Design Principles for Deep Thinking About Science With Simulations

Nancy Butler Songer
The University of Michigan
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Conclusions

1. Integration is key; Neither supplemental technologies nor technology vs. no technology studies will lead do the transformation we desire
2. Design principles for good science learning with simulations and games begin with the same design principles for good science learning more generally
3. The few design principles that are unique to learning with simulations and games are really important

Why Integration is Key

- We need empirical research results that demonstrate strong learning outcomes

Many design principles for good science learning with and through technology are the same design principles for good science learning more generally

1. focus on fewer big ideas

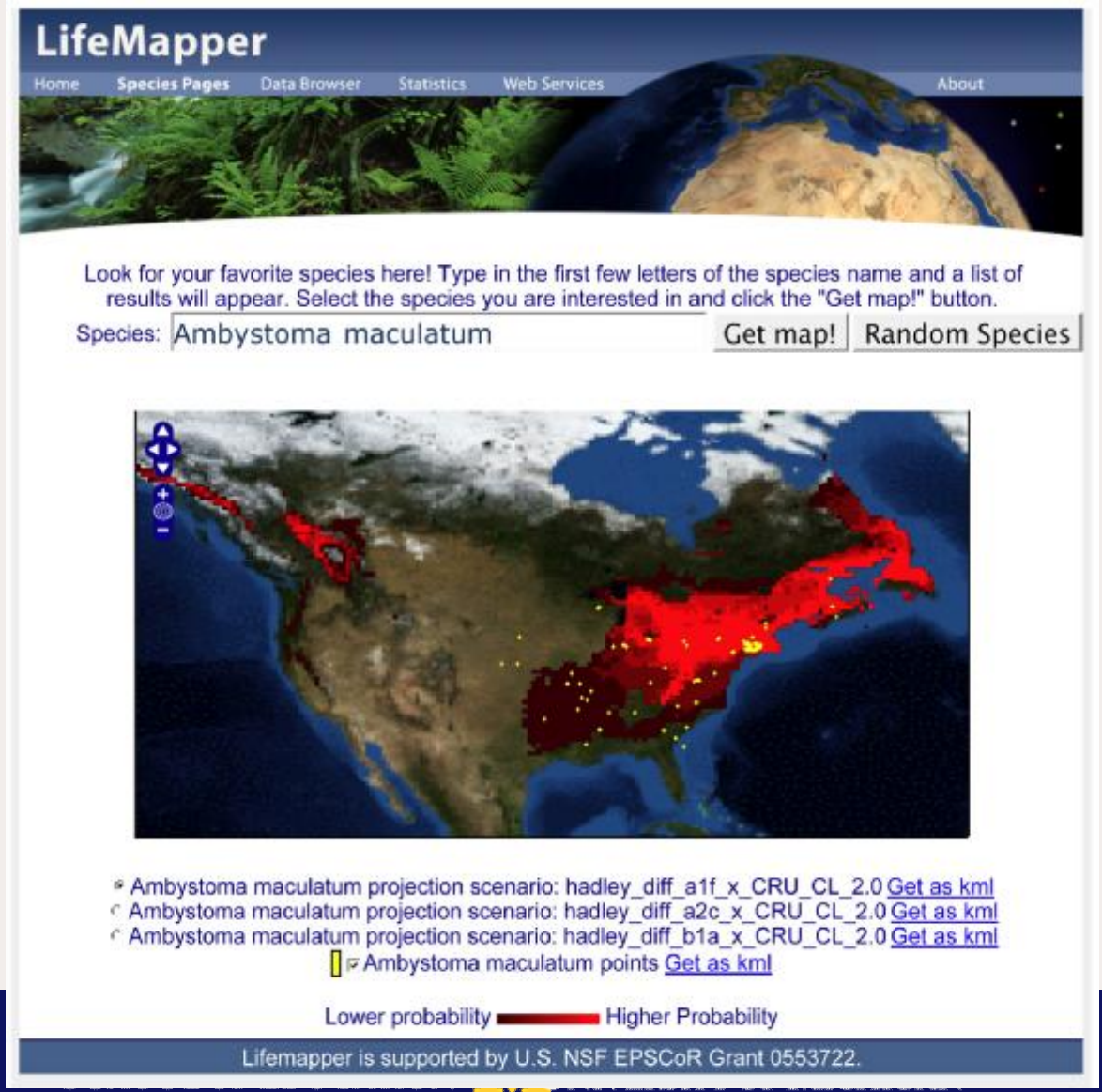
"Japanese eighth-grade textbooks cover eight topics, compared to an average of more than 65 for U.S. eighth-grade textbooks." (Linn, Lewis, Tsuchida, Songer, 2000)

