DMAS: A Web-based Distributed Mathematics Assessment System
Outline

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• DMAS System Components/Features
• Authoring Tool
• DMAS and Formulas, Graph, and Geometry.
• Test Giving and Grading Administration System
• Teacher-Student Interaction Mechanism (TSIM)
• DMAS Actual Implementation and Trial
• Assessment Markup Language (MAML) and Web Service
• Conclusion and Future Work
The assessment system (DMAS) is a Web-based Distributed Mathematics Assessment System that can be of great value to teachers and students of mathematics.

The assessment system provides an efficient, effective and systematic way to support the assessment needs of mathematics education and a platform for teachers at different schools to contribute and share assessment materials.

It utilizes distributed databases and Web technologies to achieve these functions. It also helps mathematics teachers to quickly and easily author, edit, administer and manage tests.

Teachers can also import materials, share questions with other teachers (same or different schools).
DMAS System Components

• **Core database DMAD** (Distributed Mathematics Assessment database) and other local databases: **TMAD** (Teachers Assessment Database), **SMAD** (School Assessment Database).

• **Authoring tool** for teachers

• Assessment Search engine (**DMASEngine**).

• **Assessment test giving**

• **Grading and student results administration**, comprehension diagnoses and linking to remedial materials.

• **Teacher-Student Interaction Mechanism (TSIM)**

• New **Assessment Markup Language MAML**: Mathematics Assessment Markup Language to be used in assessment material representations and encoding,

• DMAS system **interface to Web Applications**, and

• **Assessment Web Service.**
DMAS System Levels

DMAD

SMADs

TMADs

Import

Export

06/04/2008
DMAS System Features

• DMAS is designed to work as one distributed database while providing power, unity, and convenience at each participating school. The system helps create, revise, administer, and grade exams that can contain various types of questions: multiple choice, true/false, extended (essay) questions, short answers, matching, and fill-in-the-blank.

• The assessment system consists of local databases at individual school websites. Each local database collects assessment questions contributed by teachers in a particular school to be used and perhaps shared with other teachers from the same or different schools.

• Teachers can use the powerful search engine (DMASEngine) to search for assessment questions. Search can be narrowed by subject, topic, grade-level, question type, keyword, and author.

• Test authoring tool for teachers, online tests, real-time grading and results administration, comprehension diagnoses and links to remedial materials.
DMAS System Features (Cont.)

- A teacher can monitor all students from the Teacher Control Panel (TCP) in real-time and interact privately with one or more students via Teacher-Student Interaction Mechanism (TSIM) as instant text-messaging provided by the assessment system. Students are provided a help button to request assistance from the teacher.

- The system supports an accumulative submission of test questions so that in case of loss of power to a laptop, closing browser window by mistake, and so on, a student can retake the test, after authorization from the teacher, from the point where she stopped before the problem occurred.

- Although developed as a sub-system of WME (Web-based Mathematics Education), the assessment system (DMAS) is an independent web system easily interfaced to any web page through a well-defined interface. This assessment system is an open system implemented with standard web/Internet and can easily interoperate with other online systems.

- Completely Web-based.

- Free!
Authoring Tool

• One of the most powerful features and basic components of the DMAS system is offering an **Authoring Tool** for assessment tests and questions.

• Questions and tests can include text, graphs, images, or formulas. Teachers can *create new questions, view, edit (reword) and delete existing ones.*

• Different types of questions that DMAS system can support: true-false, multiple-choices, short-answer, essay (extended answer), two-columns matching questions, and fill-the-blank.

• The test author can also connect incorrect answer options to common mistakes, misconceptions, or missing background knowledge.

• DMAS can help correlate such diagnostic information with school Lesson Pages, which can help students overcome difficulties exposed by the assessments.

• Authors can import pre-made questions from DMAD into their tests. Once that happens, all those imported materials can be customized and modified if needed and included in assessment tests. Any question created or imported can be exported to again to DMAD.
DMAS system supports Math Expressions/Formulas in two ways: using Infix notations directly, or using WME-Math editor (MathEdit) to enter and edit formulas/equations.

- It uses MathEdit in two modes:
  - teacher mode.
  - student mode.

- Call MathEdit APIs to author, edit, or get Math expressions.

- DMAS gets different MathML strings returned by MathEdit and:
  - Infix code.
  - Presentation Mode.
  - Content mode.

