Game-Based Learning Assessments

Jim Diamond (EDC)

Edys Quellmalz and Matt Silberglitt (WestEd)
equellm@wested.org
msilber@wested.org

Jodi Asbell-Clarke EdGE at TERC

Playing with Data: Developing digital supports for middle-school science teachers using game-based formative assessment

Award no. 1503255

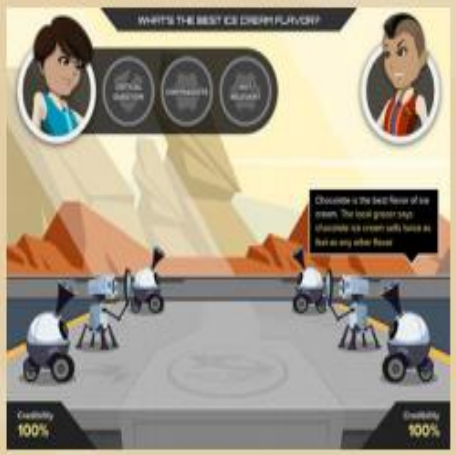
Jim Diamond (EDC) • Seth Corrigan (GlassLab)

- jdiamond@edc.org
- Playingwithdata.edc.org
- Glasslabgames.org

EDC Learning transforms lives.

GLASSLAB GAMES

- 3-year design-based research project—we've just completed Year 1
- Using a game called *Mars Generation One: Argubot Academy*
- The game helps build "the mechanics" of argumentation skills, using Steven Toulmin's basic model of argumentation and Douglas Walton's argumentation schemes
- Students build robots by matching claims to evidence within the correct argumentation scheme



Crash Course in Argubot Academy Argot

ARGUBOT: Special robots used by the kids in Argubot Academy. They're powered by a claim core and represent an argument in argubot duels.

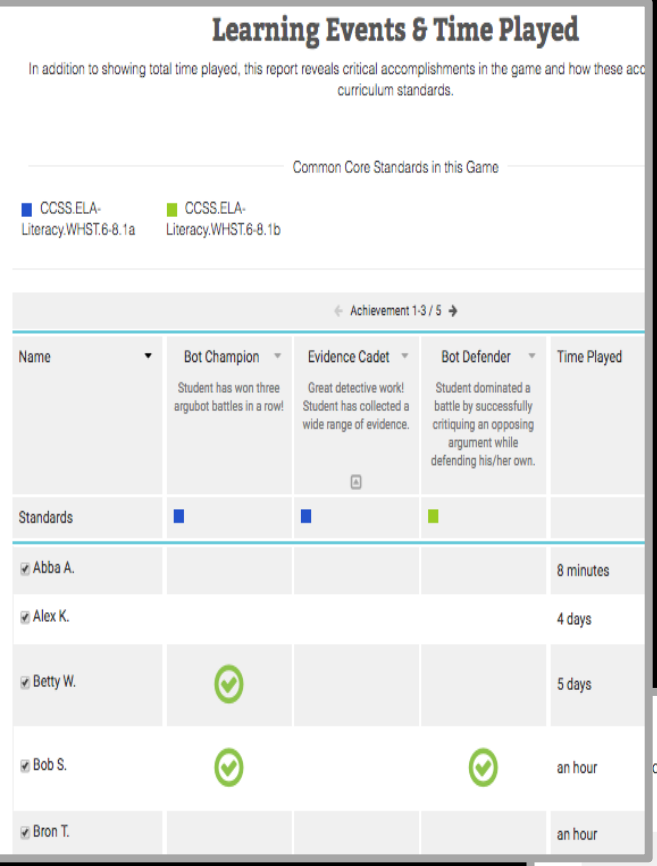
CLAIM CORE: The core powers the argubot. It's made of up of a claim -- a position taken in an argument. And evidence -- the thing that supports a claim. Without a claim core, an argubot won't power up!

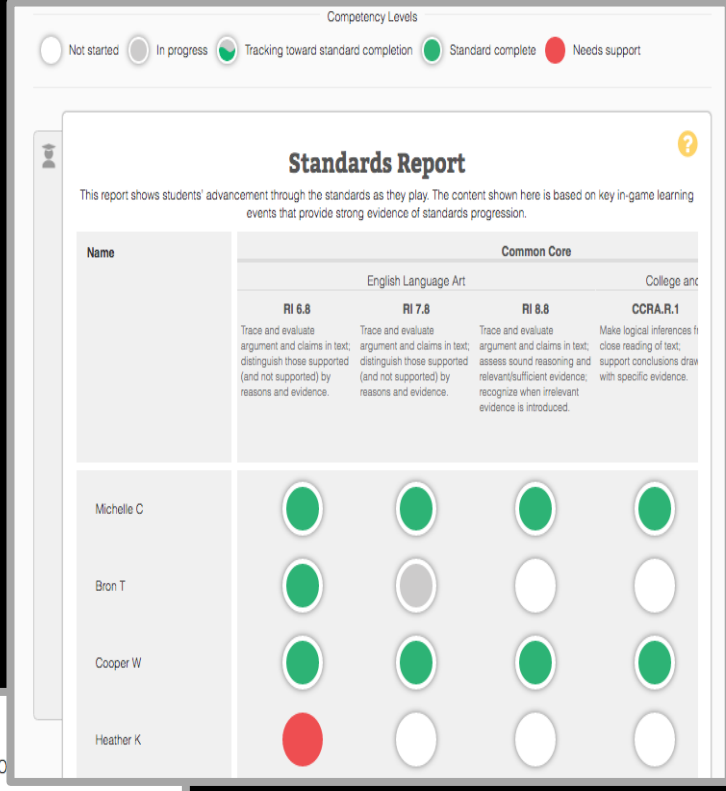
CRITICAL QUESTIONS: An advanced attack used against an argubot that has a related and supporting claim core. When the core is solid, students need to go to critical question attacks!

