KENT STATE UNIVERSITY

Features and Advantages of

WME: A Web-based Mathematics Education System

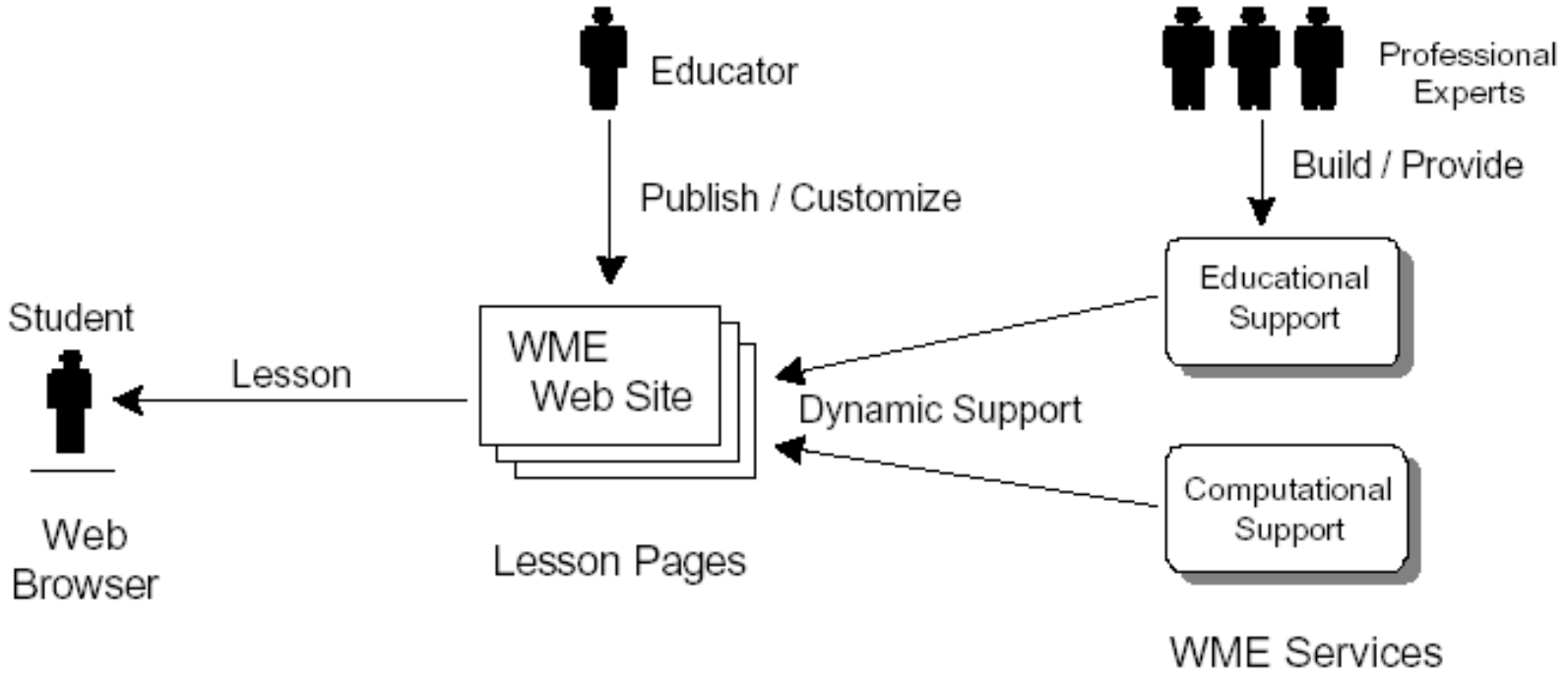
P. Wang M. Mikusa S. AL-Shomrani D. Chiu X. Lai X. Zou

Institute for Computational Mathematics

Kent State University

Kent, Ohio 44242-0001, USA

The WME Concept



The WME Pilot Project.

An Idea Whose Time Has Come

- Symbolic and numerical computation systems, have matured and become *Internet Accessible*.
- Mathematics teachers and students need help especially in the US.
- Availability and standardization of the Web and the Internet have grown and evolved sufficiently.
- Maturing technologies: MathML, ECMAScript, DOM, SVG, XML, CSS, Web Services, ...
- Increasing number of school districts have already deployed Internet/Web in classrooms.
- Web has begun to offer helpful materials for Mathematics teaching/learning.

