

# An Overview of WME: a Web-based Mathematics Education System

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## 1 What is WME and who is working on this project?

An interdisciplinary team at the Institute for Computational Mathematics (ICM/Kent) has begun to build a Web-based Mathematics Education (WME) system by an innovative combination of open Internet technologies. Figure 1 illustrates the WME concept. We believe a system like WME can help teachers provide a significantly better mathematical experience for their students. Our group consists of faculty and graduate students from Computer Science, Mathematics, Mathematics Education, and Graphic Design. WME can deliver, via the Internet or a LAN (wired or wireless), classroom-ready lessons that are well-prepared, mathematically and developmentally appropriate, interactive, and effective. In addition to multimedia content and hyperlinks, lesson pages feature interoperable and customizable manipulatives to help students understand and explore mathematical concepts through hands-on activities and guide and assist teachers in teaching mathematics more effectively.

The WME system supports, among other features, mathematical formulas through MathML, interactive geometry objects through SVG (Scalable Vector Graphics), and a distributed mathematics assessment system called DMAS. In addition, WME also makes its educational components (manipulatives, lessons, modules, formulas, geometry objects and assessments) *interoperable and customizable*. Interoperable so these components can readily be combined to form different lessons and modules. In other words, these components are plug-compatible. Customizable so teachers can easily edit any such component for their own purposes and not affect its use by others. Thus, WME is different and much more advanced than existing approaches and aims to be a modern, practical, efficient and effective Web-based system to provide more comprehensive support for implementing research-based reforms called for in mathematics education. Our WME system conforms to open standards, works with regular browsers, provides systematic access to client-side and server-side support, and allows independently developed WME components to interoperate seamlessly. In short, WME seeks to create a Web for Mathematics Education. Figure 2 (left) illustrates some of the contents and services WME can combine and integrate for effective Web-based mathematics education. This presentation will overview WME, show how it works, and demonstrate the capabilities of WME components and tools.

