Enhancing the problem authoring capabilities of WeBWorK

The American Institute of Mathematics

The following compilation of participant contributions is only intended as a lead-in to the AIM workshop "Enhancing the problem authoring capabilities of WeBWorK." This material is not for public distribution. Corrections and new material are welcomed and can be sent to workshops@aimath.org

Table of Contents

A. Participant Contributions ........................................ 3
   1. Ashton, Ted
   2. Aubrey, Jason
   3. Barton, Susan
   4. Bayne, Richard
   5. Byerly, Bob
   6. Cervone, Davide
   7. Clark, Karen
   8. Cook, Darwyn
   9. Ensley, Douglas
  10. Friedman, Paul
  11. Fuller, Edgar
  12. Gage, Michael
  13. Grainger, Arthur
  14. Huang, Hsiang-Ping
  15. Jones, John
  16. Kaskosz, Barbara
  17. Koski, Adolph
  18. LaRose, Gavin
  19. Molzon, Robert
  20. Roberts, Lila
  21. Scharff, Christelle
  22. Wootton, Aaron
A.1 Ashton, Ted

As a Perl programmer, I am troubled by the quoting issues with PG and with the fact that “my” variables don’t work correctly. As a LaTeX user, I am bothered by the restrictions on what I can do within the LaTeX portion of the code. For example, I would really like to be able to use packages such as color or tikz/pgf. I would be interested in making WeBWorK problems either completely valid LaTeX (more likely) or Perl or both.

A.2 Aubrey, Jason

I am interested in myself gaining more experience and depth of understanding regarding authoring problems in webwork and in helping in whatever way I can to improve the problem authoring capabilities.

On particular issues which has come up for me is that I have found it difficult to figure out how to integrate java or flash applets into the problems.

In the best case, it would be great to find a way to integrate the collection of Camtasia studio tutorials I’ve created in some substantial way with webwork. (These tutorials essentially consist of (a) a swf (flash) file and (b) a SCORM (XML) file.) Also, I’ve been toying around with Carnegie Mellon’s Cognitive Tutor Authoring Tools (http://ctat.pact.cs.cmu.edu/). CTAT allows you to create both flash and java-based cognitive tutors very easily and it would benefit both projects (and many students!) to make it possible integrate CTAT tutorials and problems with WebWork in some way.

A.3 Barton, Susan

I am interested in getting interactive material on the Web. Most especially for an online Statistics course and for College Algebra.

A.4 Bayne, Richard

My main interest is to make it easier to write new problems for WeBWorK, not only in subjects in which there are already problems, but especially in areas where there are few or none now.

It would also be beneficial to provide greater flexibility in students’ answering of questions. In other words, minimize the amount of syntactical errors available.

A.5 Byerly, Bob

It would be very nice to have toolkits for answer evaluators in various areas of mathematics – perhaps more importantly, a well-documented programming interface for writing such toolkits. An example would be Linear Algebra, in which one may naturally wish to ask students questions whose answers are not unique, but which satisfy a certain set of conditions. With MathObjects, it is a lot easier to write custom answer evaluators. The existence of mathematical toolkits in MathObjects, and better facilities for error checking (or at least better documentation on how to do error checking) would make this even easier.

I also feel that it should be easier for those who are not experienced Perl programmers to write problems. For problems in which answers are simple numbers or formulas, it should
be possible to create an interface for writing problems in which the writer really shouldn’t have to worry about details of the pg language at all.

A.6 Cervone, Davide

As the developer of the new MathObjects portion of WeBWorK, I am particularly interested in making these more accessible to problem authors. This includes developing appropriate documentation and examples, as well as adding features needed by authors. The MathObjects provides a new paradigm for working with the mathematical values needed within WeBWorK problems, and they have some powerful features that are not well known to problem writers. I hope this conference will help change that.

In addition, I am interested in improving the PG language to make it easier to use. Some of this involves streamlining and standardizing the existing language. Another important area to consider is the control of the textual output. It is difficult to produce tables, lists, and so on, and a more flexible syntax (something like Markdown) might make writing problems easier.

Many problem authors are hindered by the amount of perl programming that is required for writing problems. It would be nice if WeBWorK offered a problem development environment that allowed authors to specify the details of the problem, and then packaged that up in the code necessary to make a working problem file. There is quite a bit of room for development in this area.

