

# **EcoLearn: Immersive Experiences for Ecosystem Science Learning**

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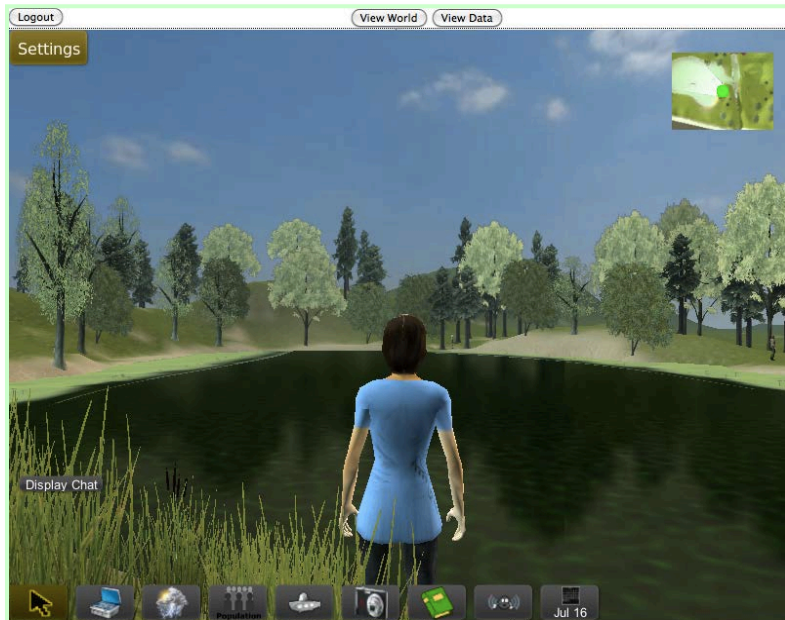
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**[ecolearn.gse.harvard.edu](http://ecolearn.gse.harvard.edu)**

**EcoMUVE:** Multi-User Virtual Environment, inquiry-based curriculum, two 2-week modules, pond + forest.

**EcoMOBILE:** EcoMUVE + augmented reality experiences on MBDs, hands-on data collection with probes or measurement tools.

**EcoXPT:** extension to EcoMUVE focused on authentic forms of experimentation in the virtual ecosystem.



# EcoXPT

- This video gives a brief introduction to the EcoXPT project:  
<http://stemforall2016.videohall.com/presentations/746>
- Also see the EcoMUVE demo video at  
<http://ecolearn.gse.harvard.edu/ecoMUVE/video.php>

# New landscape and locations

- Mobile ecosystem lab portable building near pond.
- Second housing development, farm, and golf course, as potential sources of fertilizer runoff.



# Tracers

- Visit potential sources of fertilizer leaks on June 30
- Add colored chemical to trace fertilizer
- On rainy day (July 6), see which colors leak into pond.



Settings

Quit

Data



Jun  
30

Chat



Settings

Quit

Data

## Manny Bract

Hi, I'm Manny. We've been working really hard to get the new housing development ready for the open house. I'm probably going to have to work overtime every day this week to get these lawns in shape! I think this extra fertilizer I picked up should do the trick.

OK



Population



Jun  
30

Chat



Settings

Quit

Data

### Manny Bract

Are you sure the tracers won't hurt anything? Well... as long as you're sure then I guess you can add them to my fertilizer here.

OK



Jun 30

Chat





Settings

Quit

Data



Danny

You want to put tracers in my fertilizer? I guess thats ok as long as it doesn't kill these lawns.

OK



Population



Jun  
30

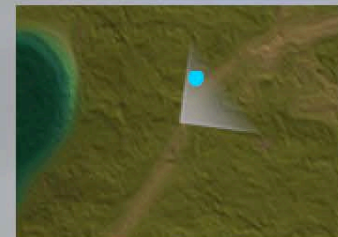
Chat



Settings

Quit

Data



Teresa

Yeah, you can put tracers in the fertilizer. It won't hurt the crops right? Science is cool!

