Moodle for Math and Science

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Note to workshop participants: See the last slide for instructions on guest access to courses and course downloads
What, 2007 and still no equation editor?

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What, 2005 and still no equation editor?

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"Moodle is not perfectly suited to math, science, or other subjects with their own special languages and notations.

Yet a surprising number of math and science teachers are using Moodle."

-- Abstract
Talk Outline

Examine two actual courses

Identify their strengths and areas for improvement

Identify three specific challenges facing math and science teachers

- "writing math"
- simulations and visualizations
- graphs and diagrams

Discuss ways of dealing with these challenges
Finding good examples is hard

CTER -- Curriculum, Technology, and Education Reform

Department of Educational Psychology
College of Education
University of Illinois
Urbana-Champaign

cterport.ed.uiuc.edu

CTER Technologies page

cterport.ed.uiuc.edu/technologies_folder

Tony Hursh's Moodle hosting site

Matt Sly's AP Physics course
Brad Frey's AP Calculus course

teachanything.net
Stretching the Envelope

What we do

What we do in Moodle
Stretching the Envelope

What we do

What we do in Moodle
Stretching the Envelope

MIT Open Courseware

Frey Sly

Moodle math/sci

Moodle "niche" math/sci

Moodle history language arts etc.

static

file
Web page
link
Book offline Assignment

interactive

Assignment
Choice
Exercise
Lesson
Quiz
Scorm
Survey

social

Blog
Chat
Forum
Glossary
Wiki
Workshop
Stretching the Envelope

I. Math notation
II. Interactive simulations and visualization
III. Graphs and diagrams
Math notation

- Options for teachers
- Options for learners
Math notation: Options for Teachers

- Scanner
- Pen tablet or tablet PC
- "Typewriter math"
- Markup languages
- WYSIWYG eqn editors
Math notation: Options for Teachers

Scanner

Frey experimented using a scanner for "HW solutions"

It was obviously not a successful experiment
Math notation: Options for Teachers

Pen tablet or tablet PC

- MS OneNote
- jarnal, jarnalnote (free)
  - notetaker and pdf annotator
  - works on any platform with Java (JRE)
    - http://www.dklevine.com/general/software/tc1000/jarnal.htm
Math notation: Options for Teachers

**Typewriter math** (a.k.a. ASCII math)

\[ \sim (p \land q) \iff \sim p \lor \sim q \]

\[ P(A \mid B) = \frac{P(A \land B)}{P(B)} \]

Frey used typewriter math in HW quizzes

"ASCII Math is to math as ASCII art is to art"
Math notation: Options for Teachers

Markup languages

- Algebra
- LaTeX

YAFIYGI ("you asked for it, you got it")
Math notation: Options for Teachers

The Algebra markup language

\[ y = \frac{(x+2)^2}{3x} \]

- Your administrator must activate the Algebra filter before you can use it
- Good for simple math
Math notation: Options for Teachers

Activating the Algebra filter (Moodle admin)

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Math notation: Options for Teachers
Aside: how filters work

The answer is \( y = \frac{(x+2)^2}{3x} \)
Math notation: Options for Teachers

The LaTeX markup language

$$y=\frac{(x+2)^2}{3x}$$

- Your administrator must activate the LaTeX filter before you can use it.
- More complex than Algebra notation, but ANY math expression can be written in LaTeX.
Math notation: Options for Teachers

Activating the LaTeX filter (Moodle admin)

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Math notation: Options for Teachers

Algebra vs. LaTeX

LaTeX resources:

- LaTeX reference sheet
  http://www.artofproblemsolving.com/LaTeX/AoPS_L_GuideSym.php

- LaTeX debugger
  http://yourmoodlesite/filter/tex/texdebug.php
Math notation: Options for Teachers

LaTeX gotcha # 1

LaTeX is normally rendered by a program called 'mimetex' on the server.

Some commercial Web hosts do not allow mimetex for "security" reasons

If your site is one of these, use jsMath

jsMath renders LaTeX markup in the browser

jsMath deployment issues (fonts...)
LaTeX gotcha #2

Importing math questions in GIFT format

::R 03-04-14:: If \( G = \{19,20,30,40\} \) and
\( H = \{2,3,4,5,6\} \) then
\[ |G \cup H| = \]
\[
\]

\{, \}, and = confuse the GIFT parser and must be escaped:

::R 03-04-14:: \( G = \{19,20,30,40\} \) and
\( H = \{2,3,4,5,6\} \) then
\[ |G \cup H| = \]
\[
\]

On Unix-like systems, use a sed script
Math notation: Options for Teachers

WYSIWYG equation editors

- M$ Equation Editor (part of M$ Office)
- MathType ($57-$99)
  - available for Windows and Macintosh
  - professional replacement for M$ Eqn Editor
  - OLE integration with M$ Office
    - http://www.dssci.com
- TeXaide (free version of MathType)
  - Windows only
  - ctrl-C outputs LaTeX to the clipboard
    - http://www.dssci.com
Math notation: Options for Learners

"Markup languages are not for learners."