Symbolic Computation and Math Education

Sample efforts:

- CAME: Computer Algebra in Mathematics Education
  `www.lonklab.ac.uk/came/`
- IJTME: the *International Journal for Technology in Mathematics Education*
  `www.tech.plym.ac.uk/maths/CTMHOME/IJCAME.htm`
- *Education meets Computer Algebra: A Double Challenge*, Symposium at IMACS ACA'98 conference on Applications of Computer Algebra (Prague, August 9-11, 1998).
- The Laboratory for Symbolic and Educational Computing (LSEC), Philosophy Department at CMU.

- NCTM Publication: *Computer Algebra Systems in Secondary School Mathematics Education*
  `my.nctm.org/store/ECat/product.asp?ID=12339`
- *Symbolic Computation in Undergraduate Mathematics Education (Maa Notes, No 24)*, book by Zaven A. Karian

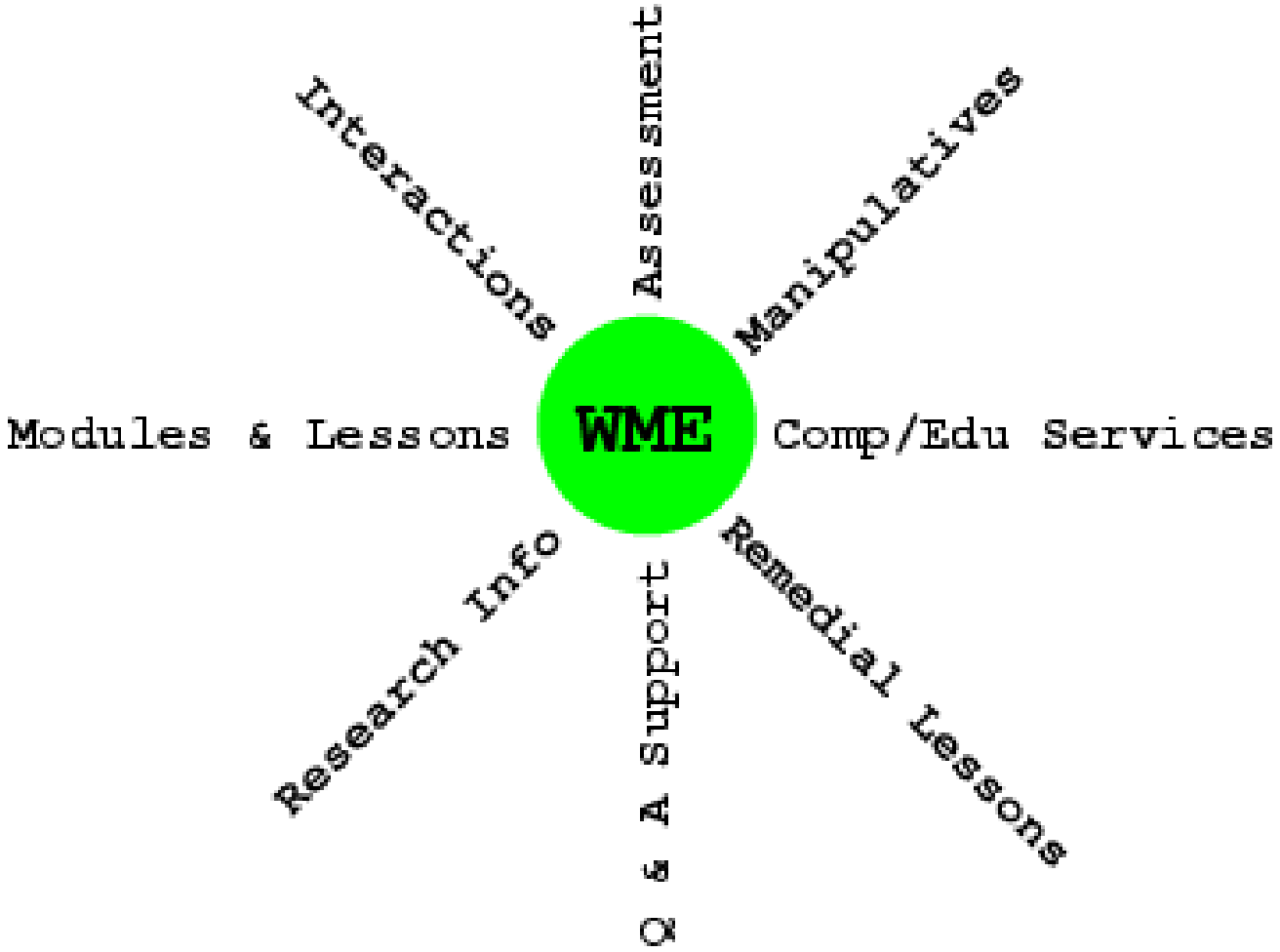
Web Helps Math Edu

- The Ohio Resource Center for Mathematics, Science, and Reading provides online resources for mathematics education.
- *Mathematics* section of the US Department of Education site.
- The National Science Foundation's *Math Is Power*.
- The IES sponsored Education Resources Information Center, an extensive literature database.