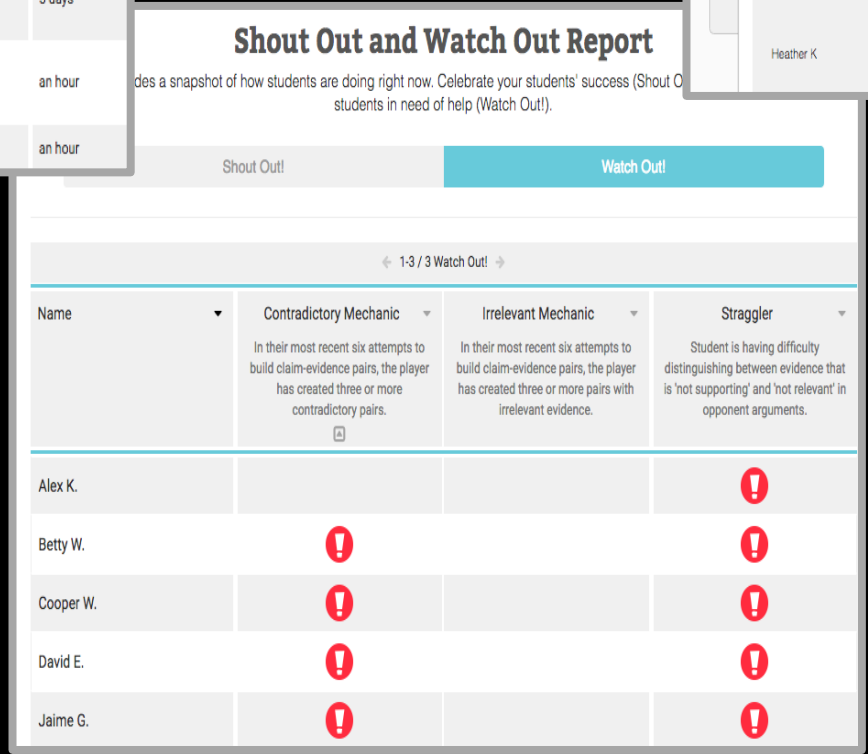
ARGU-MECH: A super-argubot, this argu-mech doesn't have just one claim core, but many! It's built to make complex arguments with multiple claims and multiple pieces of evidence.

EVO-1: Argubots start out life as Evo-1 bots. They're powered by a claim core but can't carry critical question attacks or shields. Level them up and they might evolve to Evo-2!

EVO-2: Is the next level in an argubot's life. Evo-2 argubots have claim cores that can be protected by critical question shields -- that's a shield made up of backing.







TEACHER REPOR

Research Questions

1. Is there promising evidence that teachers who have access to the revised dashboard interface and accompanying educative materials are able to improve formative assessment and differentiated instruction practices, as compared to peers who do not have access to the educative materials?
2. How do teachers make sense of and use the data, and what factors enable or limit their use of the data?

SimScientists Games

- *DRK12 PI Meeting*
- *June 2, 2016*

This material is based upon work supported by a grant awarded to WestEd from the National Science Foundation (DRL-1503481). Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

SimScientists Games

WestEd

Edys Quellmalz, PI

- Matt Silberglitt, co-PI

Daniel Brenner, co-PI

Andrew Grillo-Hill

Kim Luttgen

- Kevin Huang

- **IAI**
- Jody Underwood
- Lisa Holt

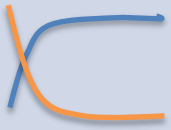
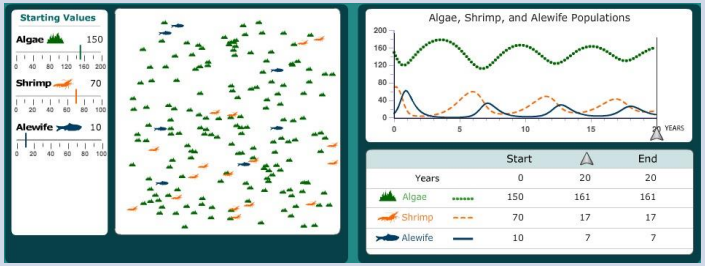
Advisors

- Rodger Bybee
- Douglas Clark
- Kenji Hakata
- Eric Klopfler
- Anna Rafferty
- Valerie Shute

Research Questions

- Utility of games as formative assessment resources
- Quality and coherence of the game activities
- Feasibility of classroom use of SimScientists games
- Effect of game use on student outcomes
-

