Features and Advantages of WME: A Web-based Mathematics Education System

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An Idea Whose Time Has Come

- Mathematics teachers and students need help especially in the US.

- Web and Internet availability and standardization have grown and evolved sufficiently.

- 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.

Web Already Helps Math

- 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.

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.

- 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.

The WME Concept

The WME Integration

Interactions · Assessment · Manipulatives · Modules & Lessons · **WME** · Comp/Edu Services · Research Info · Q & A Support · Remedial Lessons
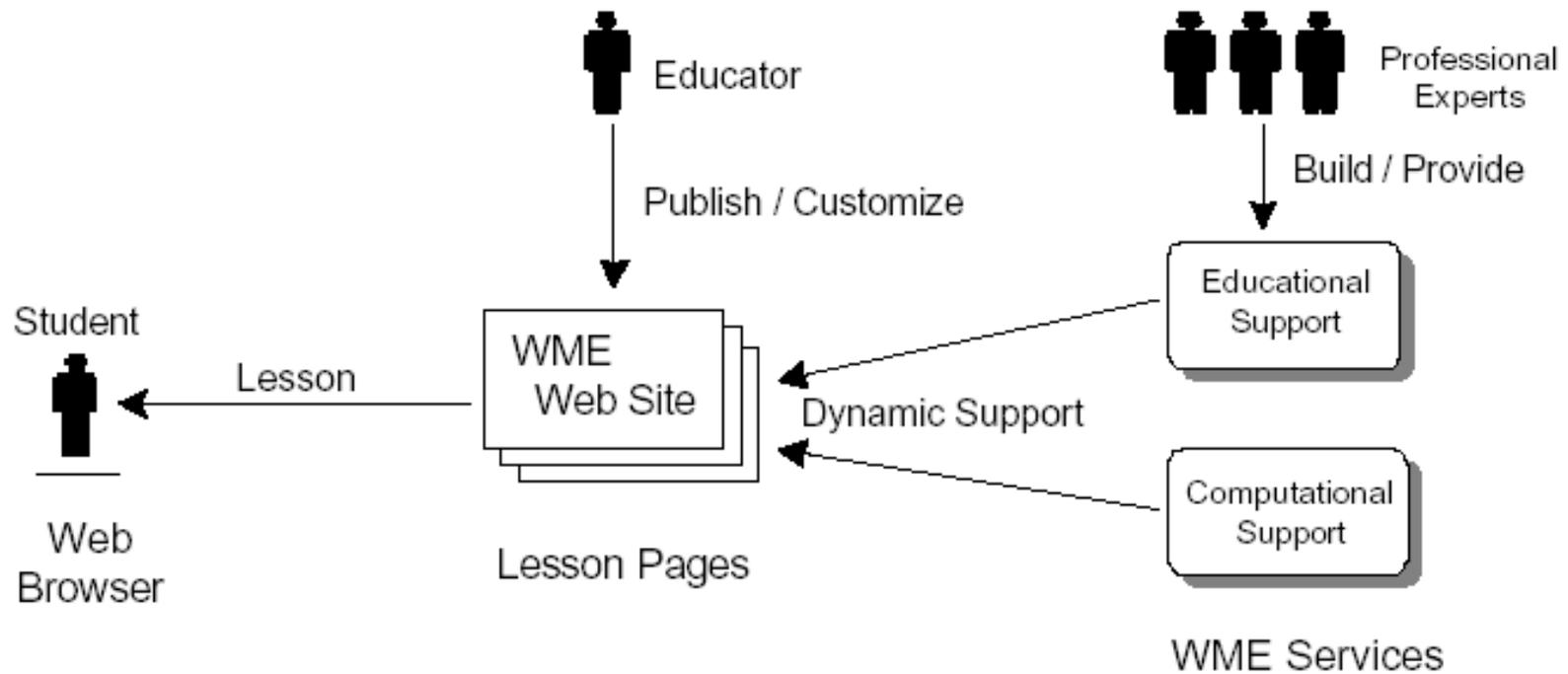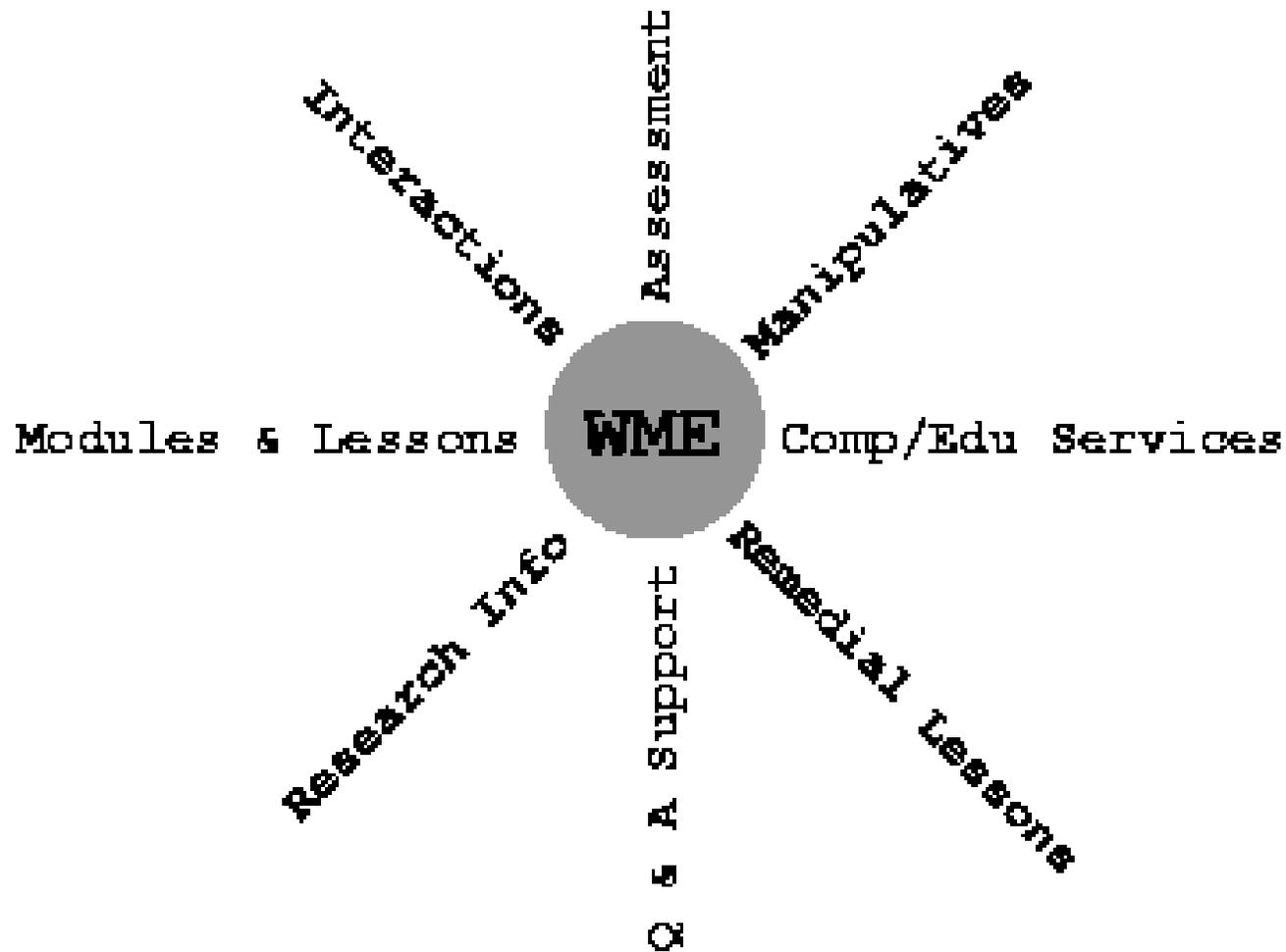
The WME Architecture
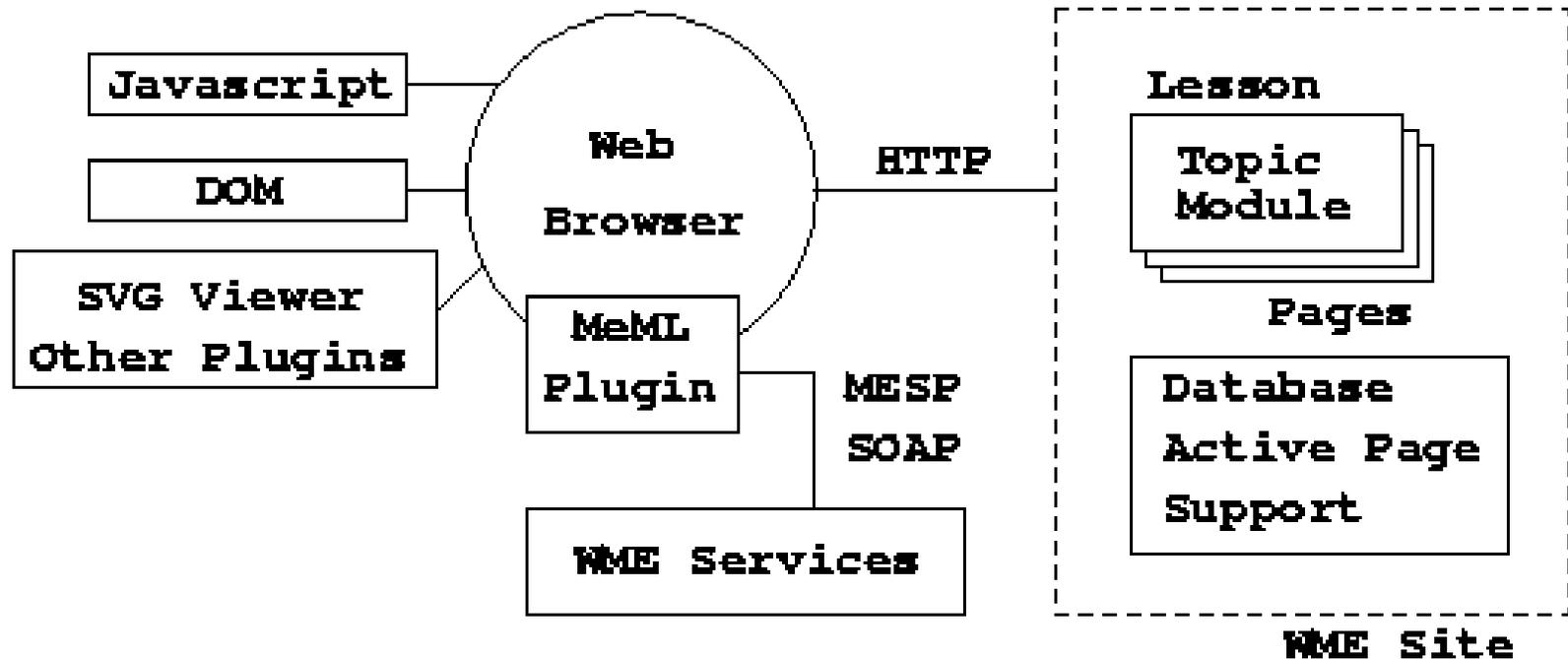
WME Components