- The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC) links to lesson plans and activities.
- The NCTM *Illuminations Project* supplies applets for hands-on learning.
- The PBS *Mathline* site.

- The National Library of Virtual Manipulatives for Interactive Mathematics (applets)
- Mathforum at Drexel University provides *Problem of the Week* and *Mathforum Math Library* among other useful materials.
- Other efforts: Internet4Classrooms, WIMS, Livemath, Mathwright, geometry.net, WebMathematica, Calc101, AcitveMath, Maple, and MathWeb.
- Also e-learning and e-education support infrastructure systems such as WebCT and Blackboard.

KENT STATE UNIVERSITY

The WME Integration



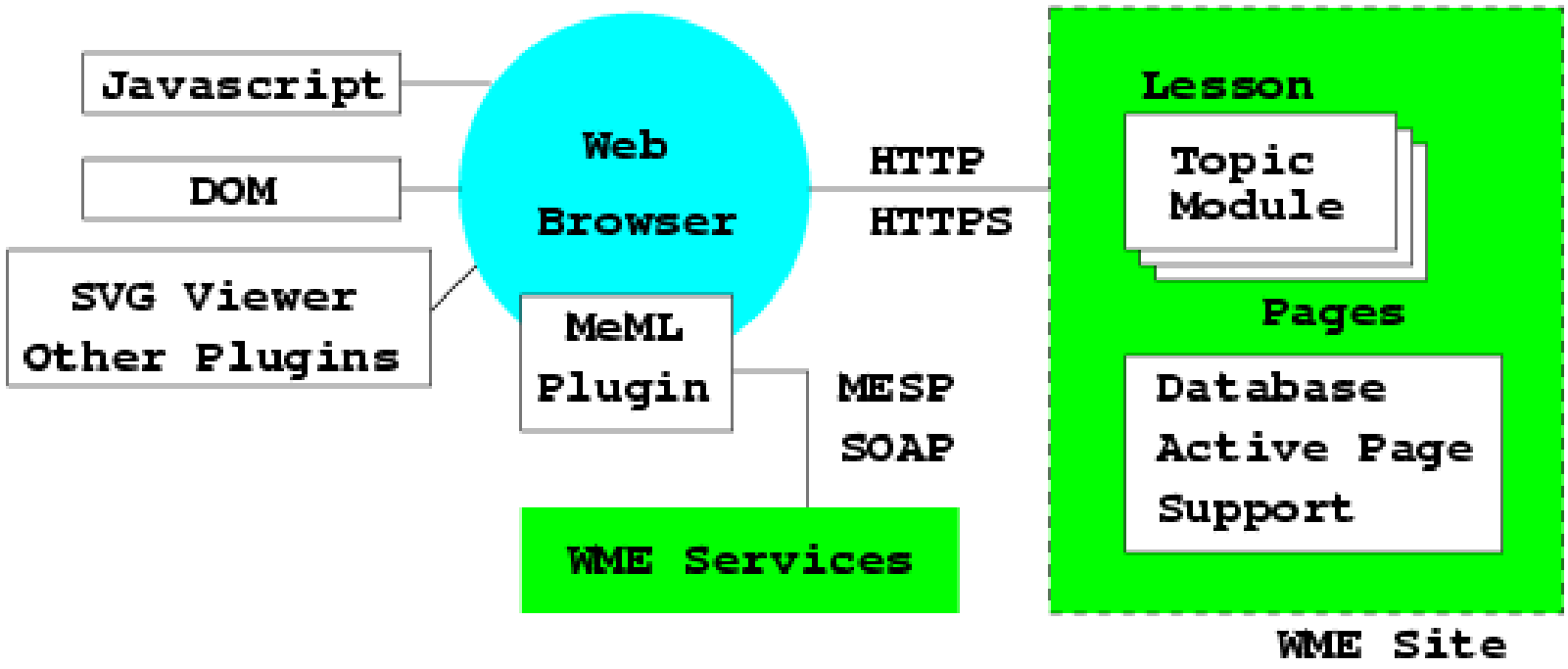
WME is Different

- Classroom-ready TLPs and TMs rather than assortments of teacher enabling materials.
- Lessons are interactive, integral, self-contained, and interoperable.
- Lessons are built by experts, conform to curriculum standards, and can cover entire grade levels.
- A WME site can be easily deployed to different schools and configured for local use.

