



Thinking Out Loud – Using Cognitive Labs to Investigate English Learners’ Interactions with Dynamic Computer-Based Science Items

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The Center for Applied Linguistics is proud to be celebrating its 50th birthday in 2009. Please visit the CAL web site at www.cal.org/cal50 for some reflection on our past and plans for our future.



- Cognitive labs with:
 - ELLs at different levels of proficiency and Native English speakers
 - Iterative: N=58, 5 events, students in grades 4-9
 - “Think aloud” protocol
- Independent judgment review of cognitive demands in both ONPAR and standard items
- Controlled studies using ONPAR and standard items
- Field Test

Timeline

- Cog Labs
 - Computer-based testing issues—Fall 2007-Spring 2008
 - Cognitive-Linguistic issues—Spring 2009
- Judgment Reviews
 - Jan 2009
- Controlled Studies
 - Science 8th Grade—Spring 2008 & Fall 2008
- Large-Scale Trials
 - Spring 2010

- The findings of the cognitive labs are summarized in respect to four principal issues:
 - Item accessibility for students
 - Onscreen supports
 - Item transitioning and navigation
 - Students' computer skills



Reduced Language Load

- Increase accessibility for ELL students on ONPAR items
- All content and task related words are supported
- Tried variations with less language and no language, and found:
 - Students of all English proficiency levels expect to see some language at the beginning of question
 - Some language provides more supports than with no language
 - Text helps to set up target, even if image sets context and content area – need text to narrow in on target
- Experimented with Rebus style questions, but these caused confusion, particularly with ELL students



Colorful, clear, consistent images and/or animation

- Stages the item context
- Activate correct schema
- Animations may help with interpretation because they require less inference than a static image – fewer perspective vectors
- Animations particularly helpful to introduce concept of time passing

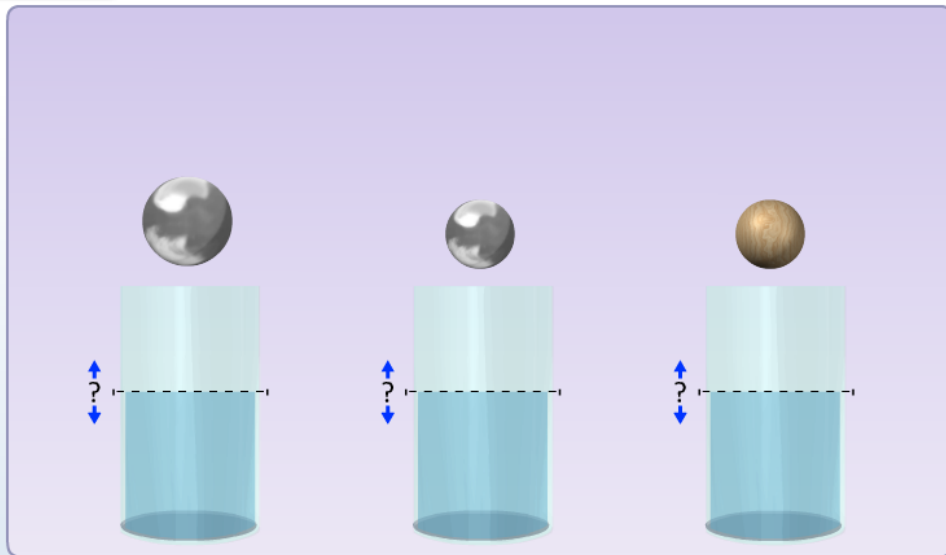
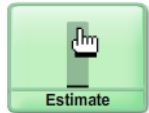
Alternative item response types

- Allows ELL students opportunity to respond in formats beyond MC and CR
- Increases interaction – more engaging

Buoyancy Item



What will happen to the water level?



Question: 1 of 1



Accessible Item

- Text cueing target
- Animations and images cueing content
- Images are clear, consistent, recognizable and supported
- “Estimate” icon
- Rollover supports on text, images, icon



- Interactive supports engage students
- Language supported with rollovers linked to images and/or animations
- Animated icon
 - Supports alternative item types
 - Rollover highlights response space
 - Interactive with animation to demonstrate task
 - Includes a word to support the task demand
- Active objects
 - Change intensity on rollover
 - Identified through highlights from text and icon

Squirrels Item



What colors are the squirrels?

