Oregon Accessible Algebra: supported electronic text (eText) to promote learning algebra for students with learning disabilities

Patricia Almond, Ph. D.
National Conference on Student Assessment
Orlando, Florida
June 19, 2011
Two Parts to Presentation

Setting the context
• Personalized Learning
• Next Generation Assessment
• Accessibility
• Supported Electronic Text

Exploratory Study of Middle School Algebra
• Course/classroom observations
• Teacher
• Student interviews
• Performance data
• Instructional materials

MeTRC: eText, Algebra, SWD in Oregon
What is personalized learning?

Personalized Learning/Education

- **Student: centered**, driven, choice
- Accommodate different **learning styles**/rates
- Teacher as facilitator
- **Engaging/Motivating**
- **Collaborative** knowledge building
- **Project based/authentic assessment**
- **Mastery**/Competency based progression
- Flexible **anytime/anywhere** learning
- Access to **technology** critical

MeTRC: eText, Algebra, SWD in Oregon
Personal Learning Environments (PLE)

Systems that help learners take control of & manage their own learning,[1] including support for learners to:

• set their own learning goals
• manage their learning, both content and process
• communicate with others in the process of learning

E-Learning personalization

Mechanism
- Google technology
- Student profile

Fig. 1. Protus system architecture.
next-generation assessment system based on a common set of standards . . . [to] serve students, teachers and administrators "better"

NEXT GENERATION ONLINE ASSESSMENTS: WHAT DO THEY LOOK LIKE?

MeTRC: eText, Algebra, SWD in Oregon
Two Next Generation Assessment Prototypes

• Virtual Environments [www.virtualassessment.org](http://www.virtualassessment.org)
  – 3-D immersive environments
  – Performance pallettes gather student data

• Scenario based assessments CBAL [http://www.ets.org/Media/Home/pdf/CBALMathSampleItems.pdf](http://www.ets.org/Media/Home/pdf/CBALMathSampleItems.pdf)
  – 5 to 15 scenario based questions
  – Students use tables, dotplots, boxplots, histograms, bar graphs, and scatterplots.
  – Describe distributions of data
  – Evaluate data from a variety of data displays
  – Justify a recommendation in paragraph format

Orlando 06/19/2011
Three Themes for Assessing Learning in Online Environments

1. **Comprehensive Models**: traditional (reading & math) & emerging (e.g. creative problem solving, systems thinking) competencies

2. **Seamless and Ubiquitous Assessment**: a continuous process that fuses assessment & learning (think inventory metaphor)

3. **Assessment Information for Decision Making**: evidence-based decisions by stakeholders (e.g., parents, educators, policy makers, researchers)


MeTRC: eText, Algebra, SWD in Oregon
ACCESSIBILITY
NimbleTools®

• High-quality accommodations in a seamless, standardized manner
• Universally designed application.
• Tools can be activated or deactivated for individual students
• Customized test delivery interface that meets the specific needs of each student.

http://www.nimbletools.com/uas/testingGear.htm
Assistance Maintaining Focus

- Auditory calming
- Masking (answer, structured, or custom)
- Guided reader
- Encouraging prompts (prompt(s), frequency)
- Breaks
- Additional time (factor)
Assistance Processing Information

- Key Word Highlight
- Flagging (text)
- Scaffolding (text, order)
- Chunking (order)
- Reduced Answer Options (prime, secondary, tertiary)
- Negatives Removed (alternate version)
- Alternate Representations (type, file name)
Tailored Representations

- Key Word Translation (language)
- Translated item (language)
- Signed (language)
- Tactile (static or interactive)
- Braille (type)
- **Audio** (text, graphic, text & graphic, or Blind)
Mike Russell, PhD
Thomas Hoffmann, MFA
Jennifer Higgins, M.Ed.

MeTRC: eText, Algebra, SWD in Oregon

Center for Advanced Technology in Education

http://cate.uoregon.edu/

SUPPORTED ELECTRONIC TEXT
Supported eText (Anderson-Inman & Horney (2007))

Supported etext is digital text that has been modified in ways that are designed to increase access and support comprehension.

