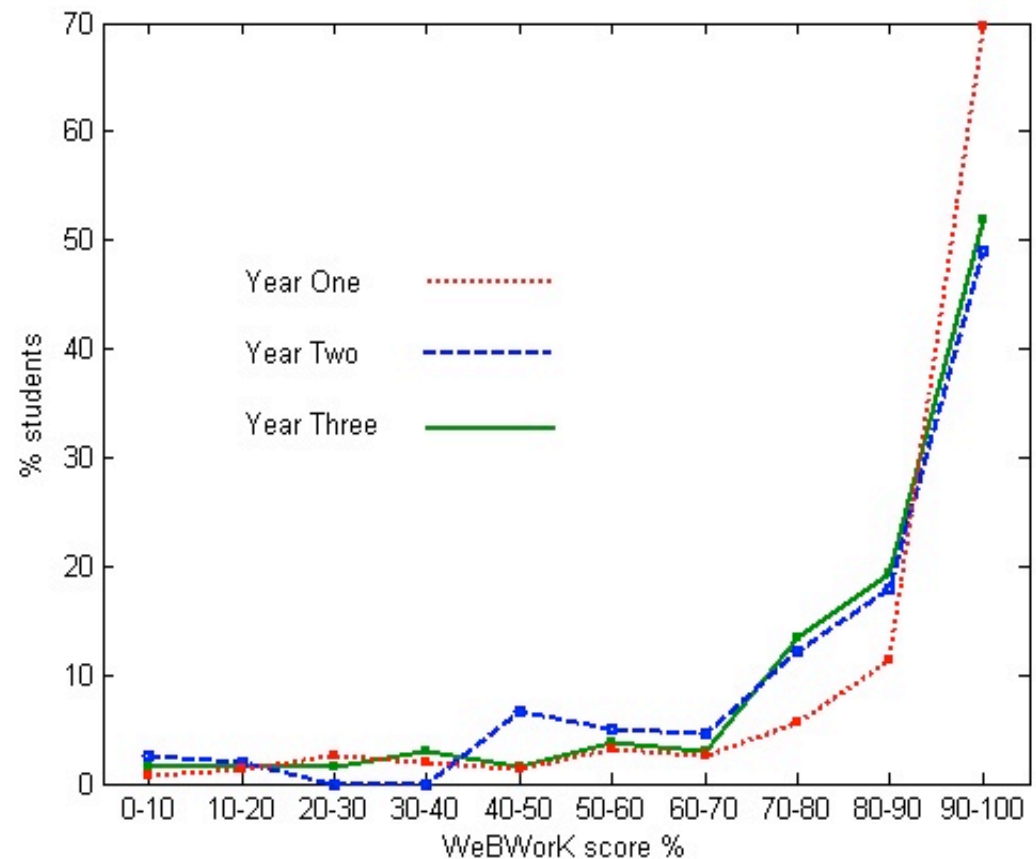
How students interact with the system

Students complete their problem sets

Score = # of successfully solved problems
 over the course of a semester. Each data
 point = % of students in the specific
 interval