2. systematic guidance in developing more complex ideas

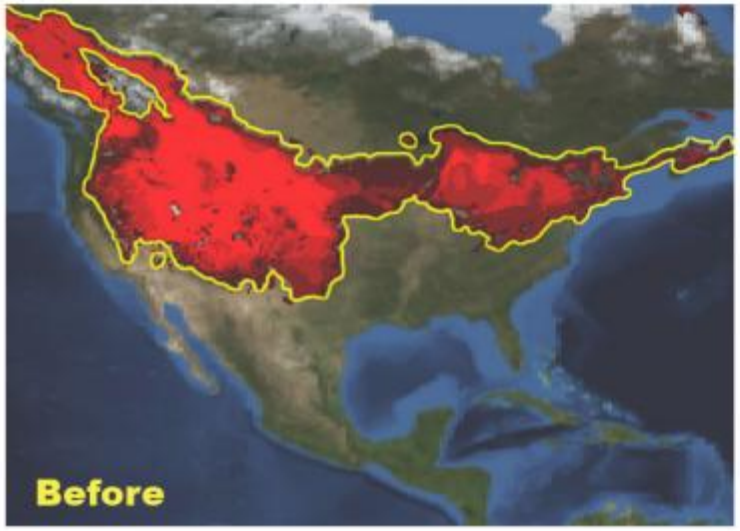
Content and inquiry reasoning scaffolds to guide scientific explanations about key science topics

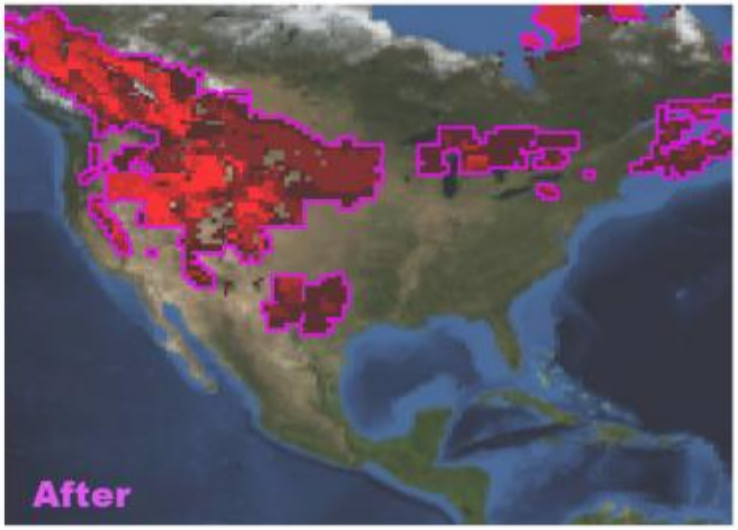
3. the ability to revisit and deepen understandings in a systematic manner

www.lifemapper .org



Changemapper





Species: Milkvetch (Astragalus cibarius)

Why did you pick it?

Build Model

Climate Inputs

Mean Temperature
Original Value: 84
New Value: 91 (increase)

Average Rainfall
Original Value: 7.3
New Value: 6.9 (decrease)