Finally, I am interested in creating means of including more interactive aspects to WeBWorK problems. These include java applets, Flash, and so on. For example, a 3D library suitable for generating objects that can be displayed in a 3D graphics java applet like LiveGraphics3D would be particularly helpful.

A.7 Clark, Karen

I have used Webwork in my classes and have had some involvement in writing problems for linear algebra. I would like to see a good solid piece of documentation come out of the workshop, not only on how to use webwork, but on how to write problems, aimed at a novice. It would be wonderful if a person who was perhaps comfortable with something as basic as equation editor on microsoft word (this describes many of my colleagues) would be able to design webwork problems.

A.8 Cook, Darwyn

We use WebWork extensively in calculus I and II at Alfred, but very little in calculus III. Because of the great success we have had in the first two calc courses we are interested in

1) extending the capabilities of WebWork in calculus III, in particular its 3D graphing capabilities.

2) Documenting the current capabilities, I have only recently learned that RPI uses WebWork quite successfully with 3D graphics.

A.9 Ensley, Douglas

I will be able to share my expertise in Flash (Actionscript) programming and my resources in pre-defined classes for Actionscript and extensible objects in Flash. In particular,
I have a handful of examples of the use of xml data files for customizing single Flash applications for individual students at “run time.” I also have some rudimentary experience in using Javascript for communicating with (Perl) programs on a server, and I am interested in learning how to do the same in Flash. My mathematical interests are in discrete mathematics.

A.10 Friedman, Paul

I am relatively new to authoring WebWork problems, but some things that I would like to work with others on at this conference include the development of (1) a (suggested) “style-sheet” for the presentation of WW problems (language, style, typesetting display, ...) and the development of macros to implement aspects of the style-sheet, (2) a (suggested) “style-sheet” for the coding of WW problems, (3) a (perhaps) centralized, committee-vetted, and robust sample-problem library containing examples of best-coding practices that can be used as copy/paste templates for WW authors everywhere.

A.11 Fuller, Edgar

I have been incorporating WeBWork into courses since 2001 at various times. Most recently, we have been using WeBWork for online homework in several large section, large enrollment courses for the last two academic years. Our largest deployment is in first semester calculus, but we have pre-calculus and applied calculus courses that use it as well. We administer gateway exams with WeBWork as well.

My interest in WeBWork centers around its uses for formative and summative assessment of student mastery. To this end my goals for the workshop include

- Improving the problem authoring interface with a specific emphasis on the management and creation of assessments
- The development of a concept and skill mastery tracking capability within the problem and assessment structure that could be used to provide more detailed feedback about student learning outcomes
- Further improvement of the gateway set capability that would further enhance the use of WeBWork for exams
- Enhancing the integration of WeBWork into course management systems such as Moodle item The inclusion of rich content such as flash components into the WeBWork problem structure in a way that allows for interaction with the flash component at run-time

Our short and long term goals at WVU with regard to WeBWork are geared towards determining the most effective use of the the system in our classes. We currently have projects underway comparing different modes of deploying WeBWork as a homework system and we have compiled data to compare the use of WeBWork for summative assessments to the use of WebCT Vista. The above goals for the workshop mostly tie in to the ways we would like to improve this process at our institution.

A.12 Gage, Michael

The WeBWork project began about 11 years ago. The instructor and student interfaces have been reworked a couple of times during that period but for the last half dozen years the authoring language (PG language) for the homework problems has been added to without a major attempt at consolidation. With the addition of a a major new paradigm for
authorship (Davide Cervone's MathObjects) it's time to review what commands are available in the language, make some decisions as to which commands can be deprecated and which commands should be updated so that the authoring language has a uniform look-and-feel and is therefore easier to learn. I expect that some compromises will need to be made to preserve some essential aspects of backward compatibility, but my primary interest is in creating a powerful and consistent set of macros that will make the language easy to learn and use in the future.

While there is much that can be done beforehand, I am interested in making the final decisions about the language style at the workshop with a relatively large group of interacting designers and authors with varying backgrounds and interests.

Some specific projects that I would like to see pursued:

List all 900 plus commands in the language – categorize them by type and provide minimal documentation. Decide which commands can be deprecated, which commands might need enhancement and provide solid documentation and examples for the commands that are retained.