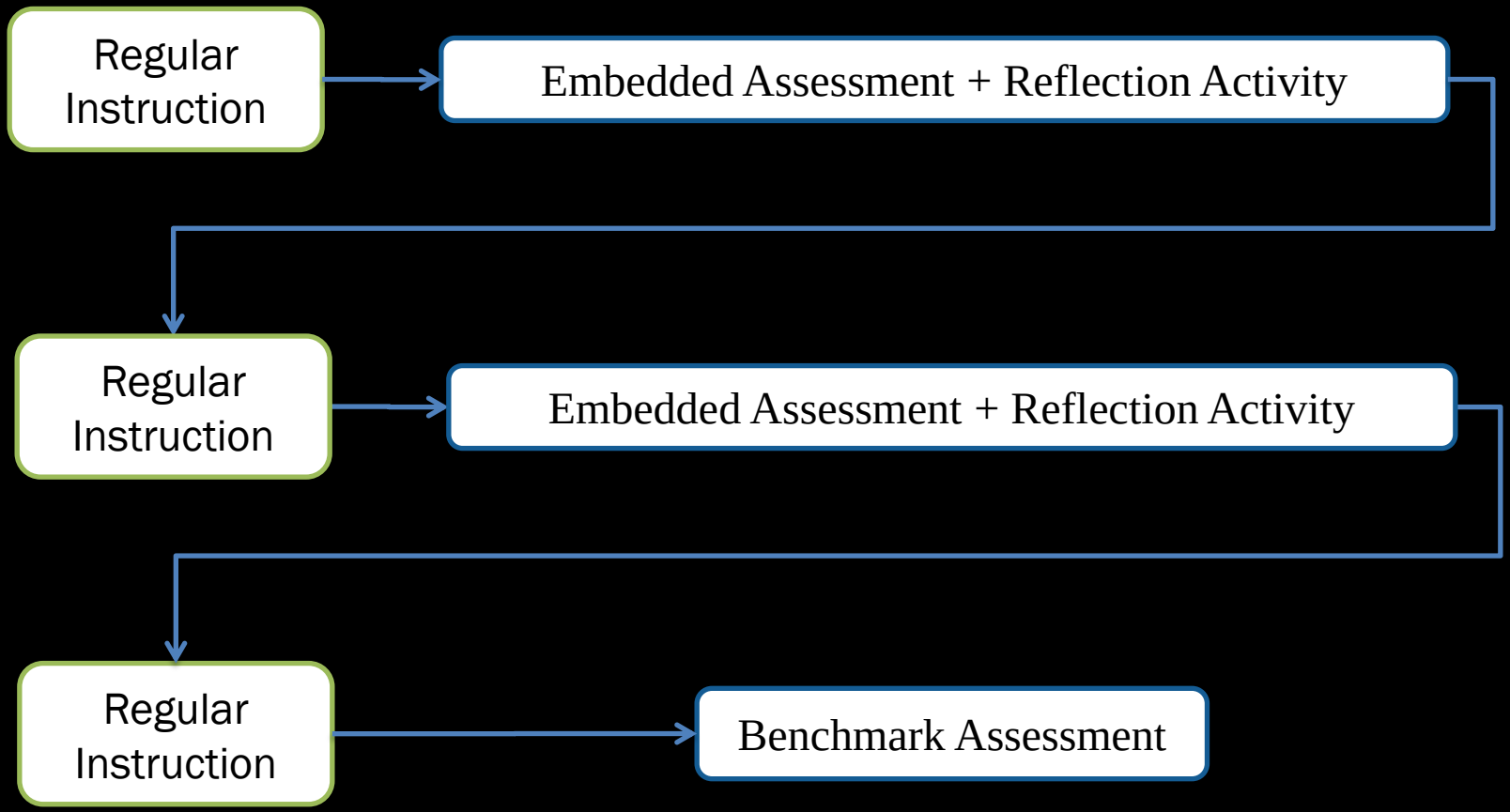
Target Models of Complex Systems

Model Level	Ecosystems Unit
Component 	Organisms & their roles 
Interaction 	Flow of matter & energy 
Emergent 	Populations & changes 

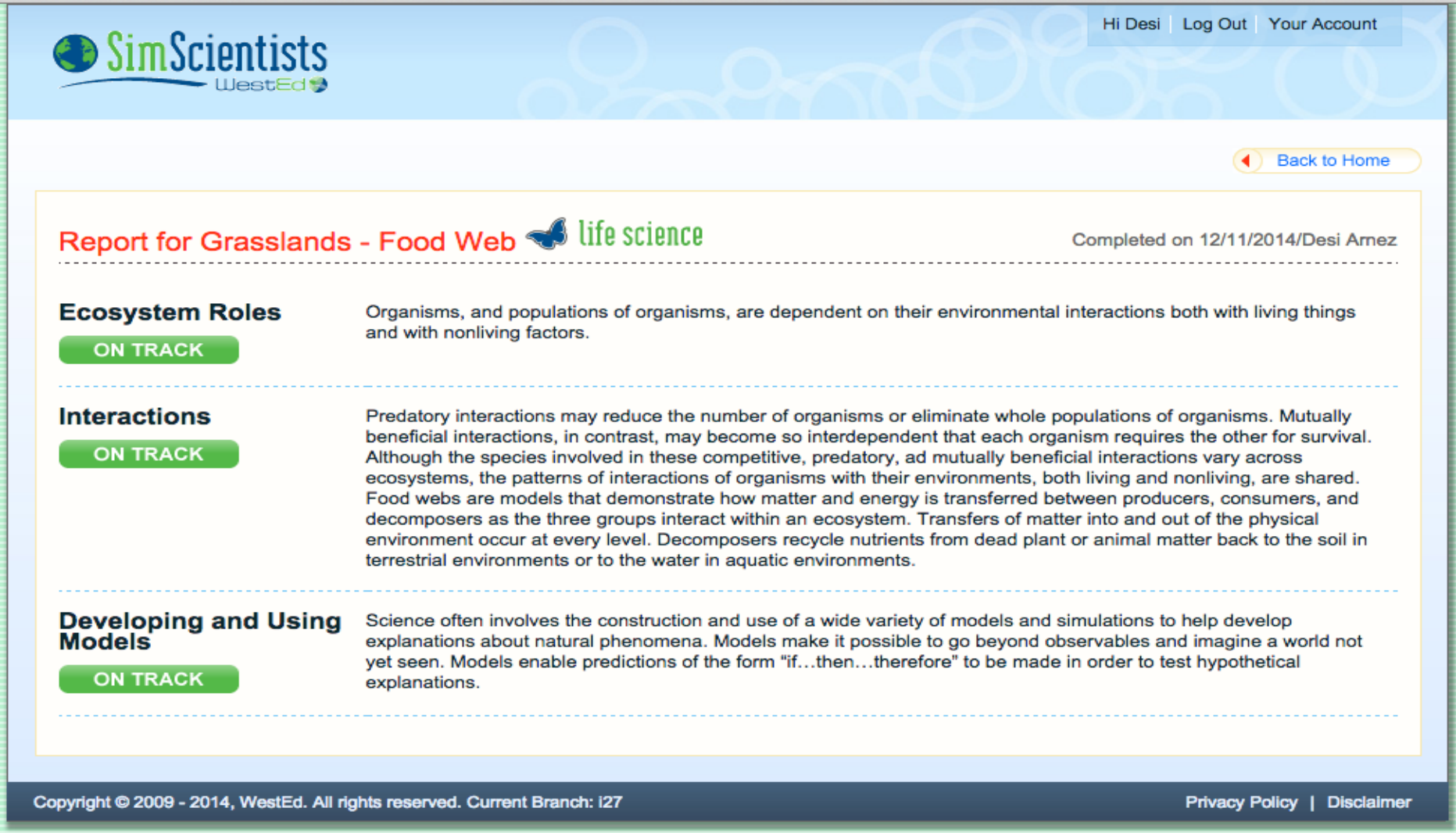
SimScientists Assessment Task Design Principles