N = 196, 158 and 135 students

Fall 2002, 2003, 2004



How students interact with the system, continued

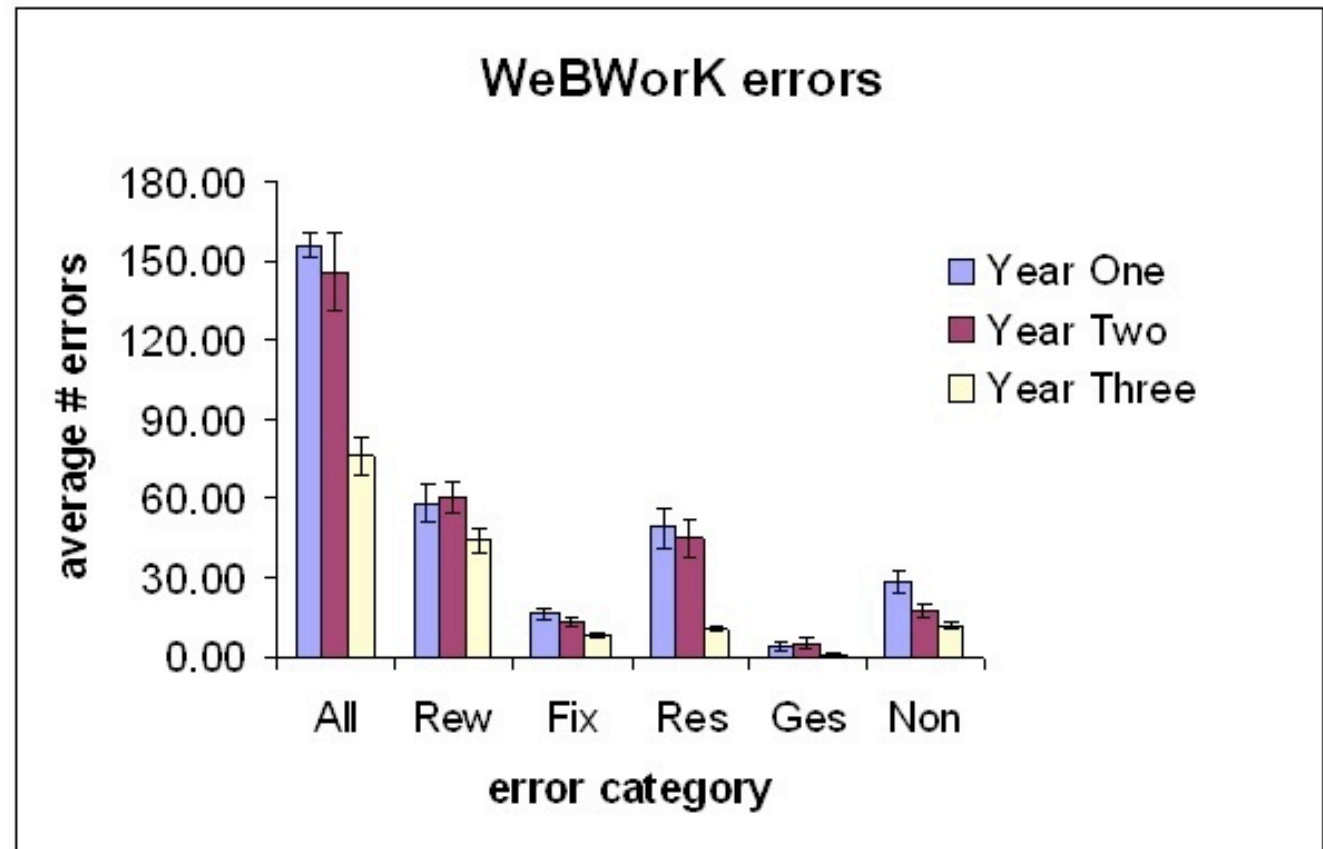
- Detailed analysis at the keystroke level for 96 Calculus I students (2002, 2003, 2004, A, B, C, D students in each cohort)
- Responses to error messages could be categorized
 - Reworking the problem
 - Fixing an entry error
 - Resubmitting the same or equivalent answer--a surprise
 - Guessing
 - Nonsense

How changes to WeBWorK influence interaction

- Preview feature: before Fall 2003
- Resubmission alert: before Fall 2004

How changes to WeBWorK influence interaction

Distribution of entry errors Calculus 1, 2002, 2003, 2004. Data are averaged across 32 students for each year and across two raters.



WeBWorK works with others

Display mathematics with

jsMath, MathJax, mathML, gif and png images

Interact with applets:

Goegebra, javaScript, Flash applets, Java applets, HTML5

Integrates as a component of Moodle -- soon Blackboard

Moodle: model Calculus site

<https://test.webwork.maa.org/moodle/>

15 September - 21 September

Text	Topic	Supplementary Problems	Recitations	WeBWork
1.6	Inverse Functions and Logarithms	1.6 21, 23, 25, 35, 38, 49	App. D, 1.3, 1.5	WeBWork Set 1 due Mon, Sept 22, 6:00 AM
2.1	Tangents, Velocity, Limits	2.1 3, 5		
2.2	The Limit of a Function	2.2 1, 3, 5, 9, 15, 25, 27		

 [Set 1](#)

22 September - 28 September

Text	Topic	Supplementary Problems	Recitations	WeBWork
2.3	Limit Laws	2.3 1, 5, 7, 10, 11 - 23 (odd), 35, 37, 57	1.6, 2.1, 2.2	WeBWork Set 2 due Tue, Sept 29, 6:00 AM
2.5	Continuity	2.5 3, 17, 20, 39, 45, 47, 60		
2.6	Limits at Infinity, Horizontal Asymptotes	2.6 3, 5, 13 - 31 (odd)		