Convert favorite existing problems to use the new methods (e.g. MathObjects) – this will help insure that best practices are maintained in the future and will make it easier for instructors to tweak the homework problems they are using.

Write new problems – in new subject areas (probability, complex variables..., more linear algebra, developmental math (pre-calculus) – that will help indicate where new extensions in answer evaluators or MathObjects will be needed in the future.

Write new problems, perhaps in old subject areas, but using new methods such as Flash or AJAX or java applets to provide more interactive and therefore perhaps more effective homework problems.

At the purely technological end of the spectrum I would like review the code that caches macros (currently the PGbasicmacros.pl and PGanswermacros.pl files) so that new macros can be added to the caching mechanism easily. Then the huge PGbasicmacros and PGanswermacros files can be broken into smaller chunks for more flexibility. The aim is to improve the speed, the flexibility and the maintainability of the underlying PG code.

At the opposite technological extreme I would like to spend a little time discussing whether we collectively have any advice to offer on which types of WeBWorK problems are more educationally effective than others – or how we might be able to measure that in the future – and give advice to new authors on writing effective problems.

A.13 Grainger, Arthur

I am interested in techniques for writing WeBWorK problems that have multiple parts. For example, consider a problem that involves finding an anti-derivative using the partial fractions technique. First, I would like the student to tell me what case he (or she) is using (i.e., the denominator is a product of: case I - distinct linear factors, case II - linear factors, some of which are repeated, case III - irreducible quadratic factors, none of which is repeated, case IV - repeated irreducible quadratic factors). Next, I would like the student to show me the factors. Next, I would like the student to express the proper rational function as a sum of partial fractions by calculating the appropriate coefficients. Finally, the student would show me the correct anti-derivative. I would like for WeBWorK to not allow the student to continue to the next step until he (or she) provides a correct answer to the current step.
Is there a way of writing a WeBWorK problem that would check a propositional logic proof?

**A.14 Huang, Hsiang-Ping**

I will be the new coordinator in the department of mathematics, U Utah. I am very interested in building the problem library which is more efficient for instructors to search for. Also for the user-friendly interface than the command-type programming. Instructors in U Utah are concerned very much about how to incorporate problem bank from other universities to increase our data base.

**A.15 Jones, John**

My main interests in problem authoring are in improving the documentation and in providing examples of both typical and interesting webwork problems. Secondly, I would like to see better integration of a meta-tagging facility built into webwork.

**A.16 Kaskosz, Barbara**

My main interest related to WebWork homework problems is incorporating Adobe Flash mathlets into WebWork problems. I have much experience working with Flash. I have published many high-functionality Flash mathlets in the Journal of Online Mathematics and Its Applications and the Digital Classroom Resources of the Mathematical Sciences Digital Library: http://mathdl.maa.org/mathDL/

My Flash page: http://www.math.uri.edu/~bkaskosz/flashmo/

very popular and I receive much email about it. At present I am the PI on an NSF grant whose purpose is creating training materials and custom libraries of classes in ActionScript, Flash’s programming language.

I am a big fan of WebWork and I used it several years ago in our URI Precalculus course. I created homework sets and I have some exposure to authoring new WebWork problems.

I know that a link to an html page containing a Flash mathlet can easily be added to a WebWork problem. I believe that much more is possible in terms of embedding a Flash mathlet as an integral part of a WebWork problem. This is the main challenge that I hope to explore during the workshop.

Let me mention that a new version of Flash, Flash CS3, and a new version of ActionScript, ActionScript 3.0, has just been released. The new ActionScript executes very fast and provides an attractive alternative to Java for creating high-functionality online teaching aids.

I am also interested in learning other techniques of authoring WebWork problems and I am very much looking forward to the workshop.

**A.17 Koski, Adolph**

Making WebWork More Accessible to New Users


2. Problem Creation: Sites such as Turing’s Craft http://www.turingscraft.com/) supply online programming practice. Learners are able to work on fragments of programs. These
fragments are then combined with existing code, compiled and tested. Learners practice with small elements of the language without being confused with all the details at once. Learners could also practice making modifications to existing problems.

a. Learning the language
b. Practice
c. Examining and modifying sample problems.