- DMAS stores MathML strings returned by MathEdit in the database for future display, editing, or computation (e.g. answer-checking):
DMAS and Math Expressions/Formulas

New Question: True or False

Is the following solution (root) right or wrong, as one of the two solutions (roots), which given by the quadratic formula?

\[ \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]

Please type your question:

Is the following solution (root) right or wrong, as one of the two solutions (roots), which given by the quadratic formula?

\[ \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]

Select the correct answer:

- Right
- Wrong
DMAS and Geometrical Graphing

- DMAS system supports geometrical graphs such as SVG (Scalable Vector Graph).
- DMAS interface can inter-communicate with other external editors such as WME-geoSVG (SVG Web-based authoring tool for geometry).
- Through this interface, students and teachers can trigger the geoSVG editor to create and draw geometrical graphs and then the interface can take care of including such graphs in specified questions.
- All interactions and communications between DMAS system and geoSVG are hidden from the users.
DMAS and Geometrical Graphing (cont.)

Please play with the following graph or manipulative to better understand fractions. Click on 3 different parts of the circle then write down the fraction. Explain why?
### Authoring Tool (cont.)

#### Manage your Tests

<table>
<thead>
<tr>
<th>Choose?</th>
<th>Question</th>
<th>Type</th>
<th>Action</th>
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<tbody>
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<td></td>
<td>Please play with the following graph or manipulative to better understand</td>
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<td>fractions. Click on 3 different parts of the circle then write down the</td>
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<td>fraction. Explain why?</td>
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<td>Is the following solution (root) right or wrong, as one of the two</td>
<td>TF</td>
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<td>solutions (roots), which given by the quadratic formula?</td>
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<td>What the following equation is called (where a ≠ 0)?</td>
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<td>Estimate what fraction of the following shape is shaded. What Fraction?</td>
<td>SH</td>
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<td></td>
<td>Is the following fraction (10/6) greater than 1, equal to 1, or less than</td>
<td>MC</td>
<td></td>
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<td></td>
<td>1? Choose the correct answer.</td>
<td></td>
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</tbody>
</table>

[Export to DMAD]
Assessment Test Giving

- DMAS system enables teachers to author, store, and conducts assessment tests either in class or as homework assignments.

- It provides teachers with different ways or permutations of Test display and can have multiple forms of same exams.

- It supports the two types of testing: online testing and paper testing.

- It also supports an accumulative submission and storage of student answers on question-by-question basis.

- Moreover, it allows some specific students (controlled only by their teachers) to Retake assessment tests if needed.

- The teacher can monitor all students from the teacher terminal in real-time to interact privately with one or more students via the Teacher-Student Interaction Mechanism (TSIM) as an instant text-messaging feature provided by the assessment system. Students can click the help button to request teacher assistance.
Assessment Test Giving (cont.)

Flow Chart of Tasks

DMAD Question Bank

Export Questions

Search/Import Questions

Teacher

Login

Export
Assessm. questions

Save/Edit
Assessment Test

Add/Import
Assessm. questions

Create New
Assessment Test

Review
Assessment Test

TMAD Database

Show/Hide
Assessment Test

Start/Re-take
Assessment Test

Submit/Store
Student answers

Display Test
Grade/Statistics

06/04/2008
Teacher-Student Interaction Mechanism (TSIM)

**Teacher**

- Teacher Control Panel (TCP)
  - Authorize/Unauthorized
  - Live Monitoring of Student Performance/grades/Statistics

**Student**

- Student Interface (SI)
- Ask for help Request
- Student Name (login)
- Send help message Reply
- Send Instruction/help Message
- Wait for Authorization
- Student Starts/Re-take Test

**DMAD Database**

**TSIM Live Interface Using Ajax XMLHttpRequest calls**

- Authorization Request
- Help message Request
- Help message Reply
- Send Instruction/help Message Request
TSIM Student’s View

Please enter your First and Last name: Dan Bob

Please wait for authorization...

Now please click the button to go to Test

1. Please play with the following graph or manipulative to better understand fractions. Click on 3 different parts of the circle then write down the fraction. Explain why?

06/04/2008
Teacher’s View: Grades Administration

practice test

Student Name: Austin Ferrari

Total student Score: (80.00/120.00) = 66.67%

Q: Is the following fraction (10/18) greater than 1, equal to 1, or less than 1? Choose the correct answer.

Answer:
- Less than 1
- Equal to 1
- Greater than 1

Add comment: 

(Q Correct Answer) Score: 10.00

Q: Estimate the fraction represented in the following problem. What fraction?

[Blank space for answer]

 practice test

Total no. of students= 13
Correct answer(s)= 12, This means: (92.31%) of students got it correct
Wrong answer(s)= 1, This means: (7.69%) of students got it wrong

Q: Is the following fraction (10/18) greater than 1, equal to 1, or correct answer.