OK



Jun  
30

Chat



Settings

Quit

Data



### Ace Mulligan

You want to put those tracers in the fertilizer I'm spreading over the golf green? I suppose thats alright as long as it doesnt hurt anything

OK



Population



Jun  
30

Chat



Settings

Quit

Data



Chat

# Fish Tanks: Tolerance Testing

- Tool to test whether different levels of specific variables kill fish
  - fertilizer
  - algae
  - bacteria
  - pH
  - temperature
  - DO
  - turbidity





EcoXPT1.0a

Experiment Variable:

Dissolved Oxygen ▼



Disolved Oxygen Tolerance Results (mg/L)

Minnows

Bluegill

Largemouth Bass



Reset

Exit

# Mesocosm Experiments

- 1 or more kiddie pools
- Student can choose up to two of the following variables to add to a tank
  - fertilizer
  - algae
  - bacteria
  - fish
  - dead matter
- Student can measure any of the following:
  - Temperature, P, N, DO, pH, turbidity and populations of algae and bacteria









Fertilizer



Algae



Bacteria



Fish



Dead Matter

1



Fertilizer

2



Fertilizer



Algae

3



Fertilizer



Bacteria

4



Fertilizer



Dead Matter

Run Experiment





Temp



Dissolved Oxygen



Phosphates



Nitrates




Turbidity




pH



Green Algae




	 Fertilizer	 Fertilizer  Algae	 Fertilizer  Bacteria	 Fertilizer  Dead Matter
Temperature				
Dissolved Oxygen	8.2 mg/L	12.0 mg/L	6.4 mg/L	7.8 mg/L
Phosphates	0.1 mg/L	0.06 mg/L	0.13 mg/L	0.11 mg/L
Nitrates				
Turbidity				
pH				
Green Algae				
Bacteria				

