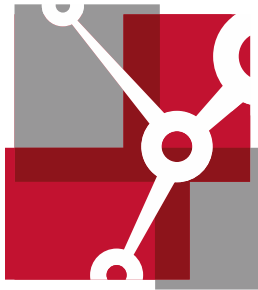*(Presented at Playful Learning Summit, Ohio University, April 10, 2014)*

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Playtesting Educational Games with Children:
Preserving the Fun

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LEARN
WORK
PLAY

DARPA ENGAGE ETC Projects

- Scott Stevens, PI with Bryan Maher, Sam Collier, Matt Champer, Ricardo Merchan

- Emphasis: Science games for 5-11 year old children

- Development: 5 ETC graduate student projects plus current effort (Sam, Matt, Ricardo running workshop this afternoon)

- Partners: CMU Human Computer Interaction Institute, Sesame Workshop

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ETC Project Contributors

- Parent page with links to contributions: http://www.etc.cmu.edu/engage/
- Illuminate, Fall 2011
- Sci-Fri, Spring 2012
- Torque It!, Fall 2012
- STEMPOWER, Fall 2012
- IMPACT!, Spring 2013
- PuppyBot Rescue (current effort)

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Illuminate

Sean Brice   Matt Champer   Qiaosi Chen   Luke Jayapalan   Jing Jin

Playtesting

First Half of Semester

- Energy ball grows and turns yellow

- Gems arbitrary

Illuminate

Iterative Changes

- Energy ball absorbed, Gems light up

- Gems regularized

Playtesting

- New goal visualization

Playtesting

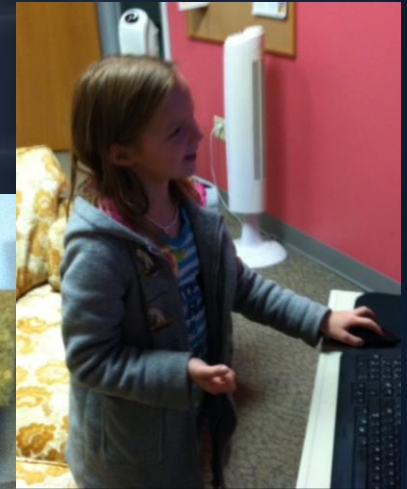## Nov 9 – ETC

1 girl
Age 6
Playtime: 1 hour

- New goal visualization works

- Energy ball visualization works

- Developmental differences

- Two-handed approach

Nov 10 – Children's Museum

10 kids – 9 boys, 1 girl
Ages 2 – 8
Playtime: 5-25 minutes

Illuminate

Playtesting

Nov 19 – ETC

11 kids - 7 boys, 4 girls
Ages 5-8
Playtime: 45 minutes

- Game is fun!

- Level difficulty is appropriate

- Rotation video in tutorial is too fas

- Tutorial works well with and without voiceover

- Narrative understood and played key role in keeping children interested

Illuminate

Playtesting

Illuminate

Playtesting

Dec 8 – Children's School

7 kids - 4 boys, 3 girls
Ages 4-5
Playtime: Limited to 10 minutes per child

- Intro makes sense
  - Crash landing a little too fast
- Mini-game:
  - Kids want to click the arrows
- Best reception ever
  - More intriguing to kids
  - Love hitting the alien

Illuminate

RumbleBlocks, Lessons Learned 1

Narrative helped attract young players, keep them interested, and motivate them to achieve success

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RumbleBlocks, Lessons Learned 2

Scaffolding was subtle so players not offended by the help; it blended with the narrative (energy balls that guided placement of tower blocks to energize ship)


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RumbleBlocks, Lessons Learned 3

- Remember surprise, pleasure, "juiciness"
- Jesse Schell's *The Art of Game Design: A Book of Lenses* (Burlington, MA: Morgan Kaufmann, 2008) – 2nd edition coming soon

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Science Content for Remainder of Discussed Games

