EcoLearn: Immersive Experiences for Ecosystem Science Learning

Shari Metcalf
Amy Kamarainen
Tina Grotzer
Chris Dede

shari_metcalf@gse.harvard.edu
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 is 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.
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.
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
Danny

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

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

You want to put those tracers in the fertilizer I'm spreading over the golf green? I suppose that's alright as long as it doesn't hurt anything.
Fish Tanks: Tolerance Testing

• Tool to test whether different levels of specific variables kill fish
  – fertilizer
  – algae
  – bacteria
  – pH
  – temperature
  – DO
  – turbidity
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
Run Experiment
<table>
<thead>
<tr>
<th></th>
<th>Fertilizer</th>
<th>Fertilizer Algae</th>
<th>Fertilizer Bacteria</th>
<th>Fertilizer Dead Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>8.2 mg/L</td>
<td>12.0 mg/L</td>
<td>6.4 mg/L</td>
<td>7.8 mg/L</td>
</tr>
<tr>
<td>Phosphates</td>
<td>0.1 mg/L</td>
<td>0.06 mg/L</td>
<td>0.13 mg/L</td>
<td>0.11 mg/L</td>
</tr>
<tr>
<td>Nitrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Algae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacteria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Collaborative team concept map and presentation
Why did the fish die?

The fish in the pond died from a lack of oxygen.

Our Concept Map

by: Amrita, Ian, Jacob, and Daisy

The fish died in the pond from a combination of problems.

- Nutrients were added into the pond.
- Fish then ate them.

- The nutrients contain a lot of phosphates and nitrates.
- Algae flourished with the nutrients.
- Plants used all the nutrients, so there were left.
- Algae died.
- Bacteria grew to decompose the nutrients.
- Bacteria used up all the oxygen.
- Fish died.
- Minnows survived on low oxygen.
- There was also less wind speed, less oxygen.

Fathead minnows This was our key piece of evidence.

Nutrients and phosphates make up part of the food that plants and animals use.

Bacteria help break up the majority of the nutrients.

Plants grow because of low nutrient levels.

Fish ate minnows because there was not enough oxygen.
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.
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.
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