Complete

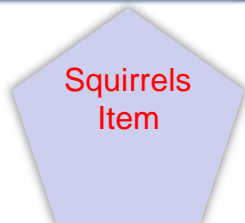
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Question: 1 of 1



Onscreen supports

- Rollovers on text highlight corresponding images
- L1 audio
- Animated icon
 - Rollover shows “where to answer”
 - Click shows “how to answer”
- Response space indicated with formatting
 - Dashed lines
 - Question marks
- Active objects identified
 - Rollover changes intensity
 - Highlights

Standardized Screen Layout

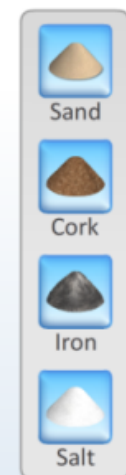


- Location and function of supports standardized and obvious so that all students have access to the same amount of information
- Use colors and design to distinguish between different screen elements
 - Item stimulus - located in most obvious location
 - Text - supported text always blue and underlined
 - Animated icon - distinctive color, larger size, located directly under the text
 - Response area - standardized design, location may change with item type
 - Response options – separate from item stimulus, in grey box

Mystery Substance Item



Which **substance** is **removed** at each **step**?



Question: 1 of 1

Standardized Screen Layout

- Text and Font properties
- Icons
- Response options
- Item stimulus
- Response space
- Navigation buttons

Mystery
Substance
Item



- Students more comfortable when they have control over the pace at which they proceed through items
 - Navigation Bar allows students to move forward or backward, or replay animation
 - “Go” button to start the item
 - “Go” buttons indicates new item
 - Students require time to process new images



Amount of information on the screen

- Too much prevents student from focusing on target
- Too little, and student may not understand target or task demand
 - Increased inference load, but student may make incorrect inference

Additional complication with items the have multiple screens

- Need cohesion between screens
- Need to highlight differences between the screens
- Need to carry over some information to next screen
- All information required to answer question on screen

Pond Ecosystem Item



How does the powerplant change the ecosystem?

Make a sentence

water decreases

pollution ↑

↓

causes [?] [?] causes [?] [?]

Question: 1 of 1

Transitioning

- Navigation Bar controls progression through item
- Item contains 3 different task demands, each setup with and animation or image
- Information from each introductory screen is carried through to the response screen

Pond
Ecosystem
Item



- We found a large variation in computer skills
 - Students with lowest English proficiency tended to have the lowest computer proficiency
- Practice items in tutorial are critical to accessibility – may be introducing additional ancillary issues
- Without tutorial, students were overwhelmed by amount of information on first one or two items, and had difficulty differentiating between supports and task demand
- Students in early labs were consistently hesitant to submit a answer
- Tutorial increases comfort level of students, particularly ELL students

Review Page



Grade 4 - LL



DONE

Review page

- Identified in the tutorial
- Flags unanswered questions
- Reduces stress level
- More closely simulates paper and pencil
- Better results



- Research results show that balancing the item's text and visual elements is necessary to produce an optimal mix of information.
 - Standardize the screen layout.
 - Actively support text and visuals with rollovers and other types of item supports.
 - Images and animations provide different information than text, so we need the right combination to facilitate accessibility.
- A coherent item needs additional information through the visual and audio channels to render it accessible
- Alternate item types, supported through an introductory tutorial, seem to be an effective way to assess high depths of knowledge for ELL students.

ONPAR Project Organization



- Funded through two EAG's (Enhanced Assessment Grants) from the U.S. Department of Education
 - Lead States
 - Science – Rhode Island
 - Math – Illinois
 - Wisconsin Center for Educational Research via the WIDA Consortium
 - Tim Boals, Project Director
 - Rebecca Kopriva, Principal Investigator
 - Center for Applied Linguistics
 - Jim Bauman, Program Manager
 - David Gabel, Lead Research Associate for Item Development
 - Cathy Cameron, Lead Research Associate for Research Operations
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