Update Model

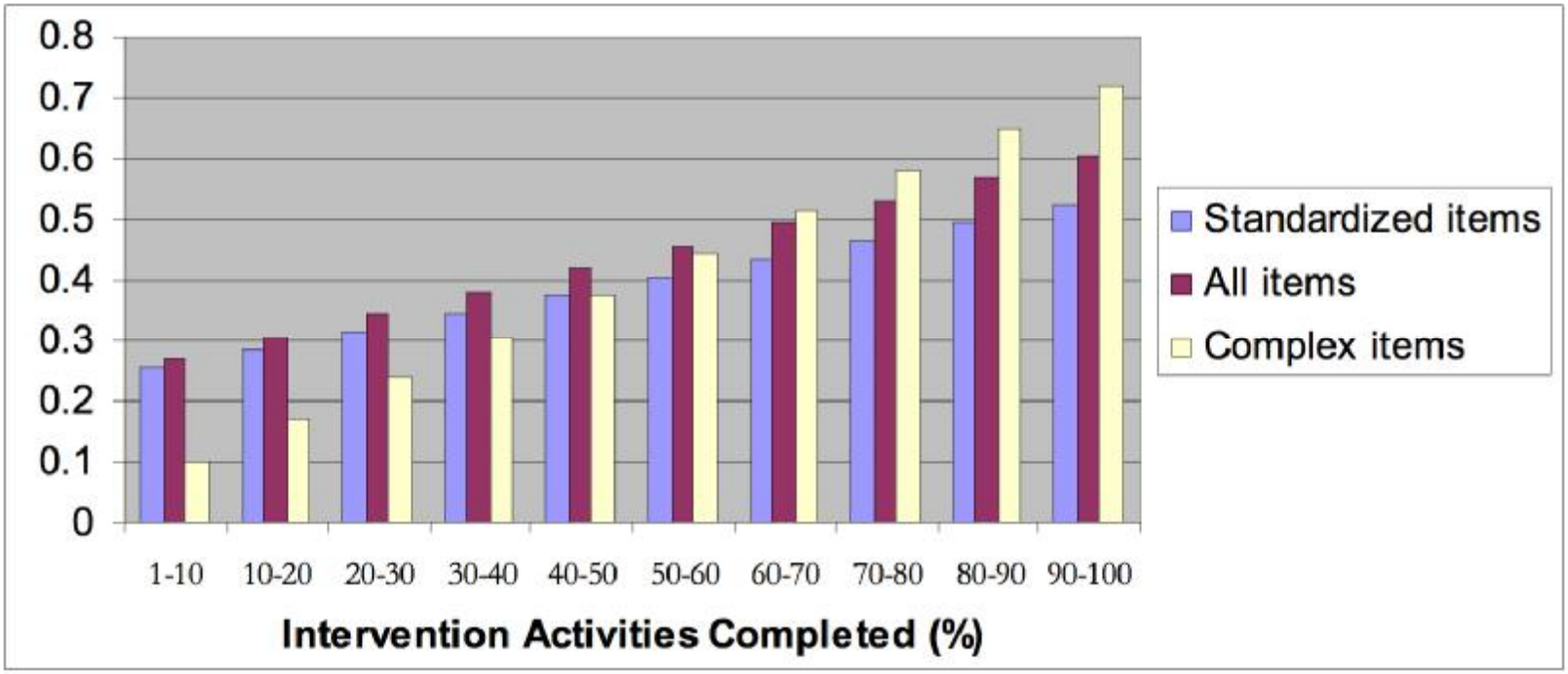
Analyze Model

What kind of change(s) did you make?

What effect did it have?