- Simulations model complex science systems
- Authentic, problem-based inquiry
- Feedback and scaffolding in embedded assessments
- Formative use of Progress Reports
- Follow up Reflection Activities that foster
  - Collaborative science practices
  - Discourse for sense-making and scientific argument

SimScientists Assessments Embedded & Benchmark



Sample Progress Reports to Students
Ecosystems



SimScientists Embedded Assessments
Formative Assessment Features

- Graduated coaching within embedded assessments
  - On core ideas/misconceptions
  - On practices applying core ideas and cross-cutting concepts
- Progress Report by concepts within system model levels and practices targets
  - *On Track, Progressing, Needs Help*
  - For individual student
  - For teacher
    - Class summary with drill-down into student detail
    - Used to suggest teams and groups for jig-saw structured reflection activities that adjust instruction and support collaboration and discourse

SimScientists Games Design Principles

–Evidence centered design

–Model based learning

–Cognitive learning research

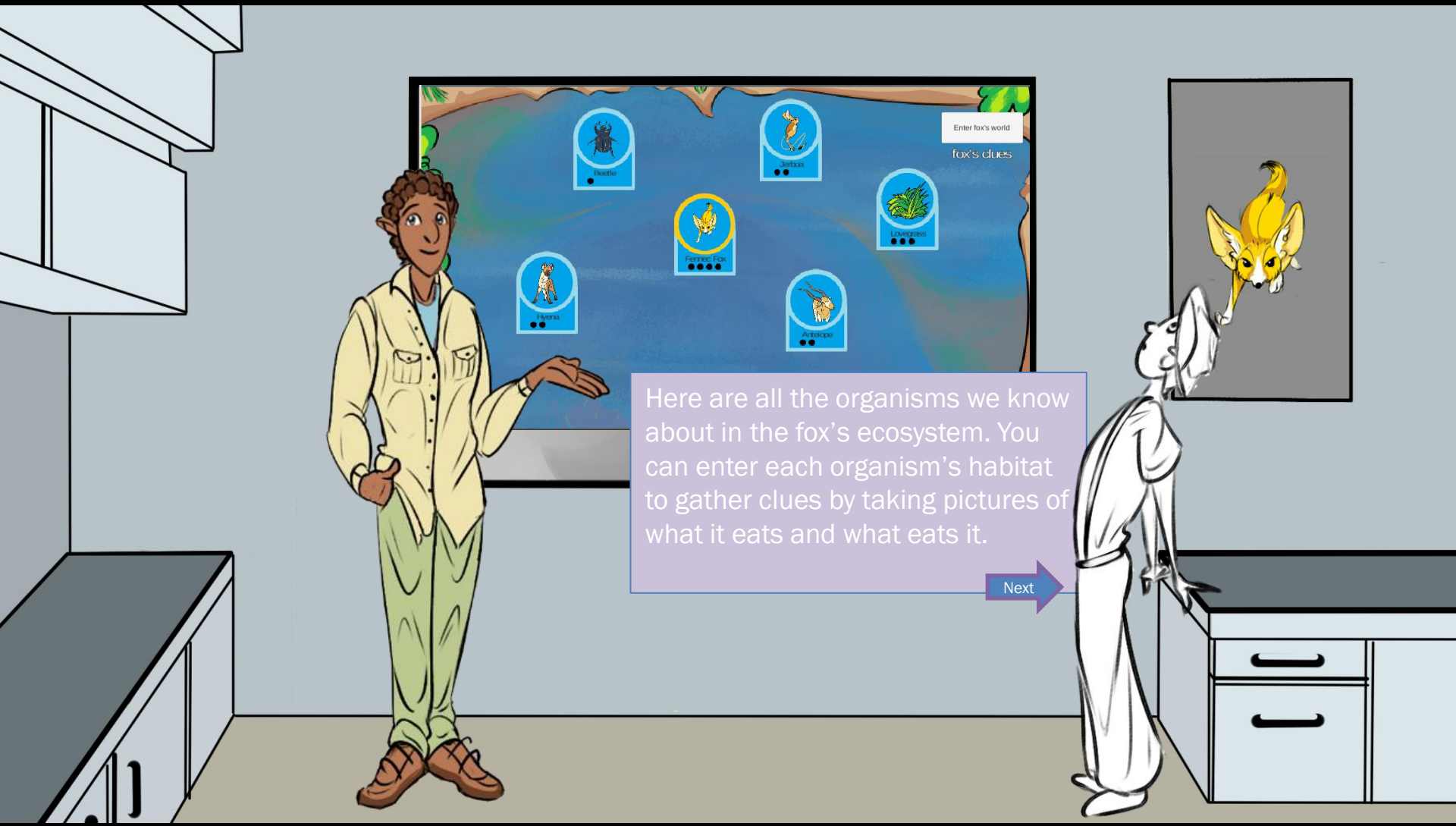
- Meaningful, real world problem
- Active problem solving/investigation
- Formative assessment with feedback, scaffolding
- Scientific discourse