- 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

Database

PHP/Apache ←→ TLP

Customization

Feedback

Editable Sections

Manipulatives

Q and A

Assessment

Show/Hide Control

Research-based
Teacher Aids
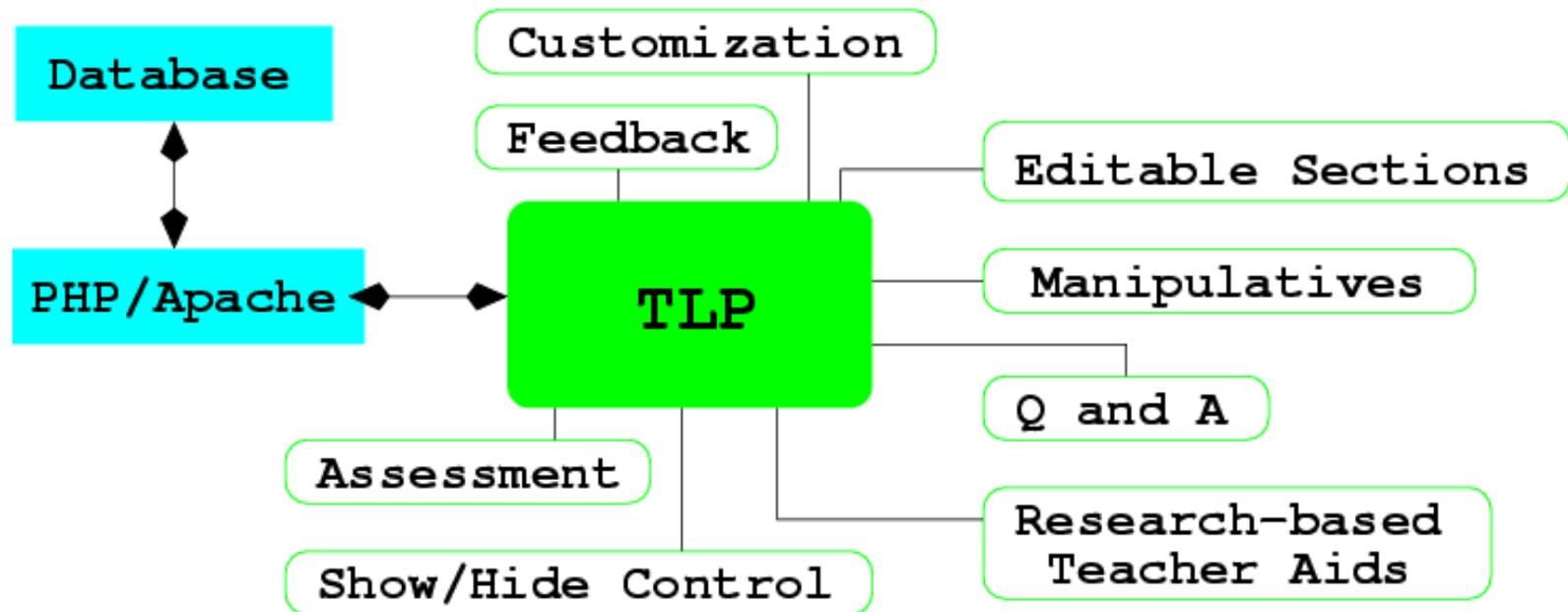
The Kimpton Site.

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.

WME Model Site Structure

A hierarchical tree diagram:

- homepage
  - . . .
  - grade 7
    - number & op
      - percents
      - fractions
      - proportions
    - geometry
      - areas
    - algebra
      - equations
    - . . .
    - . . .
  - grade 8
  - . . .