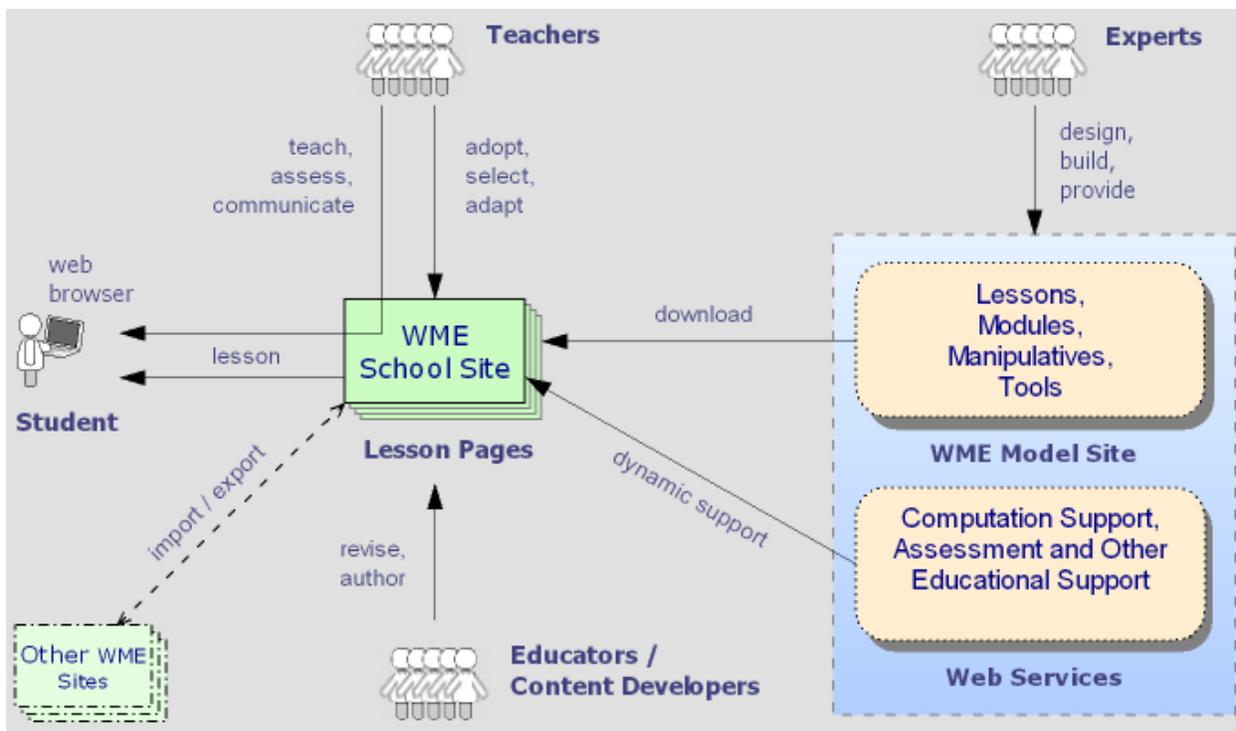


Figure 1: The WME Concept

## 2 Purpose of the WME system and results from school-based trials

WME is being developed as a modern Web-based system to support a special-purpose Web that fosters a new paradigm for creating, delivering, customizing, sharing, exploring and supporting interactive mathematics education materials online. We believe that this system has the potential to help web-based mathematics curricula grow and improve exponentially. By an innovative combination of standard Web technologies and the creation of powerful Web-based tools, WME delivers classroom-ready lessons for teachers to use in their classes that contain a variety of interactive-tools, for students to investigate a variety of mathematical

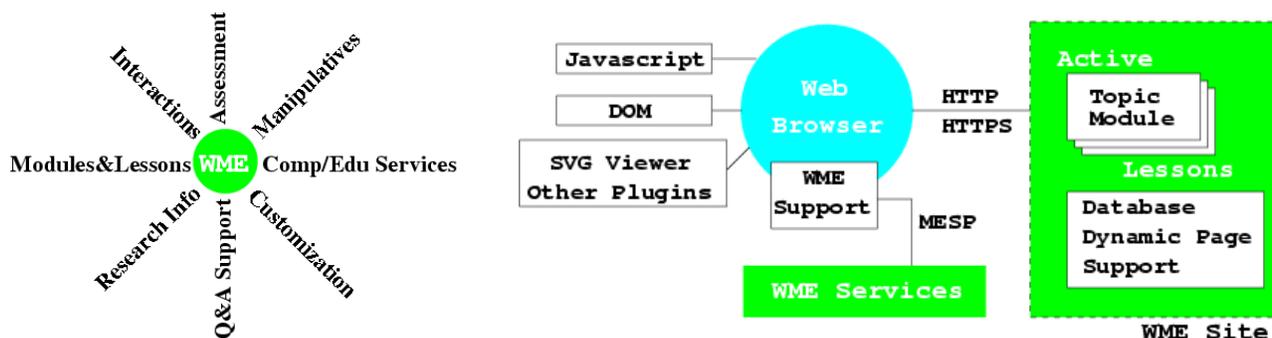


Figure 2: WME Integration (left) WME Architecture (right)

concepts. Specially designed manipulatives help students explore mathematical concepts, encourage conjectures, and other WME tools provide teachers with a way to collect formative data to facilitate whole-class discussions.

Teachers can use existing lessons, they can modify lessons, customize manipulatives, or create a new lesson with minimal training. Any new object created in the WME system can be shared with other teachers at the school or the WME community at large. The days of cutting and pasting lessons have taken a quantum leap forward. The current curriculum hierarchical arrangement is by grade level, by topic module (percents, integers, etc.) and individual lessons within these modules. Teachers can modify both individual lessons to suit their students needs and what lessons are in individual topic modules. Research-based teacher guides aligned with Ohio's academic content standards will be attached to lessons and modules to provide teachers with essential information for effective implementation of the lessons.

We have piloted several portions of the WME system in middle school classrooms using a prototype site, a step towards a model WME site that can be easily deployed to different schools. In our trials we have had a variety of teachers using WME to teach a variety of topics in grades 6, 7 and 8. The classes all have access to laptops with wireless access to the Internet. We worked through many technical and education issues in these trials. The preliminary results of these trials are that students and teachers liked using WME, they reported being engaged in thinking about the topics using the system, and that they were ready for more of our lessons. Each implementation of the test system was of a short duration (1 week or less) to gather initial data to determine where the system could be improved and how it might be affecting student learning.

During the first few implementations teachers tested lessons on percentages and fractions. These lessons were meant to help develop a better conceptual understanding. The manipulatives used ranged from interactive area models (some that looked like pizzas and chocolate bars) to interactive restaurant menus. Students chose menu items and the total was calculated automatically for each student. Students then used percent to determine tax, tip, and labor costs. Answers by each student were checked immediately. These tools allowed students to determine (at least in part) what problem was to be studied and gave some support for their responses to the questions. WME also provided the teacher with formative information about how all students were doing with each lesson by allowing him/her to view individual responses to questions immediately after answers were submitted. This gave the teacher an opportunity to create new questions either for students to respond online or for whole class discussions.

After each short trial, students and teachers supplied the researchers with their comments and suggestions about the lessons and the tools which were incorporated into the next revisions of both the content and technical aspects of the WME system. We are encouraged by the reaction of the students and teachers who have used our system and continue to increase the depth and breadth of its testing. Despite our enthusiasm for the WME system, more trials are needed to improve and refine the system and to determine the overall impact of WME on the teaching and learning of mathematics.