1  Fertilizer

2  Fertilizer  Algae

3  Fertilizer  Bacteria

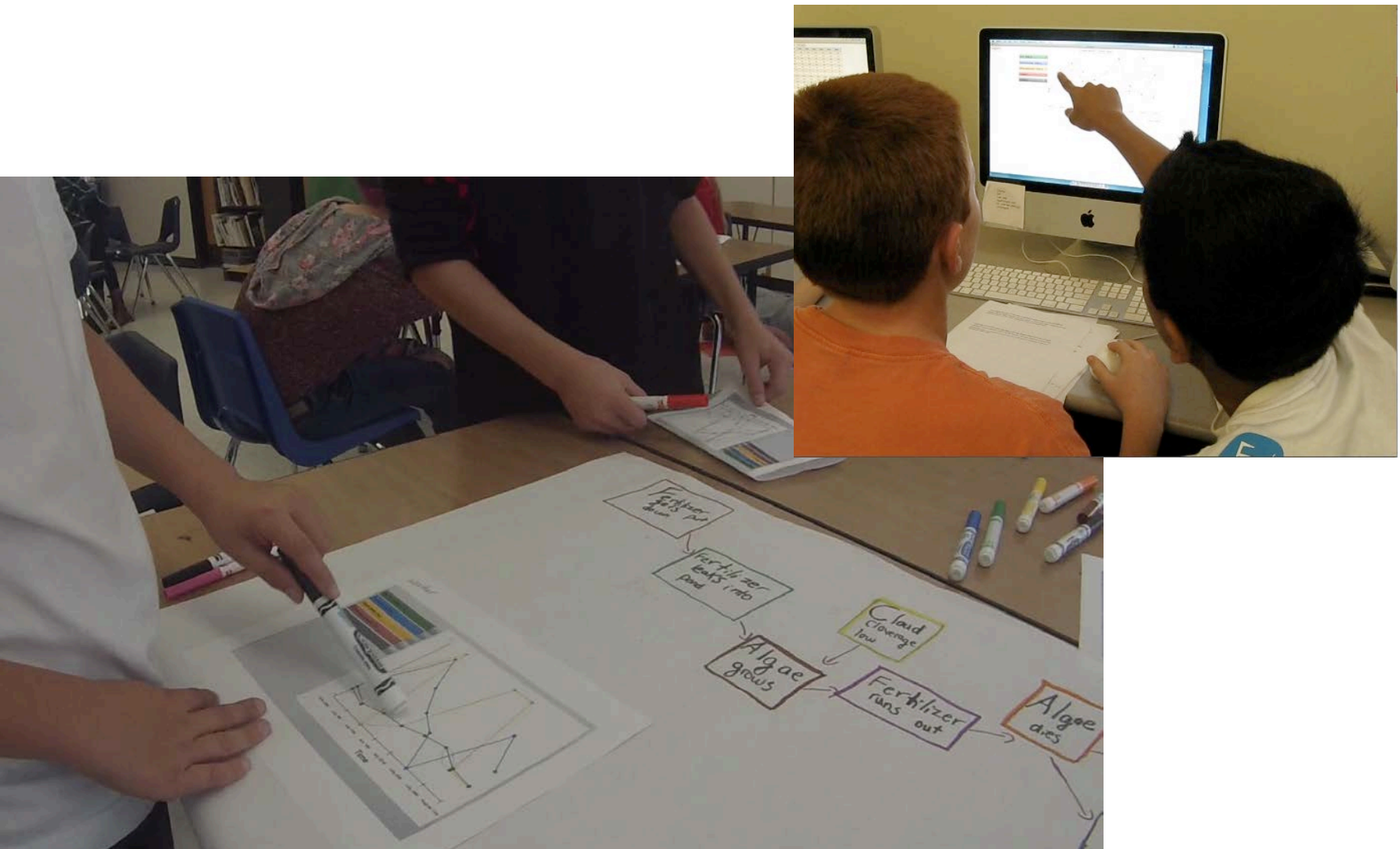
4  Fertilizer  Dead Matter

Reset

Exit



# Collaborative team concept map and presentation



# Why did the fish die?

The fish in Steele Pond from a lack of oxygen.



Measurement	June 30	July 6	July 10	July 16	July 22	July 25	July 28	Aug 15
Water temperature (°C)	22	19	21.5	24.5	26.5	27.5	25.5	25
Dissolved oxygen (mg/L)	8.4	9.5	9.4	10.2	5.4	4.1	7.3	6.4
Phosphates (mg/L)	0.03	0.1	0.03	0	0.015	0.018	0.035	0.025
Nitrates (mg/L)	0.15	0.56	0.33	0.21	0.11	0.2	0.3	0.28
Turbidity (NTU)	5	25	35	65	25	10	15	30
pH	7.2	6.7	8	8.4	7.3	7.2	7.6	8.2
Chlorophyll A (µg/L)	20	10	50	100	30	10	15	30
Air temperature (°C)	25.5	20	24.5	26.5	31	34	27.5	26.5
Wind speed (m/s)	1.5	4.5	3	2	1.5	0	3.5	2
Cloud cover (%)	40	100	0	20	100	100	20	20
Bacteria population (cells/ml)	5000	5000	5000	7000	12000	40000	33000	14000
Bluegill population	189	163	152	123	114	109	0	0
Bluegreen algae population (cells/ml)	800	900	1300	1600	1000	500	400	400
Green algae population (cells/ml)	1000	2000	5500	7000	4000	1500	1000	2000
Heron population	2	2	2	2	2	2	5	7
Largemouth bass population	38	37	35	35	33	32	0	0
Minnow population	356	320	299	278	250	237	233	416



## Reasoning

The fish died in Steele pond from a cascade of problems.

- fertilizer was dropped around the pond.
- It then rained.
- The fertilizer runoff into the pond
- The fertilizer contained a lot of phosphates and nitrates
- algae flourished with the nutrients
- they used up all the nutrients, no more left
- algae died
- bacteria grew to decompose the nutrients
- bacteria used up all the oxygen
- fish died
- minnows survive on low oxygen
- There was also low wind speed, less oxygen

Fertilizer was planted

Rained

Runoff went into the pond

Our Concept Map  
by: Amrita, Ian, Jacob and Dalsey

Nitrates and phosphate levels went up in the pond. Nutrients were in fertilizer

Nitrates and phosphates are absorbed into plants.

Plants mature

Plants die because of low nutrient levels

Fish die because there is not enough oxygen

low wind speed

Minnows thrive on low oxygen levels

Bacteria goes up because it needs to decompose the plants

Bacteria takes up majority of the oxygen

fathead minnow This was our key piece of evidence

Pimephales promelas



# Concept Map tool

- Icons represent factors (measurable variables in system)
- Arrows represent relationships between factors
- Double-click on arrows to open dialog to explain relationship
- Claim, Evidence, Reasoning model, with prompts for evidence and reasoning.