Learners should write math directly in the language of mathematics

Requirements:

- WYSIWYG
- free
- platform independent
Math notation: Options for Learners

The ideal WYSIWYG Math Editor for learners:

\[ y = \frac{(x+2)^2}{3x} \]

Unfortunately, it is not an option today...
Math notation: Options for Learners

To enter TeX manually is frustrating for most people, a wyswig equation editor will be of great help not only to students but also teachers who are trying to communicate with each other, especially those who are teaching and learning Math.

Status (Jan 2007): Assigned but not actively being worked on. "The biggest problem is IE 5.5 and IE 6.0. They use a very old dll library which enables content editable mode in Internet Explorer."

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Math notation: Options for Learners

TeXaide:

- WYSIWYG ✓
- free ✓
- platform independent*  X

*Availability:

- Windows only
- Install on school computers? Maybe not
- Install at home? BUT I HAVE A MAC AT HOME!!!

Solution: Web-based math editor
Math notation: Options for Learners

Free Web-based WYSIWYG math editors that can output LaTeX to the clipboard?

Keep an eye on sMArTH

http://smarth.sourceforge.net/

"sMArTH almost works in Firefox"

sMArTH currently requires an SVG viewer and Unicode fonts to work correctly (ugh)
Math notation: Options for Learners

How are WYSIWYG editors used by learners?

- To answer essay questions in Lessons and Quizzes
- In online assignments
- Anywhere else that a student can enter text

Moodle cannot interpret student input (e.g., essay questions must be graded manually)

To "understand" math, Moodle would need a symbolic manipulation engine like Maple.

Two projects working on this

- AiM -- Integrating Maple and Moodle
  http://maths.york.ac.uk/aiminfo/

- "Serving Maths" -- Integrating Maxima (OSS) with Moodle
  http://mantis.york.ac.uk/serving_maths
Interactive Simulation and Visualization

The traditional approach to science and math education (lecture, lab, textbook, homework, exam) has proved only partially effective for developing a high level of conceptual understanding in learners.

Interactive visualizations (math) and simulations (science) give high level reasoning a solid grounding in the senses.
Interactive Simulation and Visualization

There are LOTS of resources

A good place to start
  Merlot -- a referatory of peer-reviewed resources
  http://www.merlot.org

Technologies:
  - Java applet
  - Adobe Flash
  - Javascript (e.g. http://www.walterzorn.com)
Interactive Simulation and Visualization

Three options:

- link to an external resource
- embed the resource
- package the resource in a SCO*

*Sharable content object
Interactive Simulation and Visualization

Option 1: Link to an external resource

It's what most teachers do

Example: Sly's link to "Sink the Pirate Ship"

Problems:
- contextual distractions
- dependence on an external site
- we might to alter the behavior
- can't directly track student activity
Interactive Simulation and Visualization

Option 2: Embed the resource
YOU create the context for the resource
Eliminate contextual distractions

Demos:

• "Sink the Pirate Ship" version 2
• Gravity quiz (embeds a physlet* applet)

* http://webphysics.davidson.edu/Applets/Applets.html
Interactive Simulation and Visualization

Option 2: Embed the resource (cont)

Eliminating dependence on an external site

Get applet URL from page source, e.g.,
http://library.thinkquest.org/27585/Java/ballistic.class

Download and store in Course Files

Change the applet tag to reflect new location.
Interactive Simulation and Visualization

Option 2: Embed the resource (cont)

Altering resource behavior

Some applets are designed to be reused in a wide variety of applications. Some Javascript "glue" must be written.

Physlets are small, single concept Java applets designed for teaching physics
http://webphysics.davidson.edu/Applets/Applets.html

Mathlets are small, single concept Java applets designed for teaching math
http://cs.jsu.edu/mcis/faculty/leathrum/Mathlets
Interactive Simulation and Visualization

Option 2: Embed the resource (cont)

Some applets are designed to read a file created by a desktop application

GeoGebra (math)

GeoGebra application: http://www.geogebra.org
GeoGebra filter: Moodle Modules and plugins database*

JMOL (chemistry)

JMOL application: http://jmol.sourceforge.net
JMOL Filter: Moodle Modules and plugins database*

*http://moodle.org/mod/data/view.php?id=6009
Interactive Simulation and Visualization

Option 2: Embed the resource (cont)

Using GeoGebra

Admin:
- Download and Install the GeoGebra filter

Teacher:
- Download and install the GeoGebra desktop application
- Use the application to create a GeoGebra worksheet (ggb file)
- Upload the worksheet to the course files area
- Link to the worksheet from any text area (e.g., a Quiz question)

Student:
- Click the link and interact with the worksheet
Interactive Simulation and Visualization

Option 2: Embed the resource (cont)

Using Jmol

Admin:
  ● Download and install the Jmol filter

Teacher:
  ● Download and install the Jmol desktop application
  ● use the application to create a molecule (pdb file)
  ● upload the pdb file to the course files area
  ● link to the pdb file from any text area (e.g., a Quiz question)

Student:
  ● Click the link and interact with the worksheet
Interactive Simulation and Visualization

Option 2: Embed the resource (cont)

Problem: We can't directly track student activity

- The student interacts with the resource and then interacts with the LMS. The interactions are independent of each other.
- Assessments must often be qualitative, e.g., "What did you learn from the simulation?"