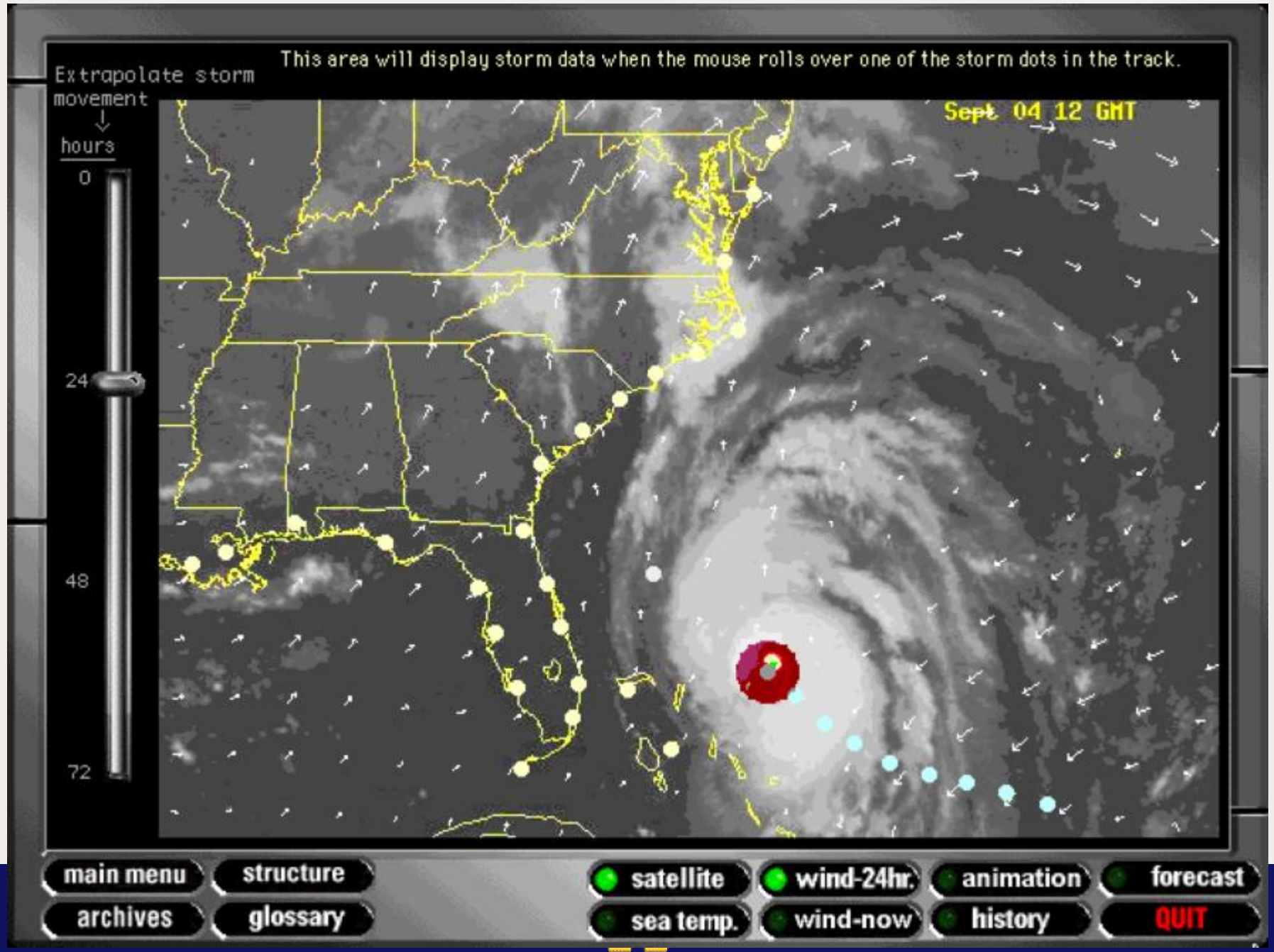
Is that reasonable?

Results: Achievement by Completion as Measured by Three Tests (N= 1885)



