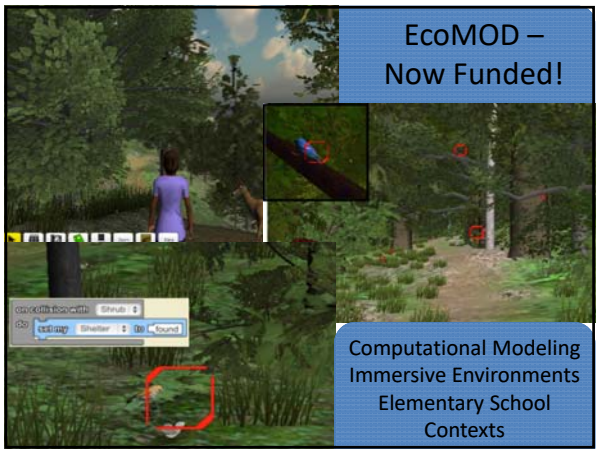


Design-Based Research (DBR)
EcoMOBILE as a Case Study

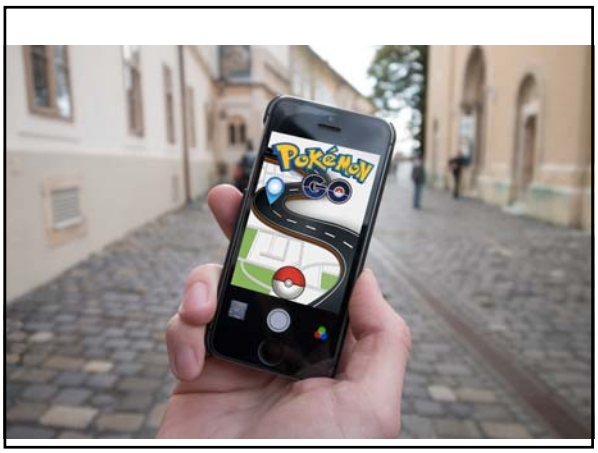
Amy Kamarainen
Shari Metcalf, Tina Grotzer and Chris Dede

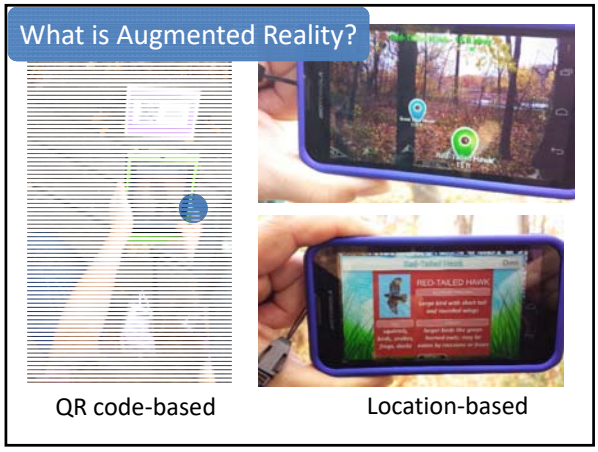
ecolearn.gse.harvard.edu

(Prabhakar Jampa)

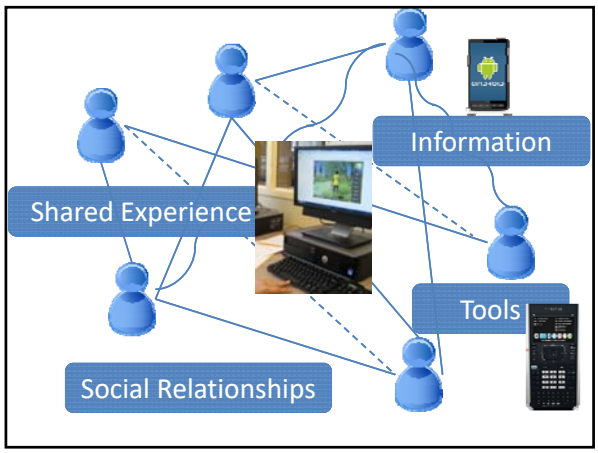
(Prabhakar Jampa)

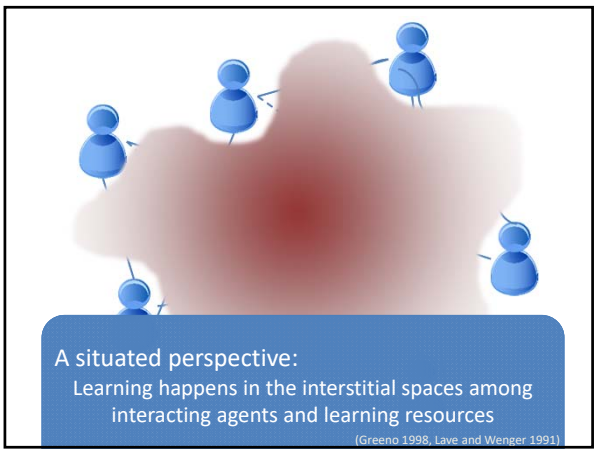
Modular and Personalized
Sit and Stay
How does this analogy map on to our education system?
What role does technology play in reimagining spaces for learning?