Example: Sink the Pirate Ship. How does the teacher know how many shots were fired?
Interactive Simulation and Visualization

Option 3: package the resource as a SCO

Any Web resource can be packaged in a Sharable Content Object (SCO).

LMSs that conform to the SCO Reference Model (SCORM*) expose an interface consisting of eight Javascript functions.

By calling these functions, the SCO can retrieve information from the LMS and pass information to the LMS.

* http://adlnet.org
Interactive Simulation and Visualization

Option 3: package the resource as a SCO (cont)

Recall the problem with Sink the Pirate Ship embedded applet

- How does the teacher know how many shots the student fired?

Solution:

- Package the applet as an SCO
- Add Javascript "glue" to interact with the resource, the student, and the LMS
Interactive Simulation and Visualization

Option 3: package the resource as a SCO (cont)

Demo 1: Sink the Pirate Ship SCO

Demo 2: several PADs* physics applications in a SCORM package

*http://www.wku.edu/pads/
Graphs and Diagrams

Options for teachers

- scanner
- hand-drawn with pen tablet or tablet PC
- generic drawing programs (e.g. O-O Draw)
- programs specifically for math or science (e.g. Geometer's Workbench, GeoGebra)
- copy/paste an image from the Web
- capture an image with a screen capture program (e.g. SnagIt)

These create a file which teacher uploads
Graphs and Diagrams

Options for learners

Learners may have access to some of the same file-creating tools as the teacher. BUT they usually have nowhere to store the file!

<table>
<thead>
<tr>
<th>Activity</th>
<th>Permits Attachment?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz essay question</td>
<td>No</td>
</tr>
<tr>
<td>Lesson essay question</td>
<td>No</td>
</tr>
<tr>
<td>Online assignment</td>
<td>No</td>
</tr>
<tr>
<td>Journal entry</td>
<td>No</td>
</tr>
<tr>
<td>Forum</td>
<td>Yes</td>
</tr>
<tr>
<td>Glossary</td>
<td>Yes</td>
</tr>
<tr>
<td>Database</td>
<td>Yes</td>
</tr>
<tr>
<td>Wiki</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The Digital Divide?
Graphs and Diagrams

Options for learners (cont)

Possible solutions

- store on the Web (e.g., xdrive.com 5GB free)
  privacy concerns?
- store in a Database entry
- (if sharing must be limited) store in MyFiles*

*MyFiles block Developed at Humboldt State University. Available from Moodle Modules and Plugins repository

http://moodle.org/mod/data/view.php?id=6009
Niche Math and Science Courses

One area of secondary math/science education to which Moodle is very well-suited: Preparing students for high-stakes standardized tests

- Mandatory statewide assessments under NCLB
- SAT and ACT

Reason:
- Students have already learned the material
- They need to practice for the test
- Questions are mostly MCQ and short answer
Niche Math and Science Courses

In my NJ District, at-risk 11th grade students are given an extra period of math daily to prepare them for HSPA*

The extra classes were designed to give students
- lots of extra practice
- remediation where needed

Small class size (approx 10 students)

Moodle was used in 90% of class activities

*After the HSPA exam in March, switch to SAT prep.
Niche Math and Science Courses

Need for individualized practice and remediation

- wide range of proficiencies
- one-size-fits-all approach was not working
- classroom management issues

The ideal solution:

1 course = 1 tutor + 1 student

Moodle makes it possible
Niche Math and Science Courses

Step 1: Build a question database

Questions from many sources

Moodle 1.6 Question database
Niche Math and Science Courses

Requirements:

- The question database is a **shared** resource
- It should be easy for tutors to create highly individualized practice quizzes
- It should be possible for tutors to share full-length assessments
Niche Math and Science Courses

Importance of semantically meaningful categories

- Chapter-1 NO
- Algebra/word-problems YES

NJ Core Curriculum Standards for math were used as a starting set of categories.

Assumptions

- Categories change
- Questions change categories
Niche Math and Science Courses

Roles and responsibilities

- Question DB developer/maintainer
- Tutor
- Methodologist
- Student
Niche Math and Science Courses

Moodle 1.6 Implementation

QDB in course 1
Images in site files
QDBA's have editing privileges in course 1
All question categories are published

Customizations:
- Category preview (Pierre Pichet)
- Question/quiz cross-reference
- Disable category export (prevent copying)
Niche Math and Science Courses

Without category preview:
Course access and downloads:

- **URL:** [http://www.scholarandkatz.com/training](http://www.scholarandkatz.com/training)
- Click "All courses" in the Course Categories block
- Click on the name of the course*
- Login as Guest with enrollment key **albuquerque**
- Click "Download a copy of this course"

*These instructions apply to three courses:

- AP Calculus
- AP Physics B
- Math and Science Features Demo

Courses were developed in Moodle 1.6.3