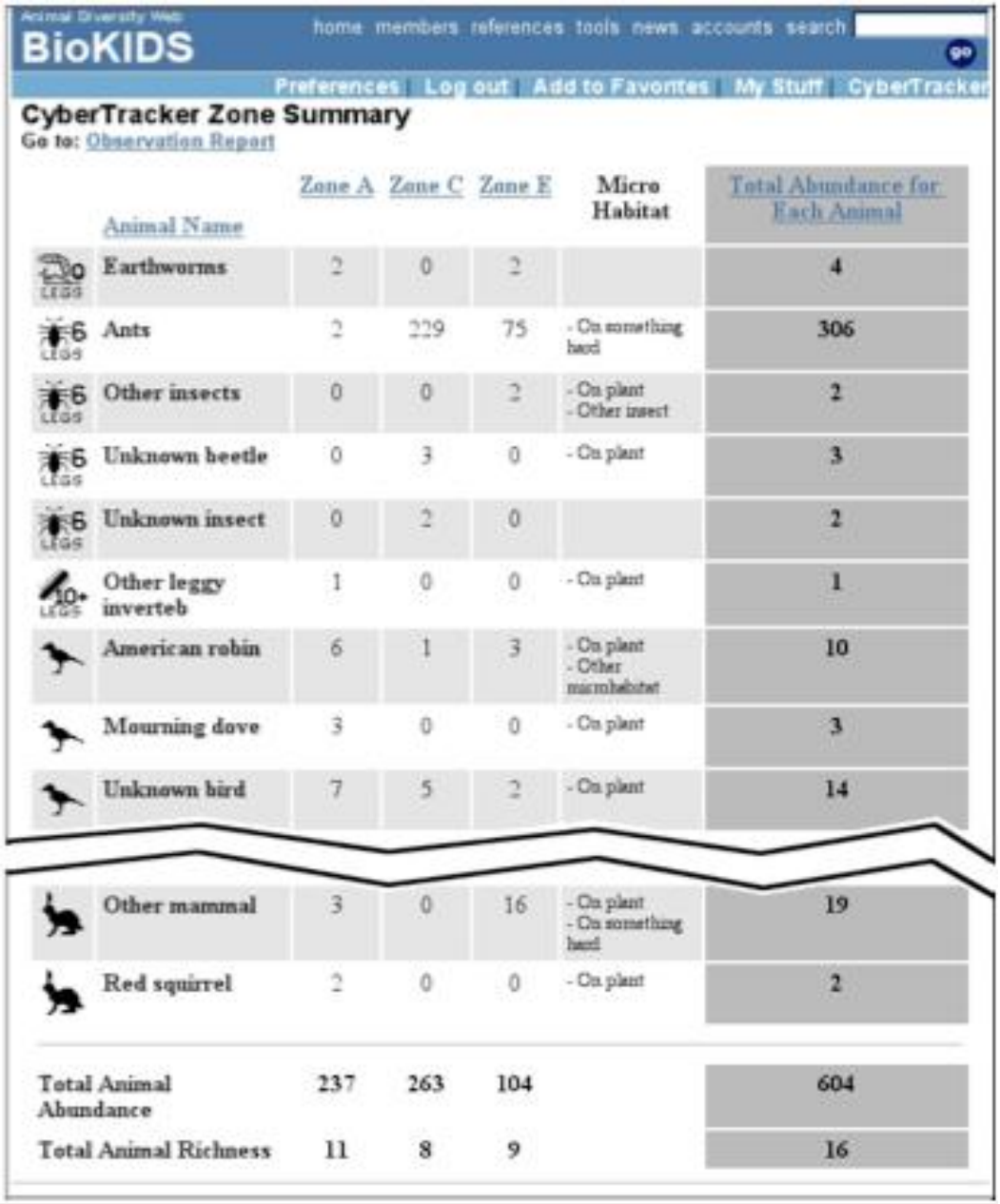
The few features for learning that are unique to learning with technology are transformative

- Unique data gathering, modeling, sharing
- New learning arising from the social construction of knowledge leading to new scales for learning communities
- Role playing (e.g., kids as authorities on their dataset)


This area will display storm data when the mouse rolls over one of the storm dots in the track.
Extrapolate storm movement
hours
0
24
48
72
Sept 04 12 GMT
main menu
structure
archives
glossary
satellite
wind-24hr.
animation
forecast
sea temp.
wind-now
history
QUIT

Construction of scientific explanations

Which zone in the schoolyard has the greatest biodiversity?



Animal Diversity Web
BioKIDS
home members references tools news accounts search
Preferences | Log out | Add to Favorites | My Stuff | CyberTracker

CyberTracker Zone Summary

Go to: Observation Report

Animal Name	Zone A	Zone C	Zone E	Micro Habitat	Total Abundance for Each Animal
Earthworms	2	0	2		4
Ants	2	229	75	- On something hard	306
Other insects	0	0	2	- On plant - Other insect	2
Unknown beetle	0	3	0	- On plant	3
Unknown insect	0	2	0		2
Other leggy inverteb	1	0	0	- On plant	1
American robin	6	1	3	- On plant - Other microhabitat	10
Mourning dove	3	0	0	- On plant	3
Unknown bird	7	5	2	- On plant	14
Other mammal	3	0	16	- On plant - On something hard	19
Red squirrel	2	0	0	- On plant	2
Total Animal Abundance	237	263	104		604
Total Animal Richness	11	8	9		16