- Balance scale and sum of cross products

- Determine whether a scale will balance, given a particular configuration of weights on each side of the fulcrum
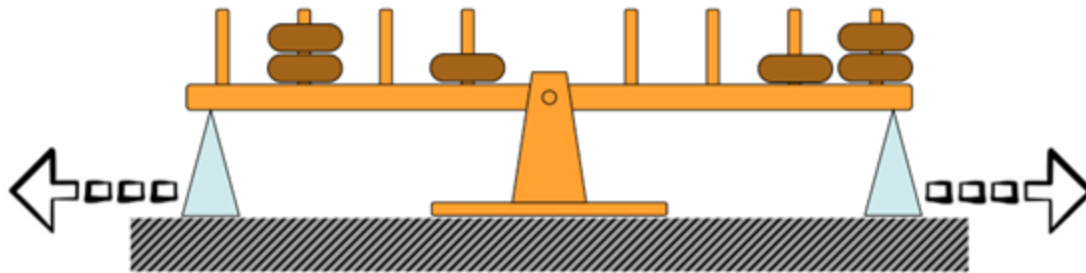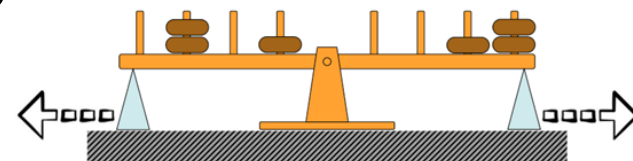

Siegler, R. S. (1976). Three aspects of cognitive development. *Cognitive Psychology, 8,* 481-520

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Objectives for Remainder of Discussed Games

Help learners progress through 4 increasingly sophisticated mental models identified by Siegler:

1. Learners only pay attention to weight, not distance.
2. Learners also consider distance, but only when the weight is equal on both sides.
3. Learners consider both weight and distance, but when the cues suggest different outcomes, they guess.
4. Learners consider both the amount of weight and distance of weights from the fulcrum; if the cues suggest different outcomes, they use the sum of cross products rule.

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PLAYTESTING: BEANSTALK

7 Playtests   57 students

Beanstalk: Socio-Emotional Learning Focus Added

For educational use only

- Jack/Jackie: plays role of peer/friend to the player (e.g., reminds player of goal; directs player to ask birds for help)

- Chicken: eager to help (like young sibling), positive and excitable

- Crow: also likes to help, but preens when correct and likes to take credit for player's activity (sharper than Chicken but not as eager)

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Beanstalk Lessons Learned

- Respecting importance of narrative: keep beam balanced so Jack/Jackie can return teddy bear to creature above

- Providing scaffolding blending with narrative: increasingly complex problem states in later levels occurs through active pod slots and water inventory