Answer:
- Less than 1
- Equal to 1
- Greater than 1

[Student names and scores listed]

06/04/2008
TSIM Teacher’s View: Teacher Control Panel (TCP)
First version of the DMAS system has been piloted at Kimpton Middle school on 10/05/2007 for the first time!

Now teacher/student feedback after the test and comparing it to the regular written tests:
- More fun!

- Teacher and students like the random order display of questions.

- Most students preferred the online assessment testing over the regular ones!

- Ease of use, simplicity, and clarity of how to take and submit answers were mentioned.

- One student preferred the written test due to not having a computer at home!

- Also easy to change answers, clean, keyboard is easier to use than hand writing!
Piloting DMAS at Kimpton Middle school and User Feedback: Teacher Mode

Student Name: Austin Ferrari
Total student Score: (80.00/125.00) = 50.00%

Q: Is the following fraction (1/4) greater than 1, equal to 1, or less than 1? Choose the correct answer.
Answer:
- Less than 1
- Equal to 1
- Greater than 1

Add comment: [ campo vazio ]

Q: Estimate the fraction represented in the following problem. What fraction?

Correct Answer: [ campo vazio ]

Display grades by:
- A Student Name.
- A Question.

Total no. of students = 13
Correct answer(s) = 12
This means: (92.31%) of students got it correct
Wrong answer(s) = 1
This means: (7.69%) of students got it wrong!
- The assessment tests appeared to be clear and most of the questions were not about the test but rather about how to use their attendance system using standard login !!

- Students login process was very smooth (actually much better than we expected!) since no userid/password to memorize.

- Students were very excited when the teacher told them that she knows who got the what question right instantly!
Conclusions and Future Work

• The DMAS system aims to be an effective and easy to use assessment tool for mathematics education. A systematic way of authoring, importing, customizing, and exporting assessment materials can help create an environment in which usage and experience can accumulate and mutually reinforce.

• We have much work to do and to add features and more improvements to DMAS system to make assessment materials ready to deploy on the Web, to provide grading help, to generate performance statistics, to provide diagnostics and to suggest remedial materials, while making tests and scores private and secure, controlling access to tests and results.

• Our goal is to put DMAS system under extensive trial in schools and collecting feedback and suggestions from teachers, students, school administrators and education experts to help us evolve DMAS. As more schools adopt WME and DMAS, the distributed nature of DMAS will be demonstrated in realistic situations.

http://wme.cs.kent.edu/dmad/milestones.html
http://wme.cs.kent.edu/kimpton/assessment/
DMAS System Interface to Web Applications (WME)

- DMAS system will provide APIs interface to other applications on the Web such as WME, MathPASS, or other applications on the Web.
- These APIs can serve different requests either from:
  - server-to-server (i.e. from other servers such as WME server to DMAS server) or
  - client-to-server (from an Internet browser to DMAS server).
- In either case, DMAS system interface will handles all different calls in proper way.
Integrating DMAS with WME
(DMAS as On-Web Service in WME using Callback)

- WME System (Client)
- DMAS On-Web Service
- DMAS Interface
  Using Callback URL and Unit ID
- Invoke URL
- Unit ID (via Callback URL)
- Record the returned Unit ID

WME Database
DMAD Database
DMAS-WME Interface Implementation

DMAS System (DMASEngine)

DMAS Search Page

Done

WME System

MeML/ HTML Page

AssmTest

MeML Page

HTTP Request and parameters (http://....)

1. source = ‘WME’
2. Mode=’Teacher’
3. Ref_page_url='.../.../wme_page.php'
4. Action= ‘newTest’

Search results (questions)/import questions to test

HTTP Response and parameters (http://....)

1. source = ‘DMAS’
2. unitID=161
3. Ref_page_url='.../.../wme_page.php'

WME Callback Page

(or search DMAD bank for questions to import)
DMAS – MACS: A Web-based Mathematics Answer Checking Service

Server

Answer Checking Service (MACS)

Computer Engine (Maxima)

Client

Web Browser

MathEdit

Answer Data (Input)

HTTP Protocol

Result Data (Output)

Web Page Form

06/04/2008
MAML (Mathematics Assessment Markup Language) is an XML markup language for DMAS.

To transmit assessment questions to and from DMAS system and to interact with outside systems.

MAML will be used for representation/encoding of assessment questions and exams.

MAML defines markup elements and attributes such as question head, type, classification, body, rubric, and so on.

The XSLT style sheet for MAML (maml.xsl) will be responsible to translate MAML markup into XHTML + SVG + MathML.
Which fraction below is equivalent to 3/4.

- 27/36
- 8/16
- 4/8
- 9/12