WME Model Site

Download

Configure

Install
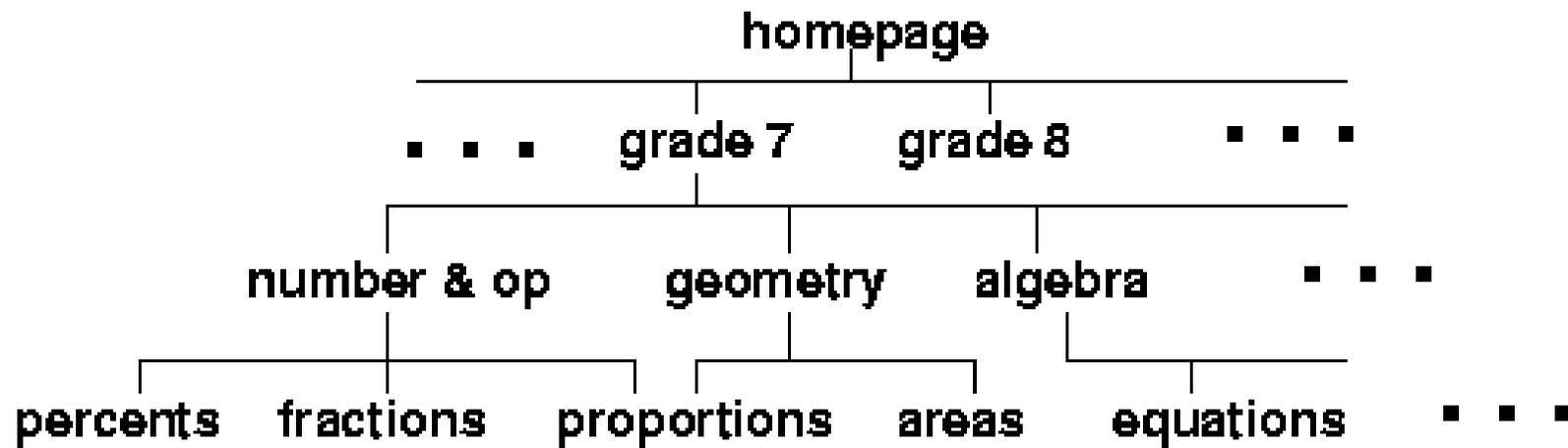
Localize
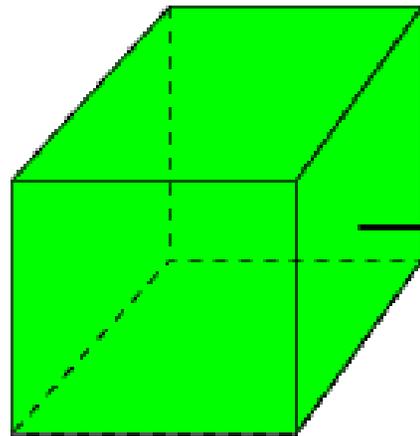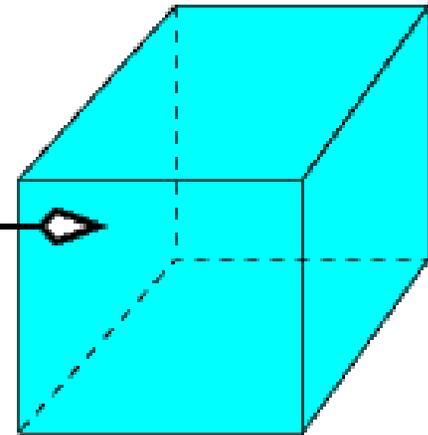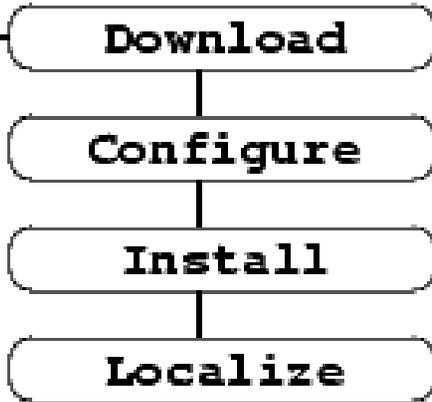
Model Site