To gain meaningful access to the curriculum, students with reading difficulties must overcome substantial barriers imposed by the printed materials they are asked to read. Technology can assist students to overcome these challenges by enabling a shift from printed text to electronic text. By electronic text we mean textual material read using a computer or some other electronic device such as a Palm, iPod, or even a LeapPad. Shifting to a computer for presenting text offers immediate advantages to readers, primarily because a computer can be used to modify the way text is viewed and read: font face, size, and color can be changed; text can be read out loud; concepts can be defined and explained; multiple illustrations can appear simultaneously; links can lead to supportive information; and documents can be accessed from different computers in different geographic locations. In short, electronic texts are malleable.

In spite of its inherent possibilities, electronic text by itself is rather limited in its usefulness to readers and learners. In order to really take advantage of its potential as an assistive technology, an electronic reading environment that intelligently transforms text into something that supports comprehension and extends meaningful learning is required. This is accomplished in a variety of ways, including embedded supports (e.g., definitions of unfamiliar terms), multiple modalities (e.g., text that can be read out loud), and links to useful resources (e.g., background information, concept map, notepad)—all of which can transform electronic text so that it is more accessible and supportive to diverse learners. We refer to text that has been altered to increase access and provide support to learners as supported electronic text or supported eText.

Supported eText

The concept of supported text was first developed by Anderson-Inman and Horney (1997, 1998) to describe electronic text that is modified or enhanced in ways that are designed to increase reading comprehension and promote content area learning.

The underlying assumption of supported text is that electronic text (e.g., a word, phrase, paragraph, page, or document) can be infused with additional text or media in ways that promote better understanding of what the author intended to communicate. In addition, the concept assumes that electronic text can be structurally presented or organized in ways that accommodate individual learning needs/styles or that can facilitate the accomplishment of targeted instructional objectives. Together, it is assumed that these enhancements can help readers overcome the perceptual, conceptual, and comprehension hurdles found in the text materials they are asked to read. Although implementations of supported eText are potentially appropriate for any learner at any reading level, most applications to date have focused on the needs of students with reading disabilities that make it hard for them to access or comprehend printed text in traditional formats. The concept of supported eText aligned with discussion of assistive technologies is the focus of the present department in RfQ.

From multiple research and development projects focused on investigating the nature and impact of supportive electronic text, Anderson-Inman and Horney developed a typology that described the specific types of resources that can be used to transform electronic text. In previous publications they described eight types of supportive resources that can be used to make the process of reading a specific text easier or more educational (Anderson-Inman & Horney, 1998; Horney & Anderson-Inman, 1999).

Unlike typologies suggested by instructional design or educational psychology (e.g., Alexi & Tirolp, 2001; Mayer, 2001), the resources in this list do not focus on what media is being used to modify or enhance the electronic text, but rather what function the supportive resource plays in the reading process.

New Directions in Research 135

Supported eText: Assistive technology through text transformations

LYNNE ANDERSON-INMAN
MARK A. HORNEY
University of Oregon, Eugene, USA

MeTRC: eText, Algebra, SWD in Oregon
Examples of Supported eText

- Text-To-Speech (TTS)
- Definitions
- Grammar & Spell check
- Illustrations
- Clickable Table of Contents (Navigation)
- Translation (English to Spanish)

- ?Math specific?
- Text-To-Speech (TTS)
- Definitions
- Grammar & Spell check
- Illustrations
- Clickable Table of Contents (Navigation)
- Translation (English to Spanish)
2. Digital Text

MeTRC: eText, Algebra, SWD in Oregon
5. Flexible Display (3)

Tale of Two Cities

…It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of
6. Flexible Display (4)

Tale of Two Cities
By Charles Dickens

Chapter 1: The Period

It was the best of times; it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way—in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only.