Zoom:



New Factor

Clear



Fertilizer



Green Algae



Bacteria



Wind Speed



Dissolved Oxygen



Bluegill



Largemouth Bass



Minnow



Abiotic

Biotic

Land Use

New Factors

Air  
Tempe  
ratureCloud  
Cover

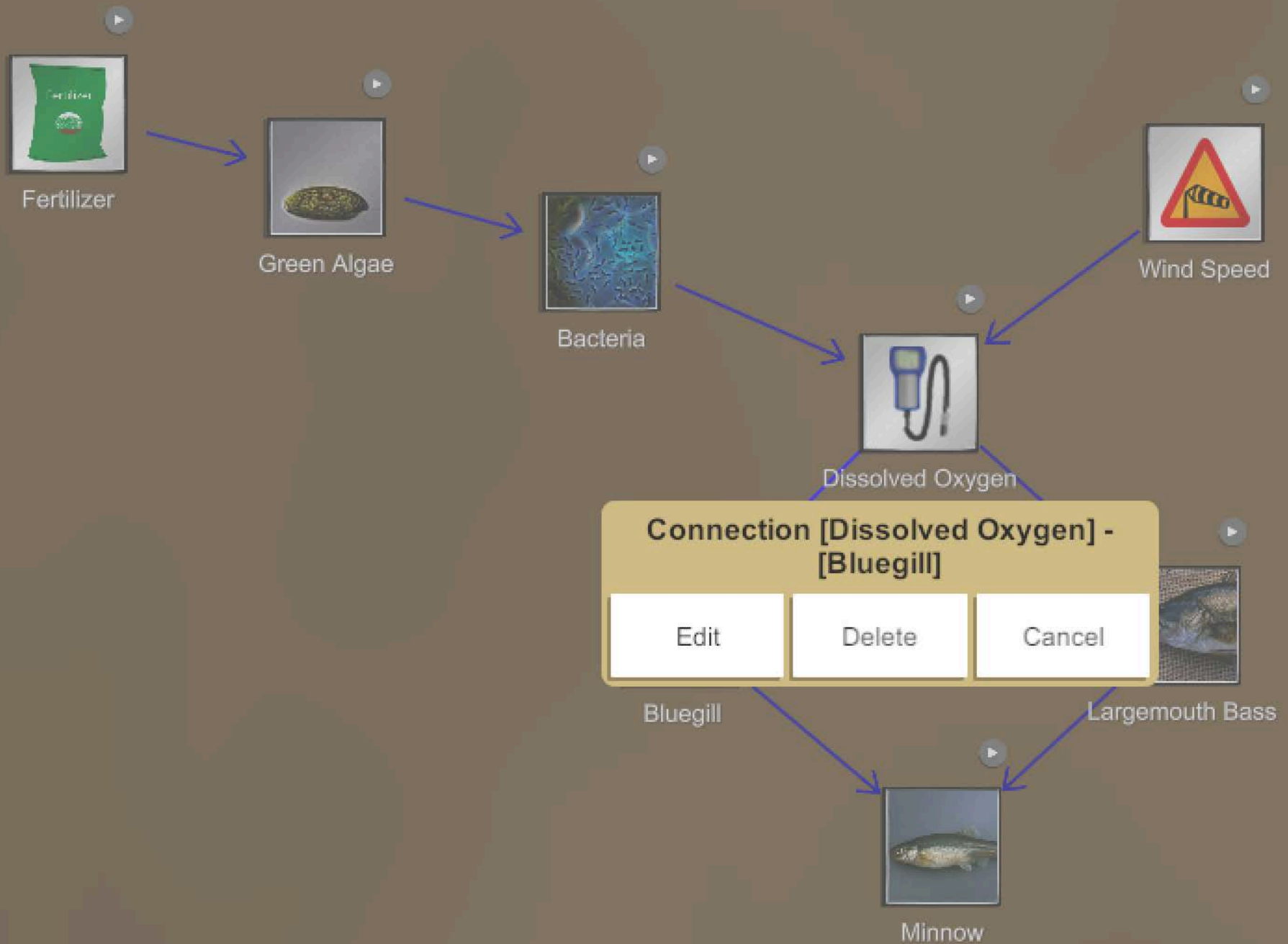
Rain

Nitrate  
s

pH

Phosp  
hatesTurbidi  
tyWater  
Tempe  
rature





**Dissolved Oxygen**

**Affects** ▼

**Bluegill**

Claim:

Dissolved Oxygen affects Bluegill

**Evidence:**

The graph shows that when the dissolved oxygen goes down the large fish population goes down.

**Reasoning:**

Explain why the evidence supports the claim using scientific ideas.

This is because fish breathe dissolved oxygen so when there is not enough dissolved oxygen for the fish to breathe, they died.

Save

Cancel

# New Investigative tools

- Sensor Buoys for 24-hour data.
- Weather simulations showing effects of temperature and wind on dissolved oxygen.
- Redesign of mesocosm tool.
- Fishtank comparison experiments.
- Notebook for experimental results



# Opportunities for T561 in Fall 2016

- A. Design and QA for the latest version of EcoXPT in development.
- Development of graphic tutorials to be integrated with the software
  - Looking for 1-2 people who are:
    - Tech-savvy
    - Experienced with digital media design, video editing, and/or graphic design
    - Have a background or interest in science

## B. Data analysis of video and artifacts from previous pilots

- Looking at student notebooks, and reviewing video and audio of teachers to inform lesson plan design.
- How can teachers guide inquiry without “giving away the answers?” – coding and data analysis of video
- Looking for 1-2 people with:
  - Teaching or other experience with middle school students
  - Background or interest in science education
  - Interest in learning data scoring and analysis techniques
  - Good communication and organizational skills
  - Paper writing and presentation skills

## C. Data analysis of student concept maps

- What factors and relationships do students include in their concept maps? Looking for patterns.
- Use of claims, evidence, reasoning
- Editing of concept maps over time, is it linked to other activities (data collection and experiments)?
- Looking for 1-3 people with:
  - Interest in learning data scoring and analysis techniques
  - Background or interest in science education
  - Good communication and organizational skills
  - Paper writing and presentation skills



## D. Data analysis of log file data.

- Look for patterns in student use of software over time. Identifying and classifying student activities.
- What and how much data do students collect? Look at completeness, systematicity.
- We have a Java tool for data analysis of log files to build on.
- Looking for 1-2 people with:
  - Programming experience, esp. Java, Unity, and/or Postgres
  - Background or interest in data analytics
  - Background or interest in statistics

Also: Pilot testing the latest version of EcoXPT in classrooms this fall.

- All participants will be invited to help with classroom piloting, so let us know if you are interested in visiting the classrooms, observing or interviewing students, and helping organize and manage data collected.