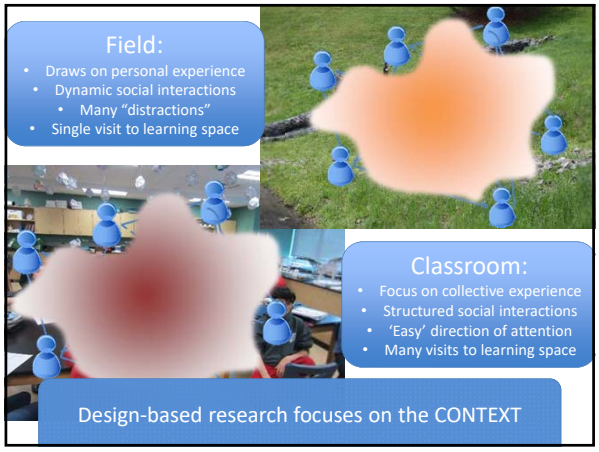

POKÉMON GO

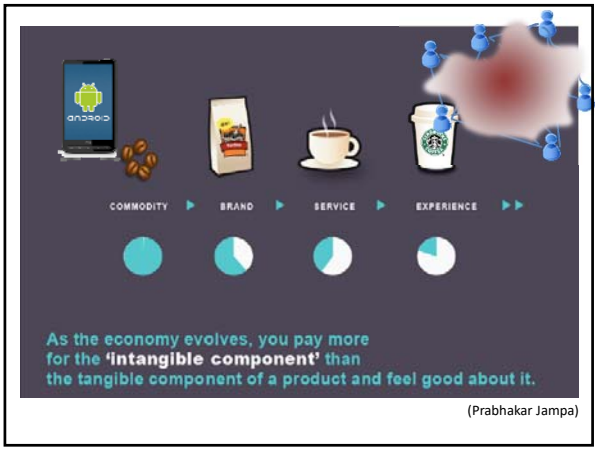

What is Augmented Reality?
QR code-based
Location-based

Mobile Broadband Devices
EcoMOBILE
Fresh AiR
Environmental Probes
Augmented Reality
ARIS


Information
Shared Experience
Tools
Social Relationships


A situated perspective:
Learning happens in the interstitial spaces among interacting agents and learning resources
(Greeno 1998, Lave and Wenger 1991)

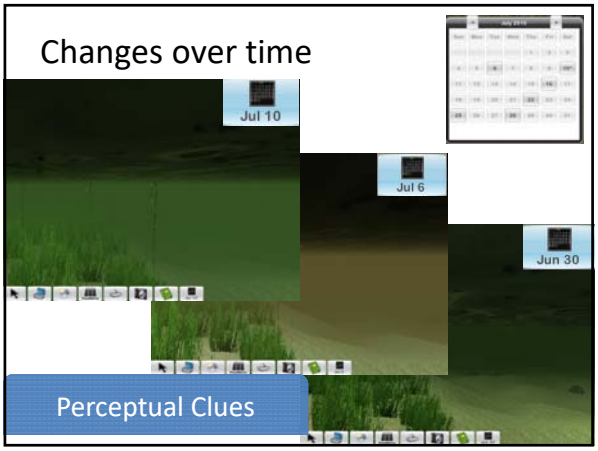

Field:
• Draws on personal experience
• Dynamic social interactions
• Many "distractions"
• Single visit to learning space
Classroom:
• Focus on collective experience
• Structured social interactions
• 'Easy' direction of attention
• Many visits to learning space
Design-based research focuses on the CONTEXT


COMMODITY
BRAND
SERVICE
EXPERIENCE
As the economy evolves, you pay more for the 'intangible component' than the tangible component of a product and feel good about it.
(Prabhakar Jampa)

EcoMOBILE is about BLENDING EcoMUVE and outdoor field trip experiences supported by mobile tech.

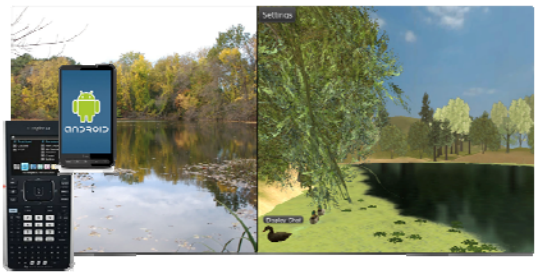
EcoMUVE Experience = Take on the role of a scientist and investigate why the fish died.