There were a king with a large jaw and a queen with a plain face, on the throne of England; there were a king with a large jaw and a queen with a fair face, on the throne of France. In both countries it...
7. Structural Tags

MeTRC: eText, Algebra, SWD in Oregon
9. Embedded Learning Supports

MeTRC: eText, Algebra, SWD in Oregon

CAST
MathML—Two Flavors

**Look:** One is designed to get the equation to look the way you want it to on screen

**Meaning:** The other is more about ensuring the meaning of the equation is preserved
Two "flavors" of MathML

Presentation MathML

“Integral sign, A, d, X, equals, d, squared, quantity, three, B, fourth power, end quantity, divided by, d, X, squared.”

Content MathML

“The integral of A with respect to X is equal to the second derivative of the quantity three times B to the fourth power with respect to X.”

Orlando 06/19/2011

MeTRC: eText, Algebra, SWD in Oregon
Exploratory Study
Middle School Algebra and Students Needing Instructional Support
Patricia Almond & Mark Horney

Middle School
Oregon Accessible Algebra Project
Framing Our Topic

- Students with **learning disabilities**
- **Algebra** (pre-algebra and algebra 1) content
- **Cognition** issues (see notes next slides)
- Supported electronic text **eText** what do we know RE algebra & LD? Examples
- Middle school (**MS**)
Cognition Issues


• **Cognitive**
  - Ability to recall related background knowledge (DOK Level 1)
  - Ability to organize information (DOK Level 2)
  - Ability to provide an explanation (DOK Level 3)
  - Ability to synthesize information (DOK Level 4)
  - Understands the meaning of an example
  - Ability to process multi-step problems
  - Ability to recall and use information presented in a task/item (working memory)
  - Understands the structure of “organizers” used to present information or to scaffold responses (e.g., how to complete a table)
  - Understands the purpose of highlighted features in text or illustrations
• **Executive**
  - Ability to set goals and expectations
  - Ability to monitor goals and progress
  - Ability to plan and sequence
  - Ability to self-regulate and reflect during problem solving
Cognition Issues continued


- **Cognitive Background Knowledge**
  - Knowledge of what histograms, dot plots, stem-and-leaf and box plots are
  - Ability to create graphical representations (e.g., histograms, dot plots, stem-and-leaf and box plots) of set of data
  - Ability to use (read and interpret) graphical representations (e.g., histograms, dot plots, stem-and-leaf and box plots) to answer questions about the data
  - Ability to select representations (e.g., histograms, dot plots, stem-and-leaf and box plots) of different types of data (e.g., frequency data, univariate data) to answer specific questions about the data
  - Knowledge of prerequisite vocabulary and symbols, and basic understand of concept (e.g., median, outliers, spread, minimum and maximum, range, box plot, stem and leaf, mode)
  - Knowledge of what data are (e.g. a number that represents a property of some item)
  - Ability to add, subtract, multiply and divide

Case Study Approach

• Classroom Observations
  – Regular mathematics classes
  – Support mathematics classes
• Teacher and Student Interviews
• IEPs and student information for Spec Ed
• School assessment data for 2010-2011
  – Statewide reading & mathematics
  – District progress monitoring (easyCBM)
• Inventory of textbooks & standard classroom materials
Mid Schl OR Algebra Focus
(Standards by Design, 2011)

• Grade 6: Foundations of Algebra, order of operations, variables, & solutions to basic Algebraic equations
• Grade 7: Understanding of operations on all rational numbers & greater fluency with linear equations
• Grade 8: Refine understanding of Algebra, slope of a line, more on linear equations & functions, & solutions to systems of linear equations.
Courses and Instruction

Regular Math Courses
Class Size 24 to 31

• Mathematics—6
• Mathematics—7
• Algebra 1 (full year)
• Algebra 1a (half-year)

Supported Math Courses
Class Size 6 to 11

• Support 360
• SPI Mathematics
• Special Education Math

Students (with & without IEPs) enrolled in a support class were also enrolled in regular math class.
Observation Highlights
(n = 26—regular = 12, support = 14)

• **Standard Fare:** Smartboard, Document Camera, and Macintosh Laptop

• **Presentation Tools:** Powerpoint, worksheets via camera, demo on board w/ dry erase pens

• **Instruction:** Warm-up, teach a concept, do together, assign problems, students work in pairs or small groups, art in math
“Read-Aloud” & Math Word Problems

• **Read aloud:** During state online texting Mathematics items were read aloud to students in support math classes. Was the accommodation helpful? In what way?