–Motivation and engagement research

- Challenge
- Achievement
- Rewards

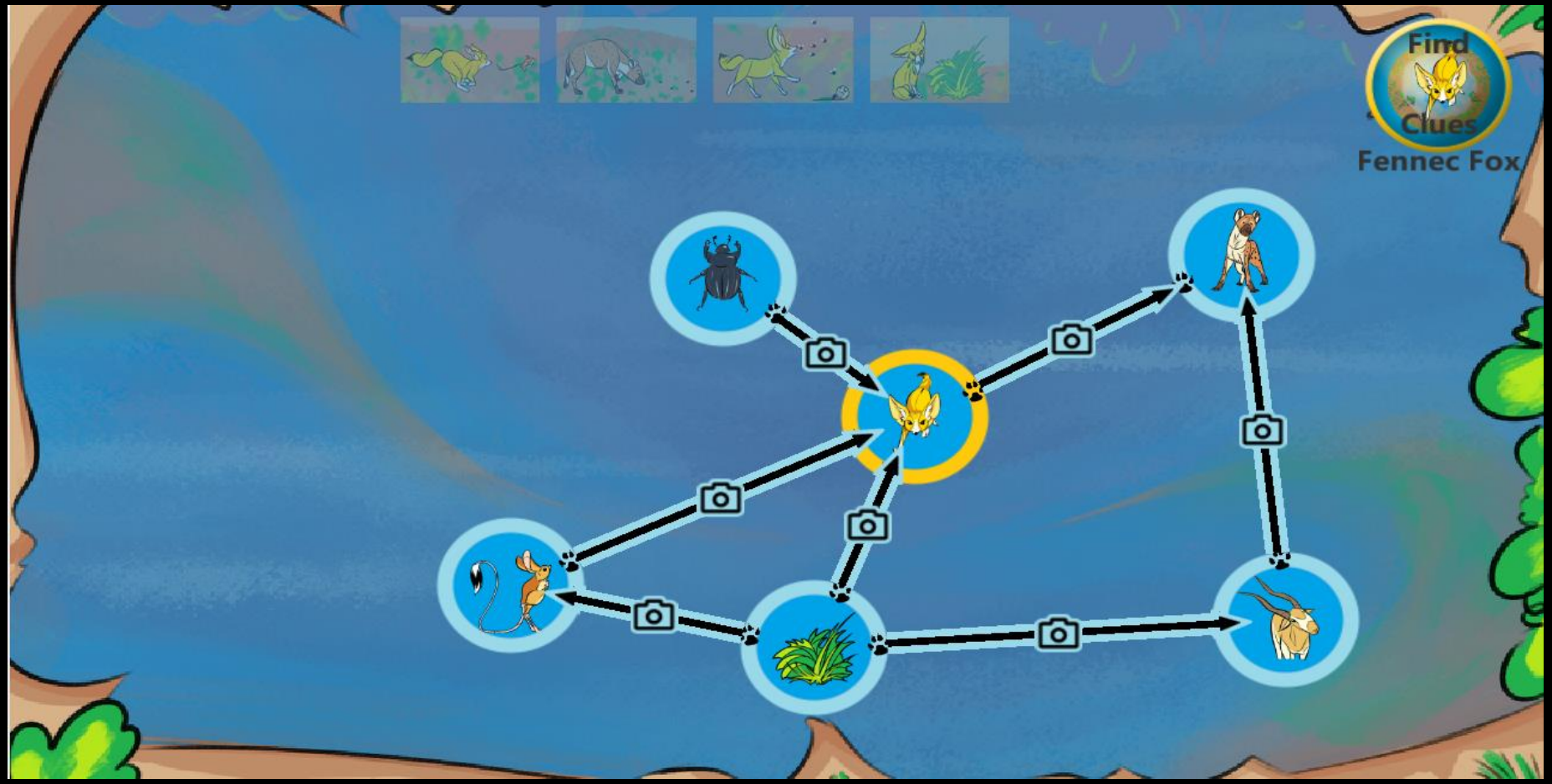
SimScientists Games Design Constraints

- 2 games, each addressing assessment targets in Progress Reports following Ecosystem embedded assessments
- Also addressing collaboration skills
- Assessment targets for a limited number of core ideas and practices
- 45 minute period to play each game in school