- Lesson pages and modules can easily be customized by individual teachers for different classes.
- Interactive control and management by the teacher during classroom delivery.
- WME integrates lessons, manipulatives, assessment tools, and teacher-student interaction for effective teaching and learning of mathematics.
- WME pilot at Kimpton Middle (Stow Ohio) has demonstrated its practicality and popularity with teachers and students.

KENT STATE UNIVERSITY

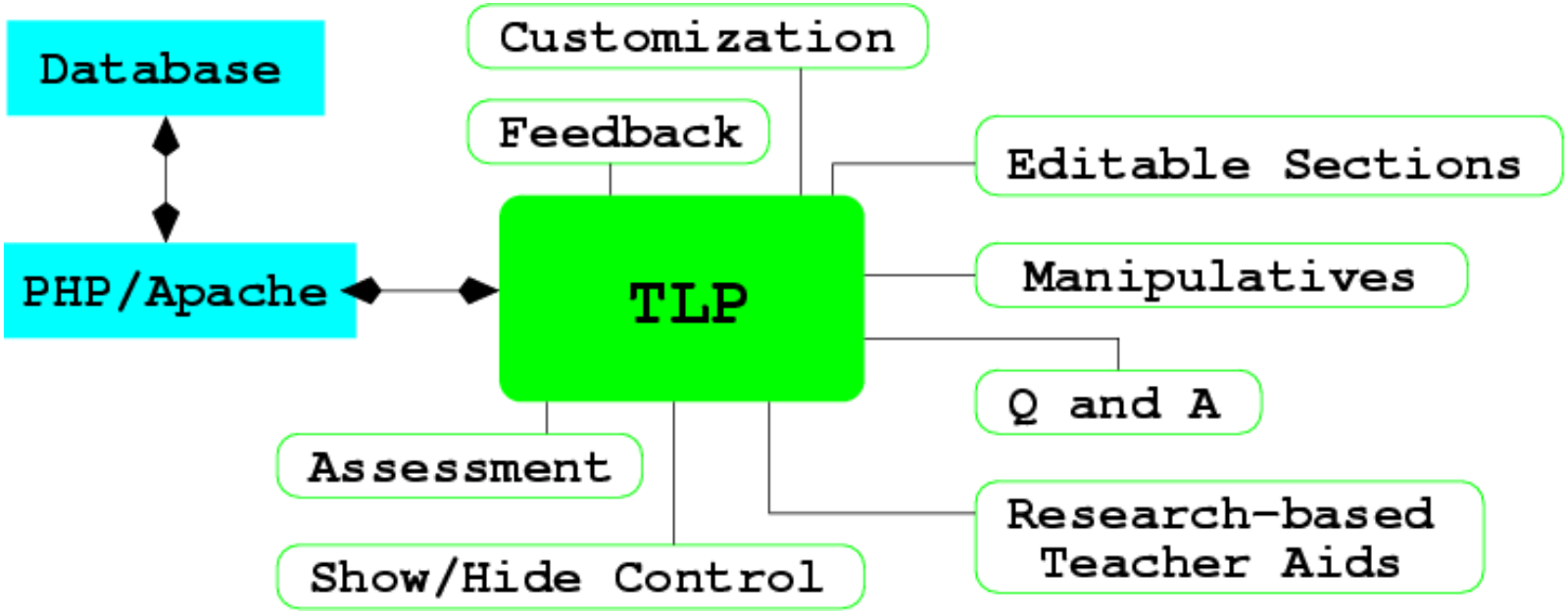
The WME Architecture



WME Components

- Interoperable *Manipulatives*, *Topic Lesson Pages* (TLPs) and *Topic Modules* (TMs)
- Assessment Support—assessment question database, test construction, grading, evaluation, and online tests.
- Client-side Support—regular browsers, javascript, SVG viewer, DOM, browser plug-in.
- Server-side Support—using active pages (PHP) and database (MySQL).
- Content-markup Support—MeML and Woodpecker
- WME Services—MathChat, MathBoard, MESP, MCP, and SOAP.