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RUMBLEBLOCKS 2.0

+ **Ages 4-9** +

237 Players

Working with CMU HCII to
make stronger
assertions about
educational game
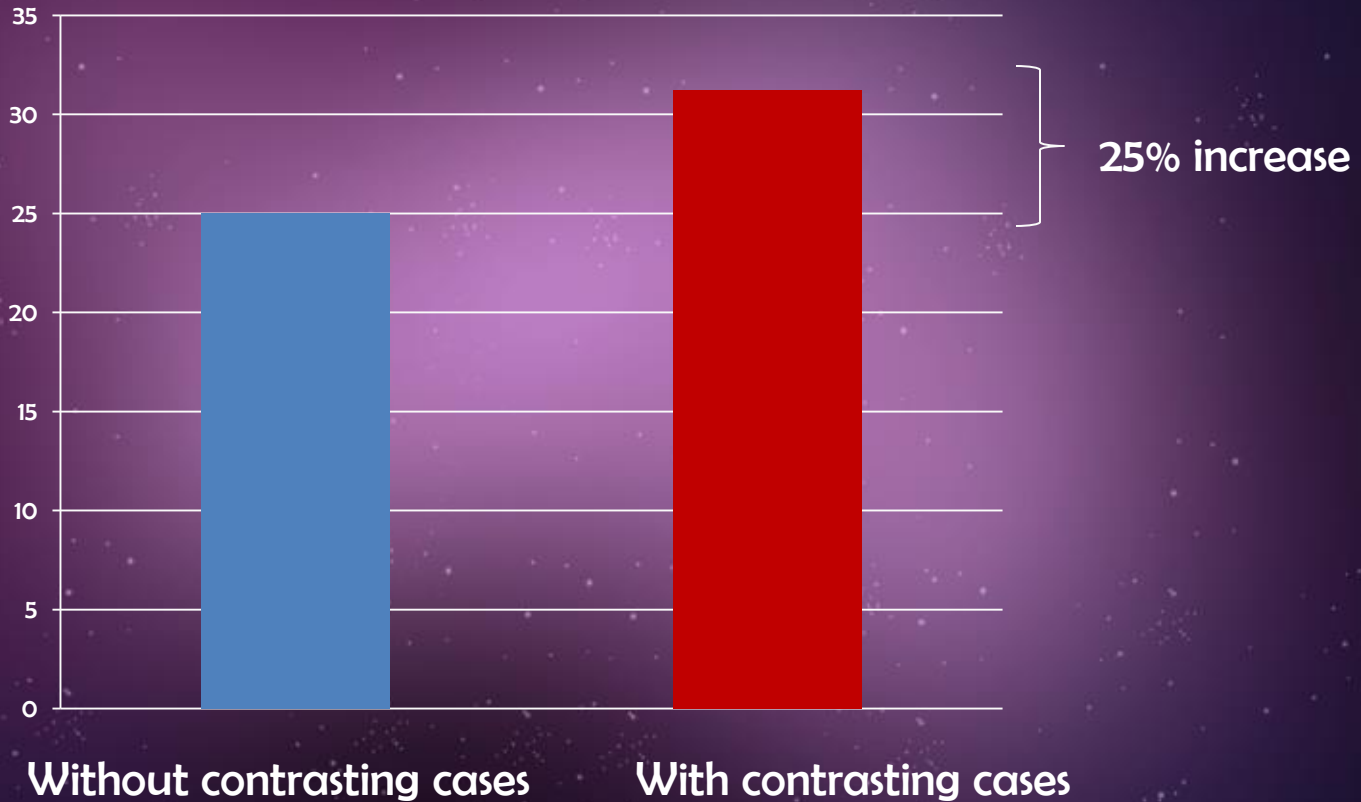
TORQUEIT!
FOR SCIENCE

WEICHUAN TIAN | JINGYI FENG | MENG HUI KOH
MATT CHAMPER | QIANRU MA | SEAN BRICE | SAM COLLIER

ADVISORS

SCOTT STEVENS | MIKE CHRISTEL

Testing (Sesame Workshop)

- 11 children. 7 1st graders. 4 2nd Graders, 11/26/2012

- User interface was unclear

- Turn making was not clear

- Sharing is hard (some children resisted, emphatically!)

- Fatigued from confusion in UI

- Game titled "Teeter Totter Go"

Changes Motivated by Playtest

Streamlined interface (make clear what actions constitute a turn)
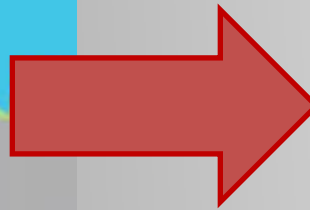
More Changes from Playtesting

- Black outlines and contrasting colors to highlight foreground
- Music adjusted (longer track, volume lowered)

Follow-Up Playtesting

- 12/3/2012, one week after test at Sesame Workshop, with 15 first graders

- Majority breezed through the game

- Enjoyed inquiry

- Enjoyed and understood the game

- Understood the need to share to succeed

Teeter Totter Go Playtest Video

Playtests! (Slingshot vs. Tractor Beam)

- Feb. 13th
- 6 Pre-K Students; Children's School

- 3 boys, 3 girls
- Both mechanics work, need to pick one

Playtests!

- Feb. 27th
- 8 Pre-K Students; Children's School

- 4 boys, 4 girls
- Most players asked for more levels to play

Playtests!

- Mar. 13th
- 21 2nd grade students, 7-8 years old
- Testing for fun

Playtests!

- April 13th
  - 6 Playtesters, 4 girls and 2 boys
  - Narrative well received

- May 3rd
  - 17 Playtesters, K-3rd grade
  - Game Well Received

PuppyBot Rescue

- Current effort, building from other games
- Developed with Sesame Workshop

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PuppyBot Rescue

- Developed in concert with Sesame Workshop to do the following:
  - Emphasize Siegler balance principles, dropping out socio-emotional learning
  - Use HTML5 (createjs) to prep for pbskids.org deployment
  - Optimize for touch: increase interactivity beyond the level established by IMPACT! team for its *Helios* game
  - Adapt game level progression, because what works for 5 year olds won't work for 11 year olds and vice versa