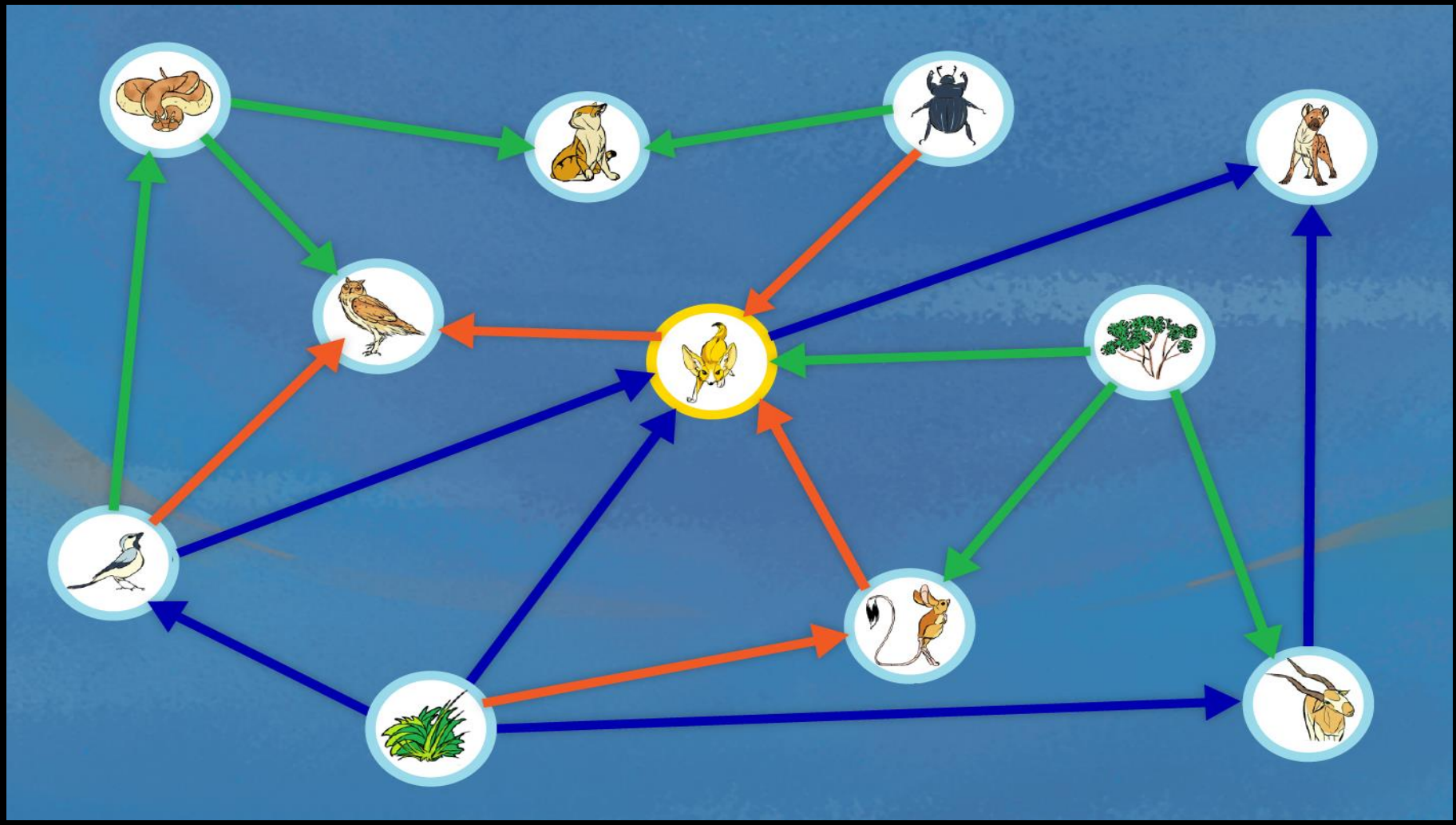

Enter fox's world
fox's clues
Beetle
Jerboa
Lovegrass
Fennec Fox
Hyena
Antelope
Here are all the organisms we know about in the fox's ecosystem. You can enter each organism's habitat to gather clues by taking pictures of what it eats and what eats it.
Next

Pictures as Evidence

Build Food Web Model of Flow of Energy and Matter
(Tier 1)