3. Courses Supported: As a high school teacher, I would like to see more support for the following courses.
   a. College Algebra
   b. Precalculus
   c. AP Statistics
   d. AP Calculus
   e. Discrete Math
   f. Logic
   g. Programming

4. Add-ins: These may already be possible. If so, then examples of the use of these objects could be included in section 1.
   a. Live Java Sketchpad Sketches
   b. Java Applets

5. Problem Selection: It should be easier to assemble coherent homework assignments. Some suggestions for classifications:
   a. Homework keyed to textbooks
   b. Homework keyed to AP Guidelines
   c. Quizzes and Test derived from competition questions like from Mu Alpha Theta.

6. System Install: This is the area with which I have had the most trouble. The USE of WebWork is fairly intuitive. I have access to the system at Rochester and it is possible to get a course up and running from in a few hours. I have not been successful in setting up an independent system on my own computers.
   a. Supply WebWork Preinstalled on Hardware
   b. Available on Websites (i.e. many web providers supply Moodle. A Moodle course can be set up in minutes. Is it possible to have a site to supply Moodle with WebWork integration?
   c. Is it possible to expand the use of the Rochester System to allow for more courses or additional teachers. Many teachers in my school would be interested in WebWork if courses could be set up for them.

7. Minor Point: When scoring multiple assignments using WebWork tools, percentages are only calculated for the selected set of assignments as a whole. To get individual percentages, each assignment has to be scored separately. It would be nice to have the option of percentages for each assignment. (Our District gradebook program can not import from WebWork, so all grades have to be transferred and enter manually)
A.18 LaRose, Gavin

My background with WeBWorK has been as a user (developing problems for the Hughes-Hallett calculus text, multivariable calculus, differential equations, and various gateway and placement tests), administrator (running our WeBWorK servers) and a developer of the WeBWorK GatewayQuiz module.

My specific interests in this workshop are in enhancing the user interface and usability (in particular in the context of the workshop, problem authoring) for the GatewayQuiz module, and in determining the manners in which this module should be extended or changed to better serve the needs of other users.

A.19 Molzon, Robert

Since Webwork problems are essentially written in the perl programming language, it can be somewhat difficult for authors not familiar with perl to begin authoring problems. In addition to perl, one should also be somewhat familiar with Tex to create good mathematical problems. This is usually not a problem for faculty at universities, but it can present a problem for high school or middle school teachers.

I wanted to make it possible for people with little or no knowledge of either perl or tex to be able to author Webwork problems with a minimal amount of training. Most people are familiar with ”editors” such as OpenOffice Writer or MS Word. A less familiar alternative is LyX, an open source document preparation program that is very easy to use, produces standard Latex output, and is highly configurable. Together with an undergraduate student, Damion Shown, I put together a small package that allows one to write Webwork problems using LyX. The problems are written in LyX and then a perl script converts the Tex output to the Webwork-perl format. It is still necessary to enter some non-intuitive code into the LyX document, but this is fairly minimal. I have attached a sample homework set written in LyX below. The LyX file is saved as Tex and then processed with the perl script ”webworkauthor”.

A.20 Roberts, Lila

As chair of a department of mathematics I have concerns about student preparation and achievement, not only in courses for the major, but in math courses that satisfy general education requirements and courses that support our client disciplines such as education and the sciences. We have a disconcertingly low success rate in calculus, due in part to students’ retention of prerequisite material from algebra and trigonometry. I am interested in developing an online review of precalculus which will provide practice for important skills just in time for when these skills are needed in calculus. Although we have WebCT Vista at my institution, the implementation in the University System of Georgia is cumbersome and not very friendly. On the other hand, my experience with implementing WebWork in linear algebra and precalculus was that it was easy to use and information one can retrieve from it is useful in diagnosing student difficulties.

A secondary motivation for participation is the development of online homework for our lowest level credit course, Introduction to Mathematical Modeling. Designed to provide students with an appreciation of “real-life” applications of mathematics, the course often falls short because of a lack of problems that provide practice with necessary algebraic skills as well as analytical problem-solving skills.
Although I do not expect to achieve both of these objectives at the workshop, I hope to develop the necessary skills to return to my institution and make some progress toward attaining these developmental goals.