# EcoMOBILE

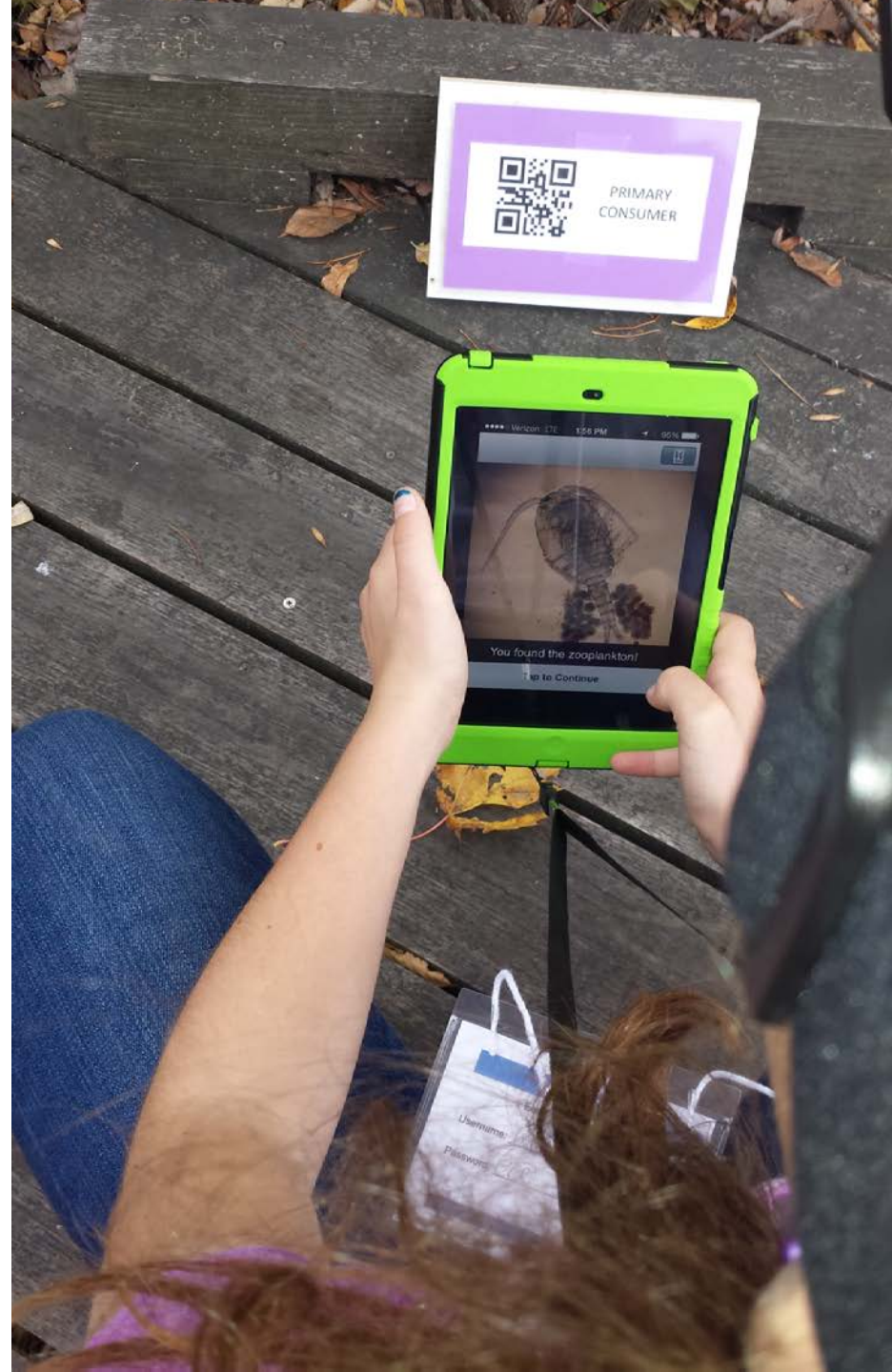
The EcoMOBILE curriculum includes augmented reality experiences on MBDs, along with opportunities for hands-on data collection using probes or measurement tools.