Resource wealthy, educationally unfocused

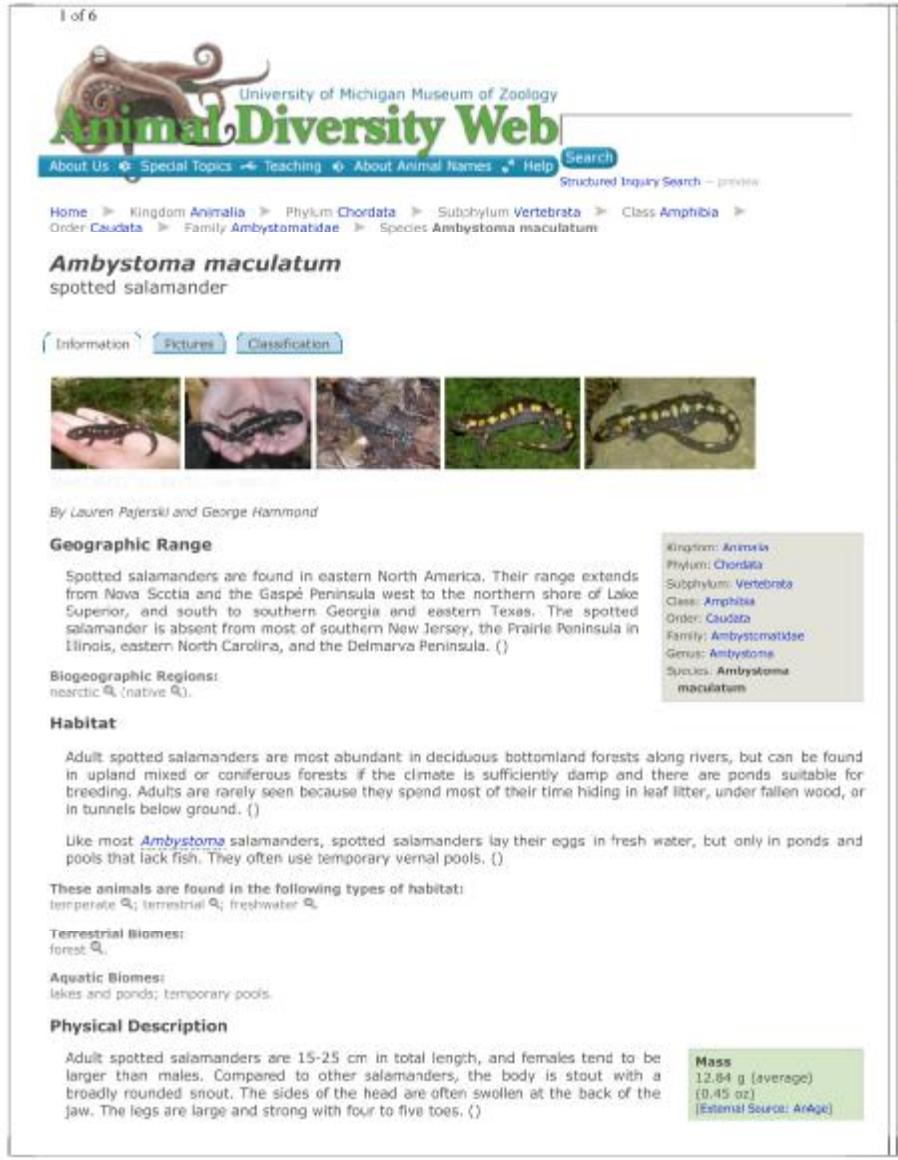
- ***Portia fimbriata***
- **jumping spider**
- ----------
- Written by Andrea Jackson, University of Michigan student
- **Classification**
  - * **Kingdom:** Animalia
  - * **Phylum:** Arthropoda
  - * **Class:** Arachnida
  - * **Order:** Aranae
  - * **Family:** Salctidae
  - * **Genus** Portia
  - * **Species:** Portia fimbriata
- **Table of Contents**