• **System:** Do students have a systematic approach to math word problems?
  
  • What is being asked?
  • What information is provided?
  • Approach to solving problem?
  • Show work? Verify answer?

Orlando 06/19/2011
### Student Interview Format—3 Items

<table>
<thead>
<tr>
<th>Condition</th>
<th>Read Item: A Silently, B Aloud, C Tchr Aloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directions</td>
<td>Read both the question and the answer choices. After (you/I) finish reading, I will ask you some questions.</td>
</tr>
<tr>
<td>Questions</td>
<td>I am going to ask you some questions about the problem and I want you to tell me what you are thinking. You may reread the question if you want to.</td>
</tr>
</tbody>
</table>
2. Fencing is sold for $1.50 per foot at the garden store. Shawn needs 24 feet of fence for his new puppy’s yard. How much will the fence cost?

A. $9.00  
B. $22.50  
C. $25.50  
D. $36.00  

Answer = B  
$22.50  

How did you get that answer?

Why do you think that is the correct answer?

“I don’t know. I just picked it.”
12. Two packages of cookies cost $5.90. How much do 6 packages cost?

A  $35.40
B  $17.70
C. $11.90
D   $2.95

Why do you think that is the correct answer?

“It is closer to the answer I got.”
Follow-up to three items n = 10

Which way of reading word problems did you prefer? Why? (Circle the way you liked best)

<table>
<thead>
<tr>
<th>Silently</th>
<th>You read aloud</th>
<th>Teacher reads aloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Both = 2

Do you find it helpful to have math test items read aloud by a teacher? (Circle one)

<table>
<thead>
<tr>
<th>Rarely/Never</th>
<th>Sometimes</th>
<th>Most/all of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>
Read Aloud

• *I kinda like you reading it and me reading. If I read it in my head it doesn’t really make sense but if someone reads it out loud it does.*

• *The teacher can explain better.*

• When asked if headphones and having the computer read it aloud was available for the online test, would you use it? *Oh yes, all the time. Then I wouldn’t have to wait for the teacher to come around and read it to me.*
In the online math test, support teachers read the math items aloud.

Q: How do you think this helps students?

- Pacing—the students seem to do better if they only complete a few items a day
- Hearing it makes a difference
- Having a familiar teacher read is better, I’m not sure if it would work as well otherwise
- Although I **cannot** tell them if their answer is correct, I ask students to explain how they got the answer
What’s next graphic

Exploratory

Design Research

Usability

Effectiveness

Implement

MeTRC: eText, Algebra, SWD in Oregon

Orlando 06/19/2011
So what’s next—completing study?

• Complete *analysis* cognitive interview
• Complete ecological description and *case study*
• *Verify* observations with mathematics teachers at middle school & seek their insights
• *Reports*
  – Exploratory Study Spring 2011
  – Literature research on focus (mathematics, supported eText, and learning disabilities)
So what’s next—Oregon Accessible Algebra Project?

Engage Technical Work Group

• Examine context
  – Personalizing learning and PLEs
  – Supported electronic text
  – Learning & mastery in algebra

• Interpret findings from spring 2011

• Develop design research studies for year two
MeTRC
Mathematics Electronic Text Research Center

FUTURE FINDINGS:
http://metrc.uoregon.edu/

Patricia Almond, Ph. D.
Center for Advanced Technology in Education (CATE)
University of Oregon
pjalmond@uoregon.edu

Project: Oregon Algebra, Learning Disabilities, and Supported eText