Kimpton Pilot Project



The Kimpton Site.

Manipulatives

Roll Start Over

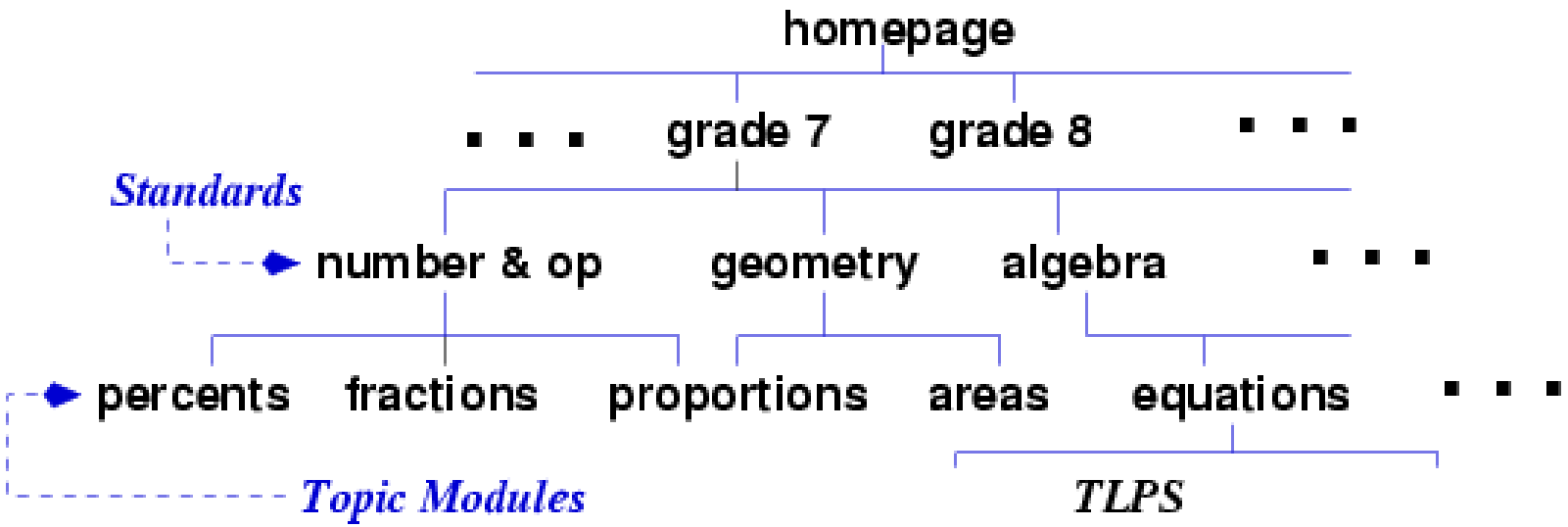
Roll count (the number of rolls you made): 0.