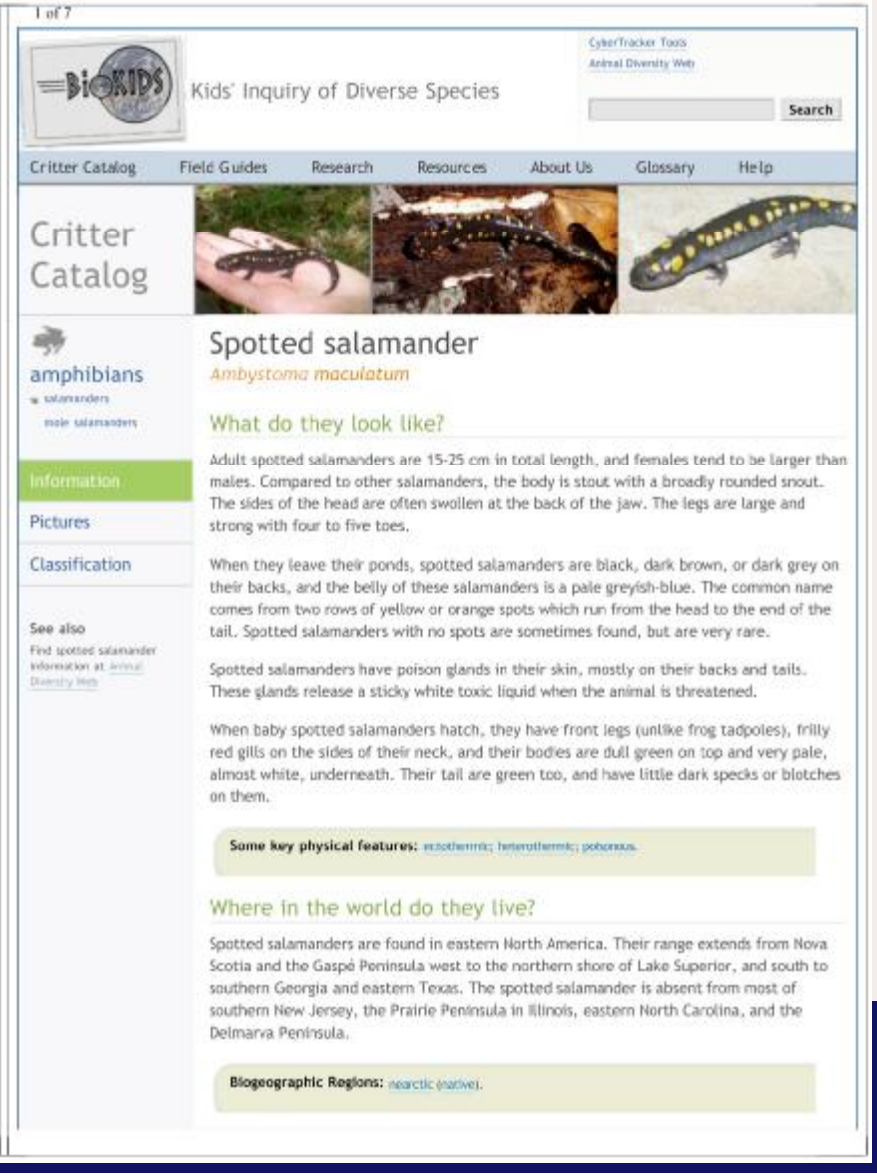
  - * Geographic Range
  - * Physical Characteristics
  - * Natural History
  - * Food Habits
  - * Reproduction
  - * Behavior
  - * Habitat
  - * Economic Importance