School 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

Base   Teacher   Class
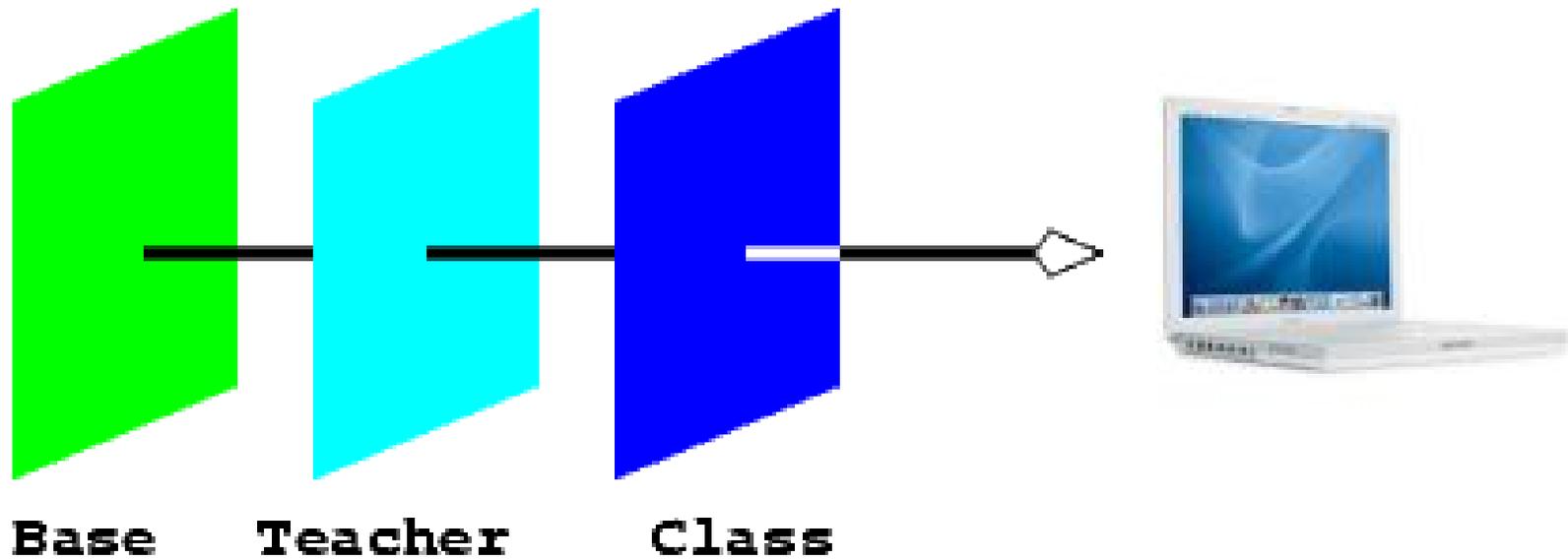
Customizing Pages

- 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

- 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

- Scallable 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
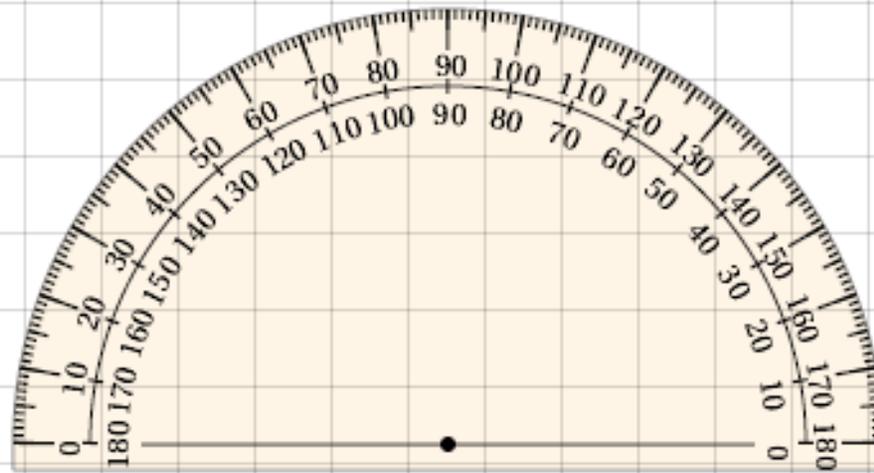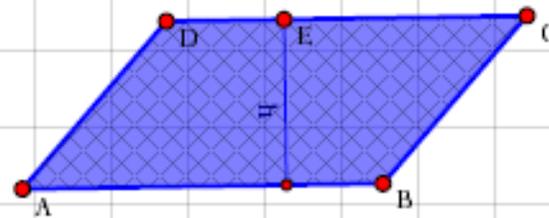
Show Grids in Inch

Show Ruler in cm

Show Ruler in Inch

Hide Protractor

Start Over

Assessment

- Test construction

- Online test taking

- Import and export test questions

- Grading and test data management

- Evaluation and guide for alternative 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 both areas: computing and education.

- System architecture, component inteoperability, 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.

- Research team ought to involve computer scientists, mathematicians, mathematics education researchers, school teachers, and education evaluation experts.