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PuppyBot Rescue Playtests

- Conducted by Sesame Workshop (as were tests with Teeter Totter Go game) with children in New York City

- Conducted in Pittsburgh area schools as well

- Dozens of children tested in grades K-3

- Young children struggled, older ones were bored before adaptive level progression was added

- Latest test (last week!) with 18 children shows adaptive strategy is working as expected

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Summary

- ETC DARPA ENGAGE projects producing games to teach science concepts to children

- Testing with children helps to preserve the fun

- Important elements include:

  – Interesting story narrative

  – Gentle, adaptive level progression (attention to problem flow)

  – Scaffolding that fits with narrative

  – Frequent interaction points, emphasis on touch-optimized for tablet usage

  – Remember the surprise, pleasure, juiciness (often via art and sound)

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RUMBLE BLOCKS

Rumble Blocks is an educational game about saving several aliens by building stable structures in a sandbox environment. The aliens' mothership was damaged and they have to retreat to several different planets while they wait for another one to come save them. In the meantime, the player must build towers by manipulating a series of blocks to help them recharge their spaceships by building stable towers that capture the necessary energy. This game is designed to teach children ages 4-11 how to build and identify stable structures.

Rumble Blocks has been formaly evaluated with several hundred guests. In our research, we have found that this age group has difficulty in understanding principles of stability, specifically making correct predictions and explaining them. In order to discover whether learning is occuring in-game, we implemented "Contrasting Case" levesls, where the player has to select which tower is more stable - these have shown that enhanced learning of principles of stability and balance is occuring. Rumble Blocks has shown to foster learning and engagement.

RumbleBlocks can be played at:
http://rumbleblocks.etc.cmu.edu/
and is also available on Learning.com and CS2N.org

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Beanstalk

Beanstalk is an educational game about balancing a beam at the tip of an ever-growing vine to return a teddy bear to the monster on the moon. Beanstalk focuses on teaching balance to the player, as they plant flowers to counter balance the bugs on the beam. The design is based heavily on research done by Carnegie Mellon University professor Robert Siegler on balance experiments and drawn from the National Research Council's Framework for K-12 Science Education and Pennsylvania's Academic Standards. Beanstalk is highly configurable, allowing anyone to change the balancing problems and other gameplay variables. Built with Unity3D, it's available for download or across major web browsers with the help of the Unity3D plugin.

Beanstalk has been formally evaluated with several hundred guests. Through playtesting, we have discovered that Siegler's findings have been confirmed. Young kids pay attention to weight and tend to ignore distance of items on a balancing beam. With this in mind, we built Beanstalk to be adaptive, allowing players who master one of Siegler's rules to continue sooner than those who do not. Beanstalk has shown to foster learning and engagement.

Beanstalk can be played at:
http://beanstalk.etc.cmu.edu/
and at Learning.com

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HELIOS

Helios follows the adventures of students aboard *The Ark*, a space station that houses the school for gifted children, "Helios." The game is designed to teach children (ages 6-10) how to solve balancing puzzles, ranging from circuits and bridges to goo and putting out fires. The design is based heavily on research done by Carnegie Mellon University professor Robert Siegler on balance experiments, and drawn from the National Research Council's Framework for K-12 Science Education and Pennsylvania's Academic Standards. Helios' is highly configurable, allowing anyone to change the problems and level type to suit varying age groups. Having been built with ImpactJS, it's available to play across major web browsers without additional plugins.

So far, Helios has been tested with 49 guests with no noticeable player fatigue after 25 minutes of play. The narrative and mechanic were well recieved by both boys and girls through a wide range of ages. Helios is currently being updated to fit in with The Electric Company narrative and style in order to possibly be broadly deployed on PBSkids.org.