 [Set 2](#)



MTH201 Probability (Fall 2009)

You are logged in as [Michael Gage](#) (Logout)





mathmoodle ► math201-fa09

Switch role to... Turn editing on

People

 [Participants](#)












Activities

-  [Assignments](#)
-  [Choices](#)
-  [Forums](#)
-  [Resources](#)
-  [WeBWorK Problem Sets](#)
-  [Wikis](#)

Search Forums

[Advanced search](#)

Administration

-  [Turn editing on](#)
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-  [Assign roles](#)
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-  [Import](#)
-  [Reset](#)
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-  [Questions](#)

Weekly outline

MTH201 -Probability - Fall 2009

 [MTH 201 Textbook, Policies, Office hours](#)

 [Class announcements](#)

 [Orientation](#)

You MUST do the Orientation webwork. (You will get free credit for doing it.) We use this to make sure that you are correctly signed up for the course in Moodle and WeBWorK. Make sure that you click the "enrol me in course" label in the left hand margin of this page.

31 August - 6 September

 [Make your workshop choice here -- SOON](#)

Lectures:

- Sections 1.1,
- 1.2 Basic principles of counting;
- 1.3 Permutations

 [WeBWorK1 -- combinatorics](#)

 [If you can't attend any existing workshops leave a note here](#)

7 September - 13 September

Lectures:

- Sec: 1.4, Combinations
- 1.5, Multinomial coefficients
- 1.6 (skim) Integer solutions of equations

 [workshop 1](#)

Print out a copy of workshop 1 and bring it with you to your first workshop this week. It is a good idea to have worked as many problems as possible in

Latest News

[Add a new topic...](#)

17 Dec, 18:44

Michael Gage
[grade cutoffs -- more...](#)

17 Dec, 14:17

Michael Gage
and more grade adjustments :-
) !!!! [more...](#)

17 Dec, 11:57

Michael Gage
[grades are really up? more...](#)

17 Dec, 10:41

Michael Gage
[Grades are up more...](#)

16 Dec, 18:33

Michael Gage
grades will be ready Thursday --
probably around noon [more...](#)
[Older topics ...](#)

Upcoming Events

There are no upcoming events

[Go to calendar...](#)
[New Event...](#)

Full Geogebra applet with debugging window



The screenshot shows a Geogebra applet window with a menu bar (File, Edit, View, Options, Tools, Help) and a toolbar with various construction tools. The main workspace displays a coordinate plane with a line passing through points A and B, and a circle passing through points C and D. The coordinates of the points are: A = (-1.77, 5.27), B = (2.4, 3.57), C = (-1.07, 2.3), and D = (-2.67, 3.13). The line is labeled with the equation $a = 2$. The circle is labeled with the equation $c: (x + 1.07)^2 + (y - 2.3)^2 = 3.25$. The debugging window at the bottom shows the XML output of the applet, including the `<show algebraView="true" spreadsheetView="false" auxiliaryObjects="true" algebraInput="false" cmdList="true"/>` tag. Below the XML output are several buttons for debugging: `getXML`, `setXML`, `getConfig`, `setConfig`, `Hide A`, `Show A`, `A red`, `A blue`, `Delete A`, and `Reset`. There are also input fields for getting and setting the coordinates of point B.

```
<?xml version="1.0" encoding="utf-8"?>
<geogebra format="3.02">
<gui>
  <show algebraView="true" spreadsheetView="false"
  auxiliaryObjects="true" algebraInput="false" cmdList="true"/>
</gui>
```

getXML setXML getConfig setConfig Hide A Show A A red A blue Delete A Reset

get coords of B:

set coords of B:

State is preserved from one viewing to the next!

[local](#)

[internet cloud](#)

Summary

- Immediate feedback on homework is educationally valuable -- big time!
- WeBWorK offers maximum extensibility and flexibility -- **Ask the questions you should, not just the questions you can!**
- **Free** -- open source software - Mathematics community support - share the work. Install your own server
- **or** -- Hosting for moderate size classes can be arranged at the MAA server -- sign up at <http://webwork.maa.org>

The End

- Finding information
- Getting involved
- <http://webwork.maa.org/wiki>