Sum	2	3	4	5	6	7	8	9	10	11	12
Count	0	0	0	0	0	0	0	0	0	0	0

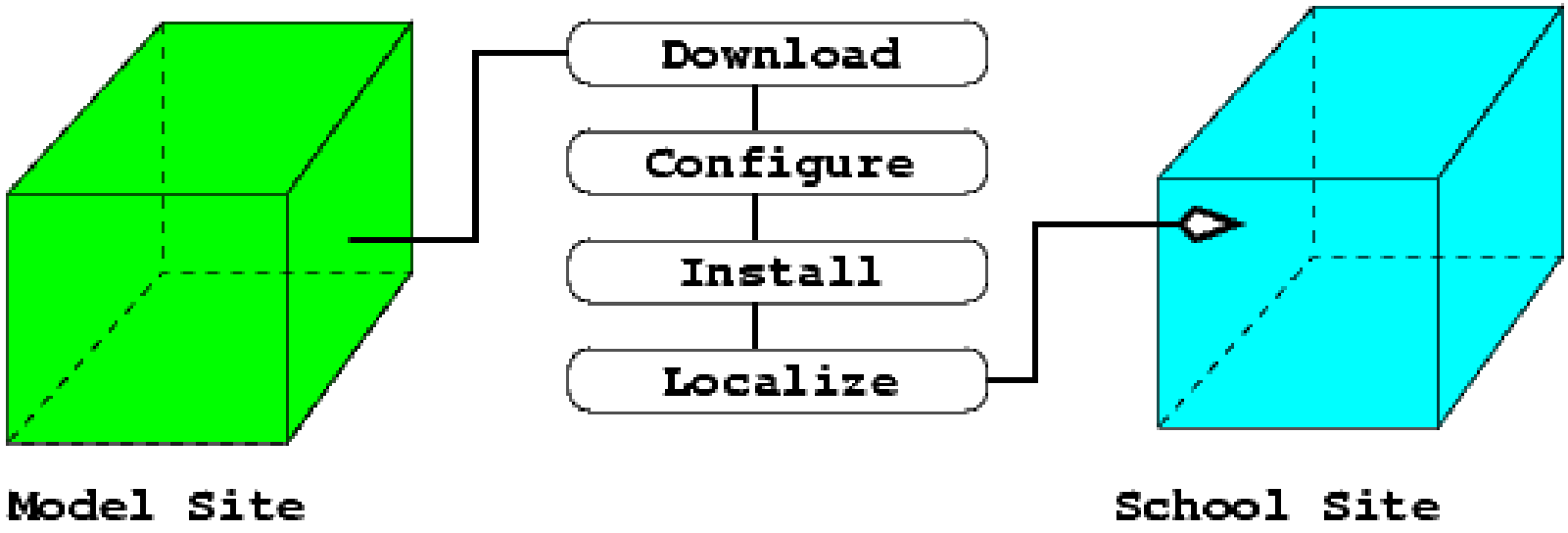
Example 1, Example 2, Example 3.

KENT STATE UNIVERSITY

WME Model Site Structure



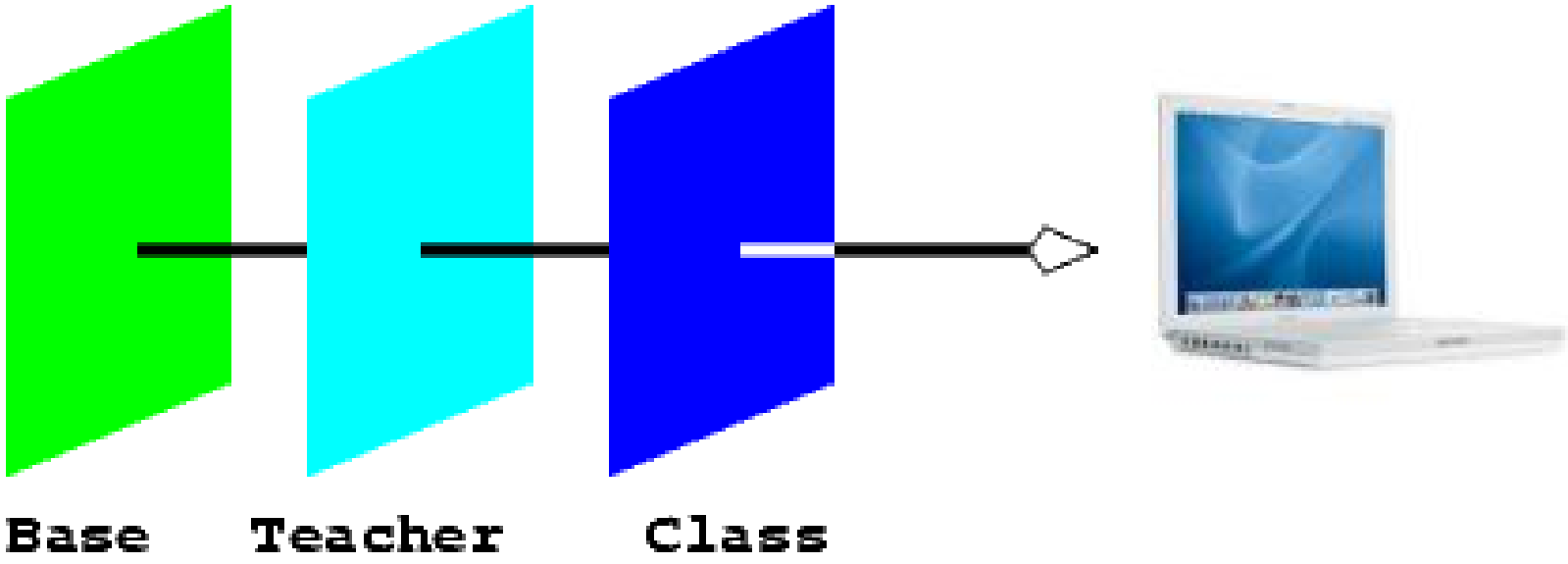
WME Model Site



WME Model Site

- In-School customization—user accounts, grade levels, course listings, course sections.
- In-class customization—TM and TLP selection, management, page content modification, page questions management.
- In-page customization—manipulatives editing: including text, presentation, and functionality.