Tier 3 Food Web



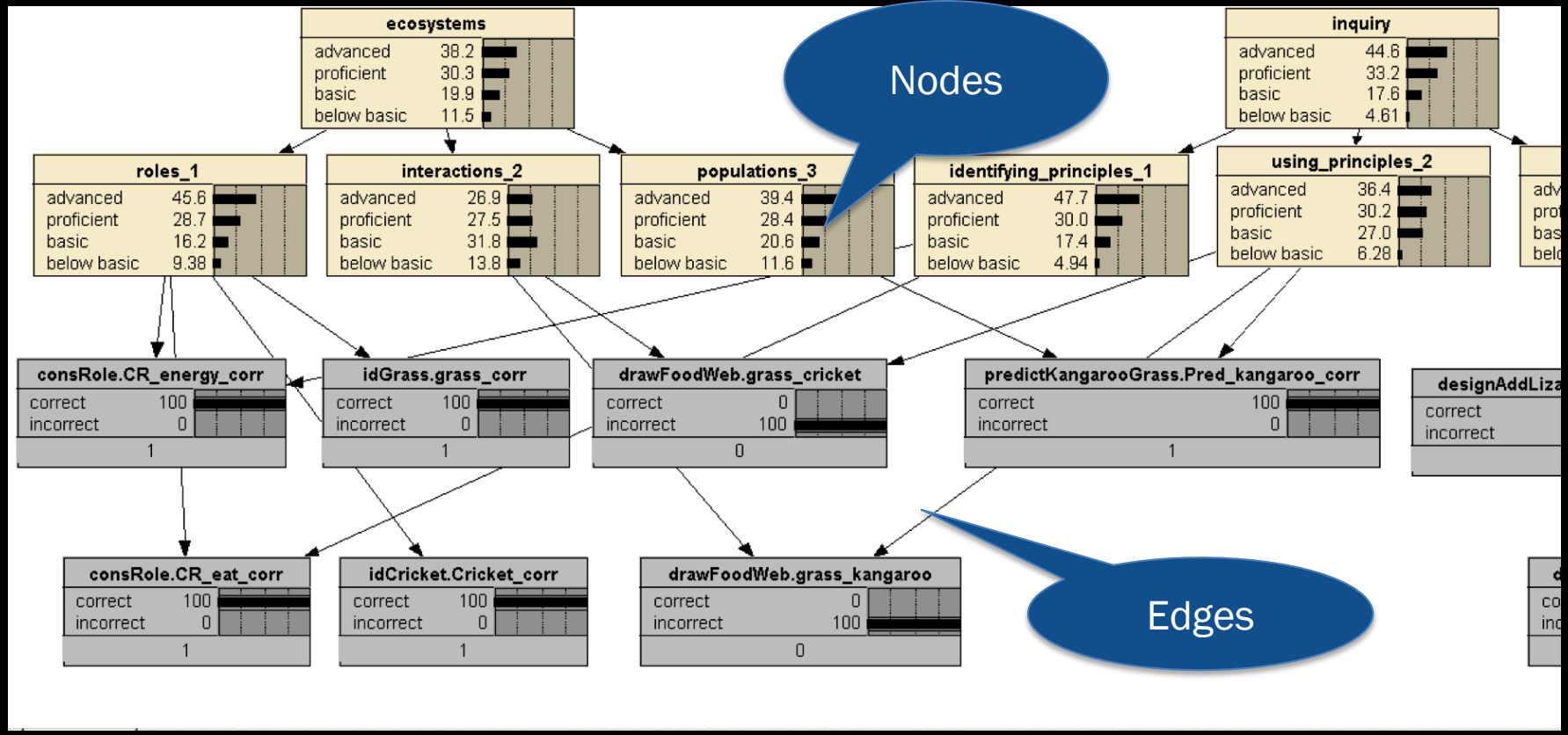
Collaboration in Game

SimScientists Games

- Evidence Model

- Student responses to explicit questions/activities in the game
- Observable variables in BN
- Scoring aggregated to rewards, badges

Fragment of a Bayes Net From the Calipers II Ecosystems Benchmark Assessment



Note: the conditional probabilities associated with the edges are not visible in this view

SimScientists Game Architecture

- Game Activities Producing Evidence about Progress on Assessment Targets
  - Responding to activity tasks and questions
    - In Game 1, by
      - collecting pictures, videos of organisms and their roles (eating/being eaten by other organisms), entering images in notebook, classifying the roles,
      - placing into the energy flow model, aka foodweb
    - In Game 2, by
      - Designing, running, interpreting graphs of simulations of population dynamics by changing numbers of organisms in the population
      - Making predictions, explaining population changes, critiquing, developing arguments of others' designs, explanations, recommendations
  -

SimScientists Selected Publications

- Davenport, J. L., & Quellmalz, E. S. (2014). Assessing science inquiry and reasoning using dynamic visualizations and interactive simulations. Forthcoming chapter in *Learning from Dynamic Visualizations: Innovations in Research and Practice.*
- Quellmalz, E. S., Davenport, J. L., Timms, M.J., DeBoer, G.E., Jordan, K.A., Haung, C., & Buckley, B.C. (2013). Next-generation environments for assessing and promoting complex science learning. *J Ed Psych*, 51, 523-554.

Buckley, B. C., & Quellmalz, E. S. (2013). Supporting and assessing complex biology learning with computer-based simulations and representations. In D. Treagust & C.-Y. Tsui (Eds.), *Multiple Representations in Biological Education* (pp. 247-267). Dordrecht: Springer.

Quellmalz, E. S., Timms, M. J., Silberglitt, M. D. & Buckley, B. C. (2012). Science assessments for all: Integrating science simulations into balanced state science assessment systems. Invited article, *Journal of Research in Science Teaching (JRST), 49*, 363–393.

Quellmalz, E. S., Timms, M. J., Buckley, B. C., Davenport J., Loveland, M., & Silberglitt, M. D. (2012). 21st century dynamic assessment. In M. Mayrath, J. Clarke-Midura, & D. H. Robinson (Eds.), *Technology-based assessments for 21st century skills: Theoretical and practical implications from modern research* (pp. 55–90). Charlotte, NC: Information Age.

Quellmalz, E. S., Silberglitt, M. D., & Timms, M. J. (2011). How can simulations be components of balanced state science assessment systems? *Policy brief*. San Francisco: WestEd.

Quellmalz, E. S., Timms, M. J., & Buckley, B. C. (2010). The promise of simulation-based science assessment: The Calipers project. *International Journal of Learning Technologies, 5*(3), 243–265.

- Quellmalz, E. S. & Pellegrino, J. W. (2009). Technology and testing. *Science,* 323, 75–79.

Quellmalz, E. S., DeBarger, A. H., Haertel, G., Schank, P., Buckley, B., Gobert, J., Horwitz, P., & Ayala, C. (2008). Exploring the role of technology-based simulations in science assessment: The Calipers Project. In J. Coffey, R. Douglas, & C. Stearns (Eds.), *Science assessment: Research and practical approaches* (pp. 191–202). WDC: National Science Teachers Association.

Contact Information

Website:

www.simscientists.org

Email:

equellm@wested.org

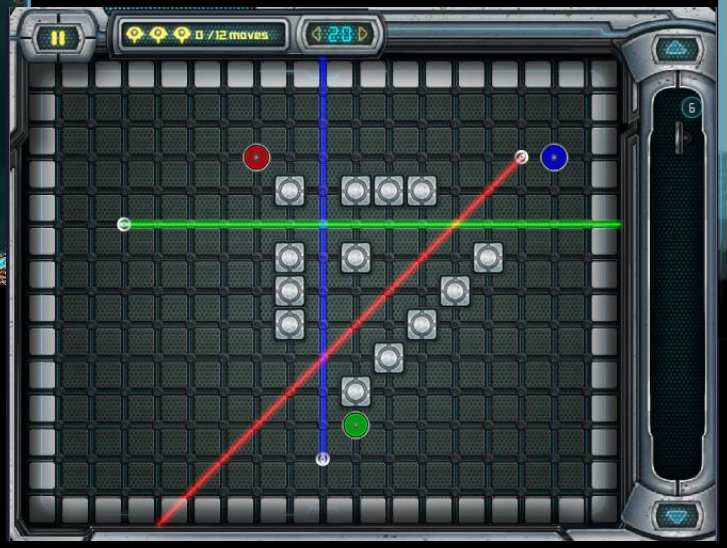
msilber@wested.org

Zoombinis

What Lies Below...Implicit STEM Learning in Games

EDGE at TERC

Leveling Up



1. Pre/post Assessments with Control/Games/Bridge classes.

2. EDM studies to measure how learners play the games.

3. HLM studies to see if how they play makes a difference in STEM learning.

EdGE at TERC

Leveling Up

Imp Studies	EDM Studies	HLM Studies
Bridge classes show sig gains in pre/post tests	EDM detectors reveal behaviors consistent with implicit understanding	"It's how they play the game"
Same gains for Bridge, Games, and Control groups	Data mining models distinguish STEM errors (e.g. law of reflection and slope) from puzzle errors	We can see when they are struggling
In progress	n/a	Do kids go outside?

EdGE at TERC

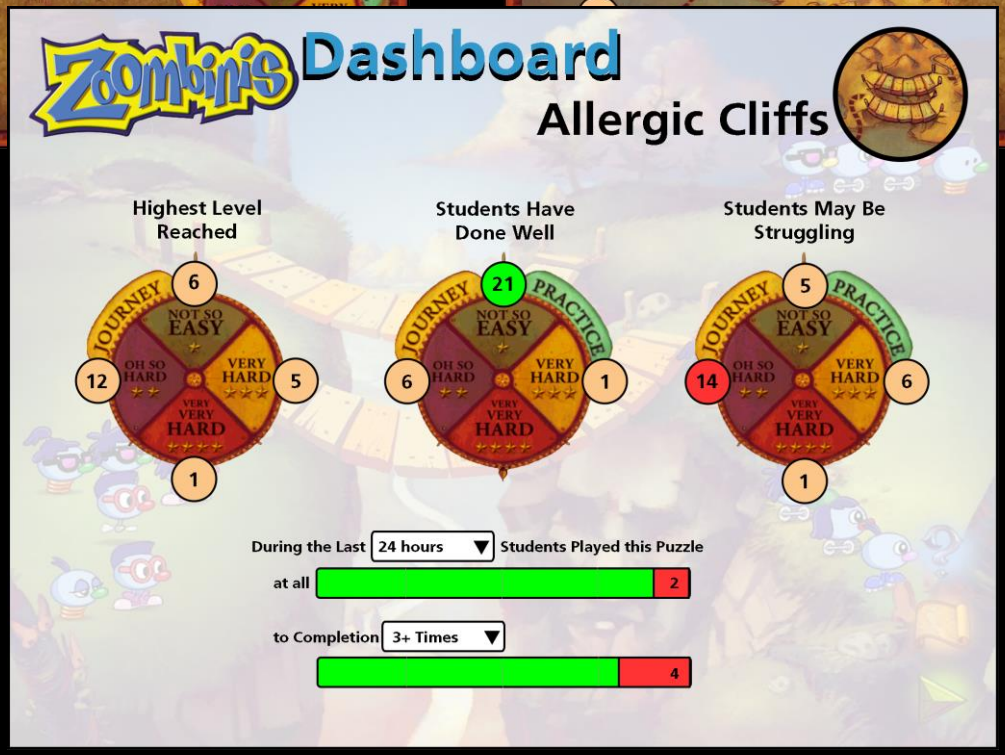
Computational Thinking Learning Progression

Trial and Error	Testing a Solution	Implementing a Solution	Identifying a Strategy	Generalizing a Solution
Problem Decomposition		Abstraction		Generalization

edge at TERC


Zoombinis Dashboard
Where in the game are my students now?
WHO'S BAYOU
MOUNTAINS OF DESPAIR
DEEP DARK FOREST
THE BIG, THE BAD, & THE UGLY
Students Not Active in Game
JOURNEY
PRACTICE
NOT SO EASY
OH SO HARD
VERY HARD
VERY VERY HARD


Zoombinis Dashboard
Where in the game are my students now?
Alert
Sofia
created a group of Zoombinis where all have the same trait for at least one attribute.
Close
Show Me
MOUNTAINS OF DESPAIR
THE BIG, THE BAD, & THE UGLY
JOURNEY
PRACTICE
NOT SO EASY
OH SO HARD
VERY HARD
VERY VERY HARD


Zoombinis Dashboard
Allergic Cliffs
Highest Level Reached
Students Have Done Well
Students May Be Struggling
JOURNEY
PRACTICE
NOT SO EASY
OH SO HARD
VERY HARD
VERY VERY HARD
6
12
5
1
21
6
1
5
14
6
1
During the Last 24 hours Students Played this Puzzle
at all
2
to Completion 3+ Times
4

edge at TERC

EdGE at TERC

DataArcade

EdGE at Terc

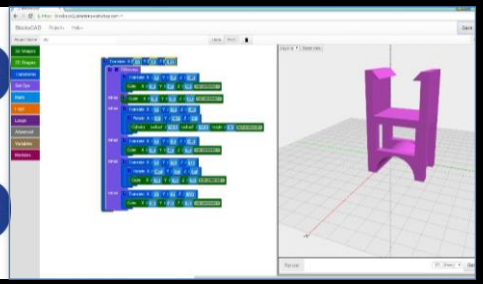
in partnership with

Landmark College & MIT

rti.

BlocksCAD

BlocksCAD



It Takes a Team

Erin Bardar; Teon Edwards; Jamie Larsen; Barbara MacEachern; Katie Stokinger; Elizabeth Rowe

new knowledge.org

Questions

What types of topics/skills are ripe for GBLA?

When is GBLA NOT a good idea?

What types of information are most useful for teachers?

What does GBLA offer that is unique?