**A.21 Scharff, Christelle**

Over the past two years, Pace University faculty (Dr. Olly Gotel and Dr. Christelle Scharff) have been collaborating with faculty at Cornell College (Dr. Andy Wildenberg) to adapt WeBWorK to the needs of Computer Science, and to Computer Programming Fundamentals in particular. Programming Fundamentals cover fundamental programming constructs, algorithms and problem-solving, elementary data structures, recursion and event-driven programming. We contributed WeBWorK problems for the Java, Python and SML (Standard Meta Language) programming languages. Dr. Wildenberg and Cornell College students developed an extension to WeBWorK called WeBWorK-JAG that can automatically collect and grade free-form program fragments written in Java. WeBWorK-JAG is based on Junit, an open-source testing framework. Our WeBWorK server is accessible for full experimentation at http://atlantis.seidenberg.pace.edu/webwork2.

A number of systems for the delivery and automated assessment of programming assignments have been developed in the last five years. These systems include:

- CourseMarker (www.cs.nott.ac.uk/CourseMarker);
- CodeLab (http://www.turingscraft.com);
- MyCodeMate (http://www.mycodemate.com);
- BOSS (http://www.dcs.warwick.ac.uk/boss);
- Gradiance (http://www.gradiance.com);
- Viope (http://www.viope.com); and
- OWL (http://owl.course.com).

We believe that looking at these systems can help the WeBWorK community in improving WeBWorK and in particular its authoring capabilities.

In this workshop we would be interested in:

- getting an idea of the current state of the development of WeBWorK;
- getting a list of the plug-in extensions that were contributed to it (and that we may not know);
- understanding the overall architecture of WeBWorK to be able to contribute to it and enhance WeBWorK in particular in terms of its authoring capabilities in the most efficient way;
- sharing our findings on using WeBWorK in Computer Science with the larger WeBWorK community;
- getting advice on how to build a WeBWorK community in Computer Science; and
- sharing ideas on improvements of the authoring system of WeBWorK based on our survey of the systems similar to WeBWorK existing in Computer Science.

**URLs:**

- WeBWorK web site: http://atlantis.seidenberg.pace.edu/webwork2
- Project web site: http://www.csis.pace.edu/~scharff/webwork/webwork.html

**Posters/Papers:**

Contributors:
• Dr. Gotel, Pace University, NY
• Dr. Scharff, Pace University, NY
• Dr. Wildenberg, Cornell College, IA

Students:
• Jacqueline Baldwin, Cornell College, IA
• Nathan Baur, Cornell College, IA
• Sophal Chiv, Royal University of Phnom Penh, Cambodia
• Eileen Crupi, Pace University, NY
• Tabitha Estrellado, Pace University, NY
• Allyson Ortiz, Pace University, NY
• Veronica Portas, Pace University, NY

A.22 Wootton, Aaron

My primary interest in this workshop stems from my desire to author my own questions in WeBWork geared toward particular problems or examples I present during the classes I teach. The major obstacle I have encountered in the past when attempting this has always been the same - the programming language required to write and modify problems is fairly complicated. Though I have had some success with these projects, it usually takes a lot of time and in many instances I have had to give up because I simply cannot understand all the code for the problem or I just do not have the time. By attending the workshop and actually being a part of the group of people enhancing the authoring capabilities, I feel I will become much better and quicker at modifying and writing problems which I feel will ultimately enhance my teaching abilities by allowing me to incorporate WeBWork more in my classes.

Though my primary reason to participate in this workshop is to improve how I can use WeBWork effectively in the classroom, there is another more embarrassing reason. Though I have been using WeBWork for two years, I still do not understand how it really works. Though the workshop is focused on problem authoring, I still feel I will learn a great deal about how WeBWork works which is something that interests me on a personal level, and will
also give me more ammunition when trying to convince the computer staff at the University of Portland to install WeBWork on the University system (something I have been trying to do for two years).

I am hoping as both an educator and a low level programmer I will be able to contribute on a number of different levels to the workshop. As an educator who uses WeBWork, I will offer my personal experiences of problem writing in WeBWork and my thoughts and opinions on what would make problem writing easier for me personally. As a low level programmer, I will be able to assist more experienced programmers in implementing some of the ideas developed during the workshop.