Play Helios at: http://www.etc.cmu.edu/projects/impact/?page_id=18
Works best with Google Chrome or Mozilla Firefox

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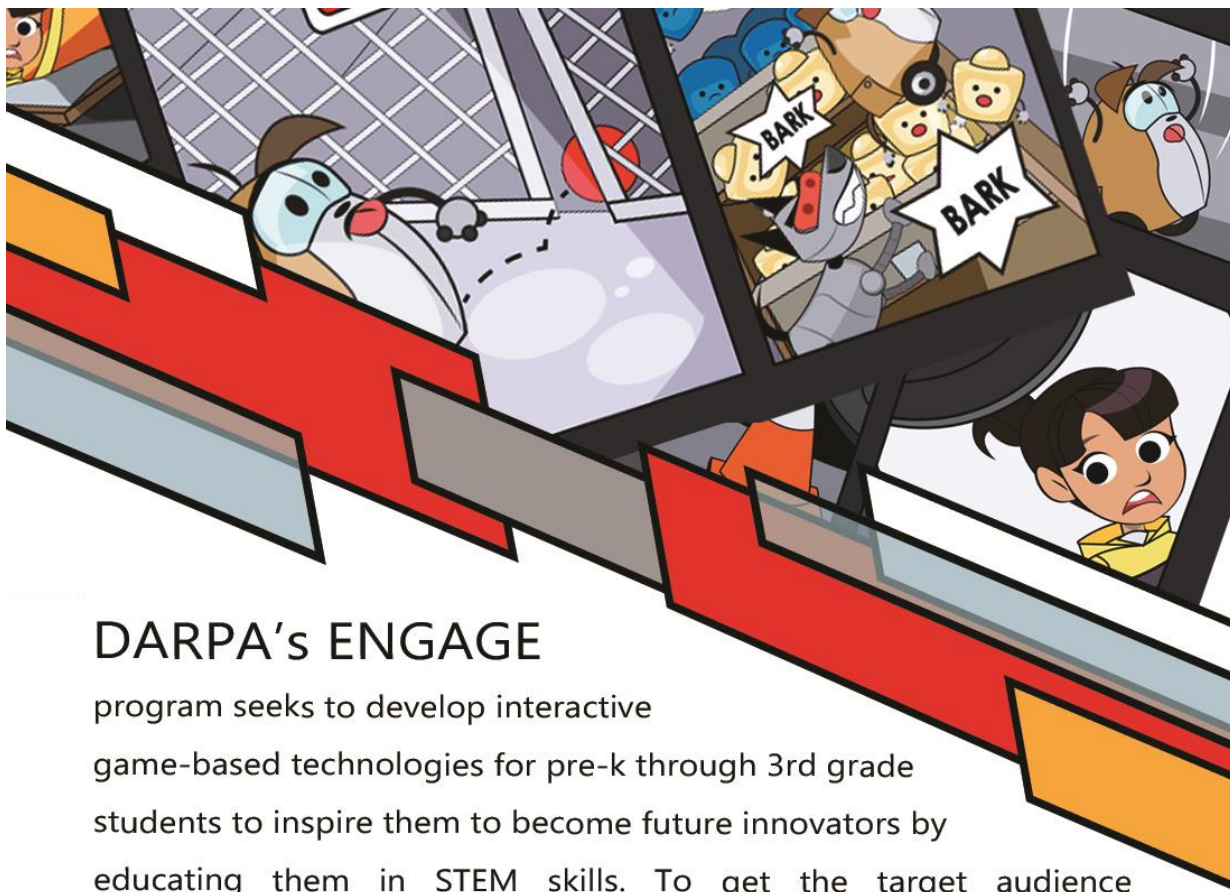
DARPA's ENGAGE

program seeks to develop interactive game-based technologies for pre-k through 3rd grade students to inspire them to become future innovators by educating them in STEM skills. To get the target audience to play, these games must meet the highest standards for quality and entertainment. The goal is to create games that improve over time by analyzing play across a large population of anonymous users. As a result, ENGAGE hopes to not only produce valuable game-based teaching tools, but to also provide insights into teaching techniques that can be applied to future products and classroom STEM learning. Our games can be found at: **etc.cmu.edu/engage**

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Summary

- ETC DARPA ENGAGE projects producing games to teach science concepts to children: http://www.etc.cmu.edu/engage
- Testing with children helps to preserve the fun
- Important elements include:
  - Interesting story narrative
  - Gentle, adaptive level progression (attention to problem flow)
  - Scaffolding that fits with narrative
  - Frequent interaction points, emphasis on touch-optimized for tablet usage
  - Remember the surprise, pleasure, juiciness (often via art and sound)
- Afternoon workshop with Sam Collier, Matt Champer, Ricardo Merchan will demo games and let you play!

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