Physical Characteristics

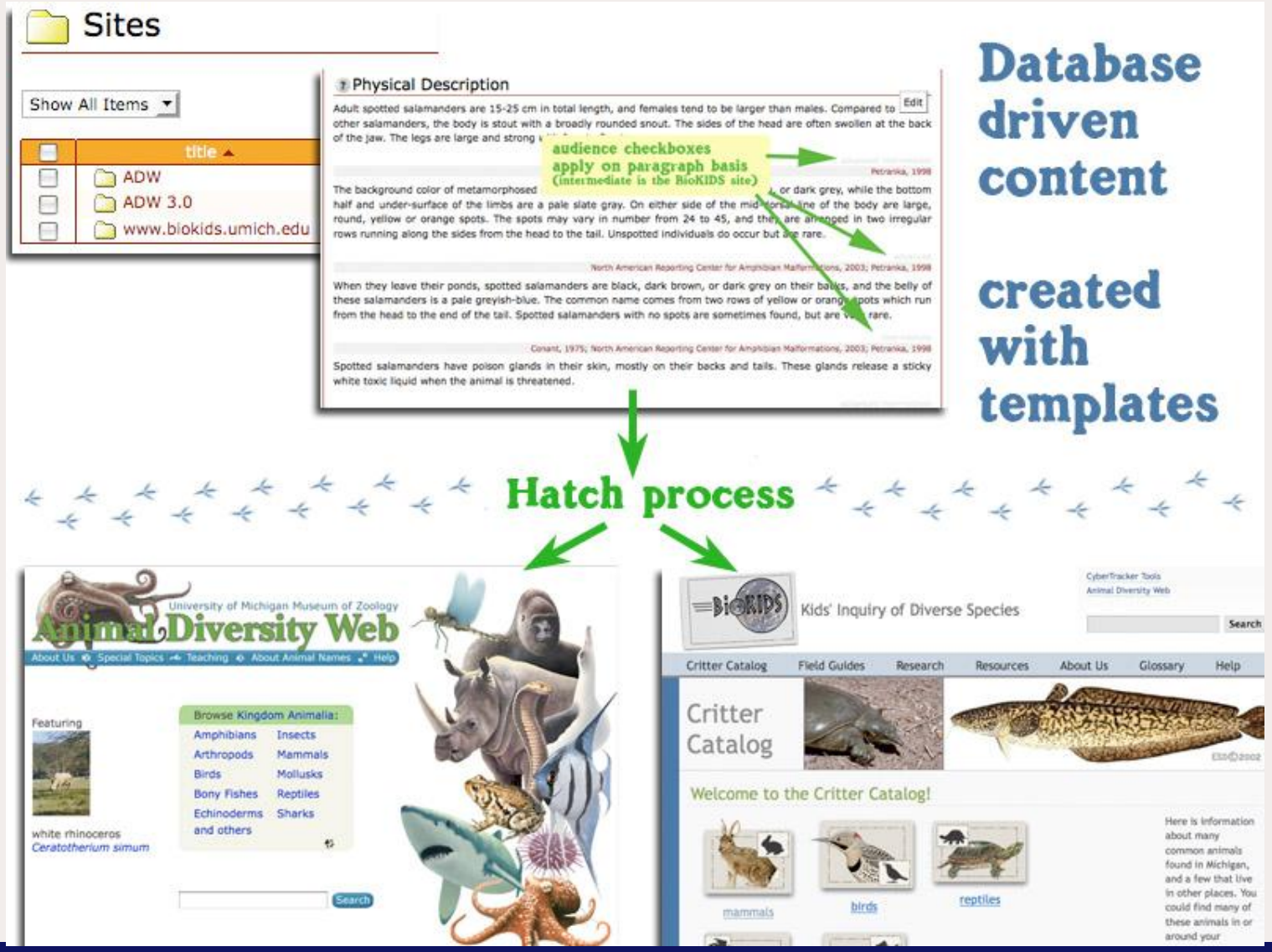
- The appearance of *P. fimbriata* is unlike that of other spiders. They are about 1 cm long, and have cryptic markings, tufts of hair and long spindly legs. Because of their unusual appearance, *P. fimbriata* are often mistaken for detritus by both prey and potential predators. (Jackson 1992)
- ^ **Food Habits**
- *P. fimbriata* are primarily **araneophagic**, meaning they eat other spiders, including other salticids. *P. fimbriata* also eat insects and the eggs of other spiders.
- *P. fimbriata* are predatory, and they use several methods of predation. One is **aggressive vibratory mimicry**, in which *P. fimbriata* climb on to the web of their victim and use their legs and palps to pluck signals on the web. They imitate the signals of their intended victim's prey. When the victim comes close to *P. fimbriata*, they make their attack.
- *P. fimbriata* are specialists at catching **cursorial salticids**. Most cursorial salticids don't build typical webs, but they spin orb-like nests out of silk. *P. fimbriata* make vibratory signals on the silk of the nest. When the salticid pokes its head out to investigate, they attack. This is called nest probing.
- Another type of predation used by *P. fimbriata* is cryptic stalking. In this method, the hunter moves very slowly. If the salticid turns to face it, *P. fimbriata* pulls its palps back and out of the prey's view and freezes. In this position *P. fimbriata* **resembles a piece of detritus**. Other jumping spiders of the genus *Portia* exhibit aggressive mimicry, nest probing, or cryptic stalking. *P. fimbriata* is the only species that exhibits all three behaviors. *P. fimbriata* also displays species specific predation tactics. The jumping spider *Euryattus* (species unknown), is sympatric with *P. fimbriata* in the rainforests of Queensland (Jackson 1985, Jackson 1998)

Transforming the Animal Diversity Web





Both Sites Created from One Template



Transformation from Resource Rich Stuff to Learning Ecology for Complex Thinking About Key Science

Universal Design Principles for Good Learning

1. fewer big ideas
2. systematic guidance for deep thinking about focal concepts
3. the ability to revisit and deepen understandings in a systematic manner

Unique Principles

4. unique data gathering, modeling, sharing
5. new learning arising from the social construction of knowledge leading to new scales for learning communities
6. role playing (e.g., kids as authorities on datasets)

Why are simulations essential?

Harvest essential, unique dimensions of the technology towards deep thinking about core science and strong empirical outcomes