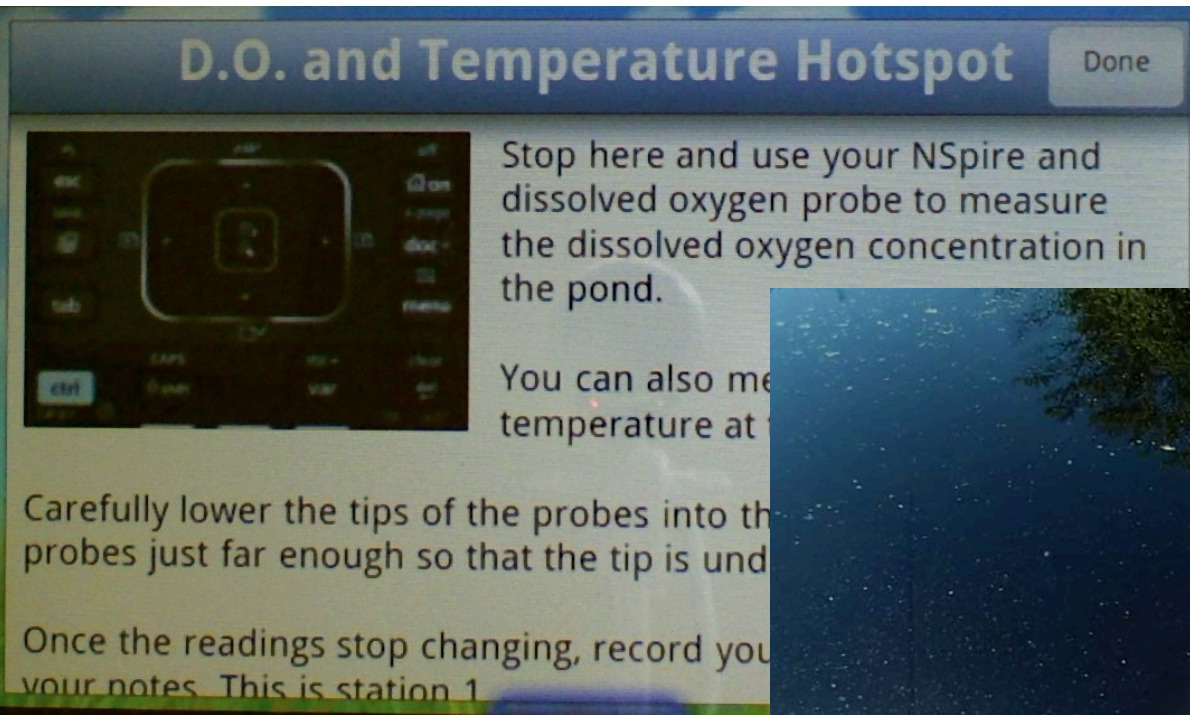


# New types of instruction for mobile learning outside the classroom

Location-based GPS coordinates or QR codes guide students to physical locations, provide contextualized information, ask questions, or guide data collection opportunities.



Physical interactions with organisms and environments; self-directed, real world data collection guided by AR.



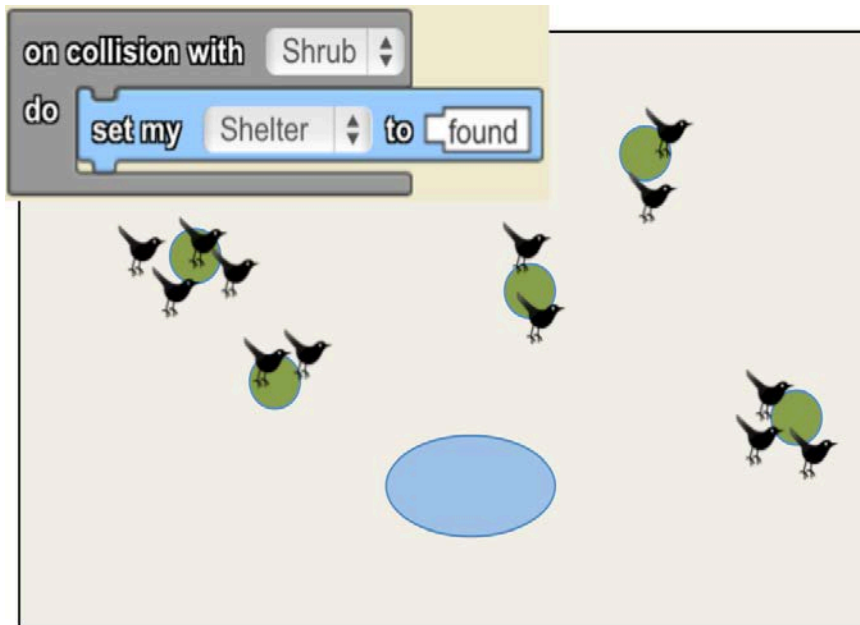
# EcoMOBILE Opportunity

- The EcoMOBILE research grant has ended, but we are sharing the AR experiences and teacher materials online for free use through Harvard using ARIS <http://arisgames.org>
- A possible T561 project would be to learn to use ARIS and help develop and adapt two EcoMOBILE experiences for the ARIS platform, and also provide teacher support materials.



# One more possibility

- EcoMOD: Integrating Computational Thinking into Ecosystems Science Education via Modeling in Immersive Virtual Worlds
- STEM + computational thinking
- elementary science education
- modeling and simulation



2D microworld