Page Customization Layers



Customizing Pages

- Classroom-ready lessons and modules can be modified by teachers to suit their particular needs and requirements.
- Adding questions, modifying test, changing parameters, and adjusting manipulatives are done through password controlled simple on-Web tools attached to each page.
- Customizations are per page, per teacher and per class.

Customization Demo

Mathematics Chat and Bulletin Board

- MathChat encourages student participation in topic discussions
- MathChat simulates classroom teacher-student interactions.
- MathBoard encourages student-student interactions and generally facilitates communication among all in the class.
- Both must support Math input and display.

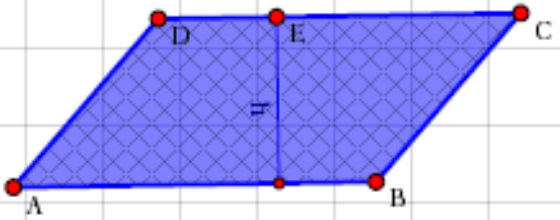
SVG-Based Manipulatives

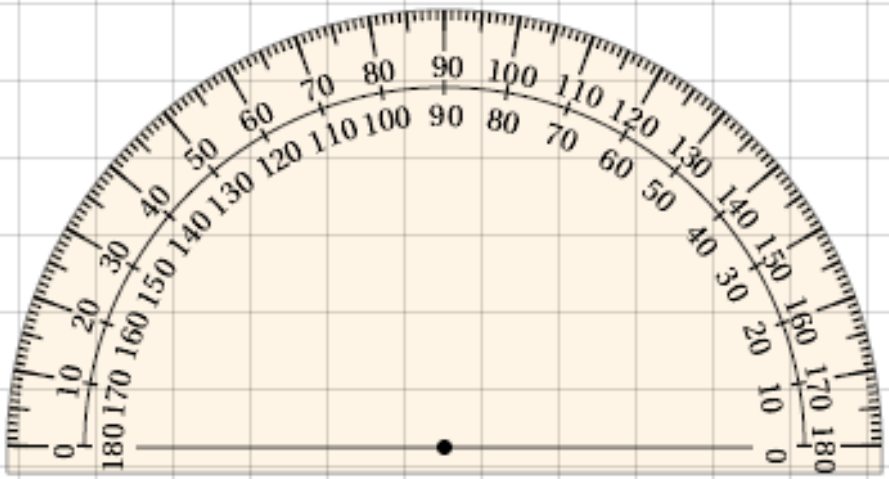
- Scalable Vector Graphics is an emerging W3C standard.
- Compactly delivers interactive graphics to support authoring and running manipulatives.
- Geometry-aware manipulatives support constraint-preserving user operations.

Base = 4.70 Height = 2.16

Area of the Parallelogram = 10.14

Area of the Rectangle = 10.14





Cut the Parallelogram

Show Grids in Inch

Show Ruler in cm

Show Ruler in Inch

Hide Protractor

Start Over

Assessment

- Test authoring, construction, and editing
- Online test taking
- Importing and exporting test questions
- Automatic grading and test data management
- Results evaluation and leads to interventions

Top 10 Advantages

10 *Accessibility*

9 *Compatibility and interoperability*

8 *Richness and variety*

7 *Integrated, dynamic, and classroom-ready*

6 *Efficient communication*

5 *Concepts not steps*

4 *Educator support, convenience, and control*

3 *Real-world motivations*

2 *Practical and flexible*

1 *Interactive, hands-on and self-paced*

Research and Collaboration

- Research and development challenges arise in computing and in education.
- System architecture, component interoperability, portability, usability and customization.
- System interfaces, markup language design, protocols, manipulatives, and tools.
- Educational effectiveness, practicality, and teacher/student acceptance, in-class trials, and effects evaluation.
- A research team ought to involve computer scientists, mathematicians, mathematics education researchers, school teachers, and education evaluation experts.