Changes over time



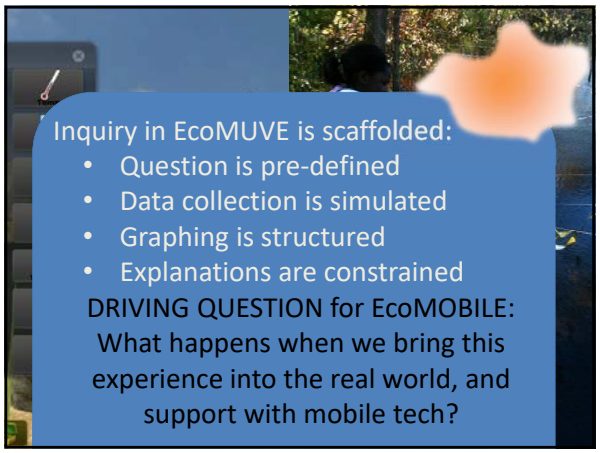
Perceptual Clues

Data and Graphs

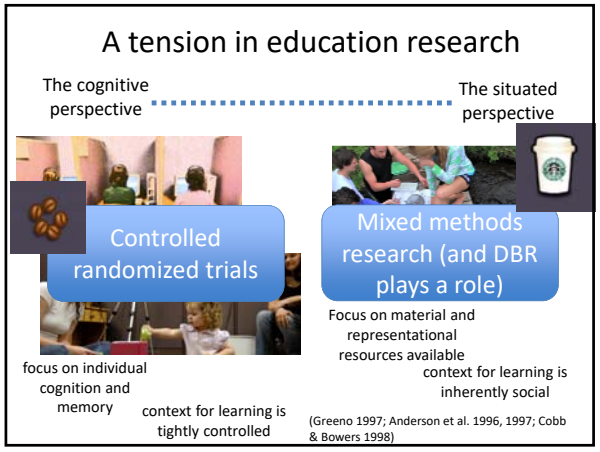


Similarities in surface and deep features of a learning environment should promote transfer to new situations.

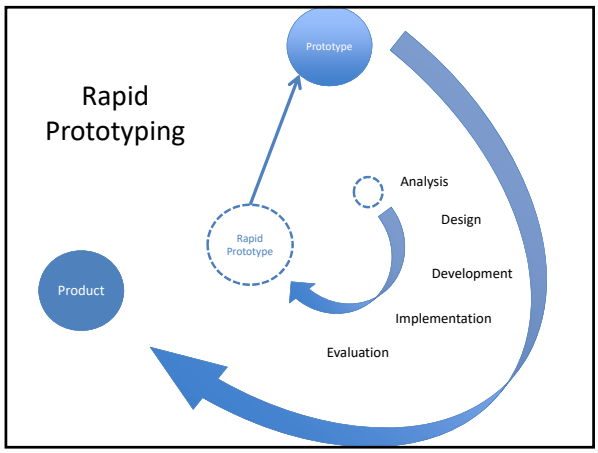
(Goldstone and Sakamoto 2003)

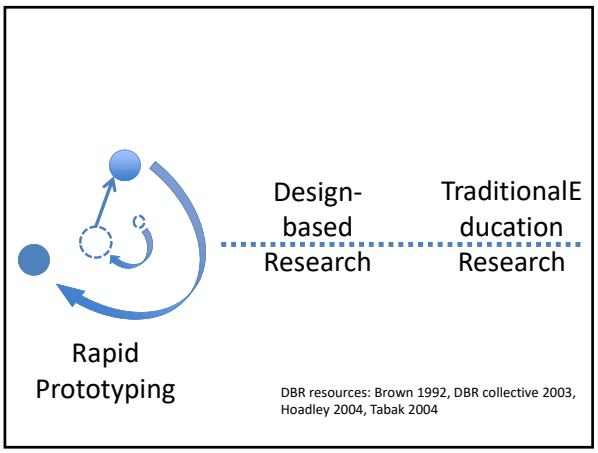

Inquiry in EcoMUVE is scaffolded:
• Question is pre-defined
• Data collection is simulated
• Graphing is structured
• Explanations are constrained
DRIVING QUESTION for EcoMOBILE:
What happens when we bring this experience into the real world, and support with mobile tech?

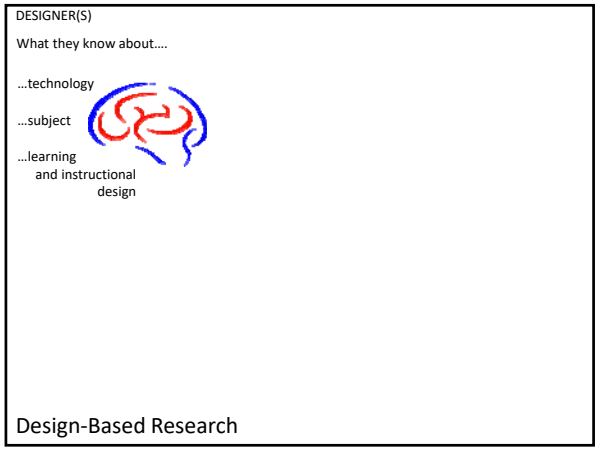
Design intentions for EcoMOBILE experience:
• Give students agency in collecting and analyzing data in realistic scenarios
• Show that what they learned in the classroom holds relevance when they step outside
• Offer the ability to see and notice things they may not have known were there
• Support opportunities to work together to solve a problem
HOW DO WE KNOW IF WE'RE MEETING THESE GOALS?

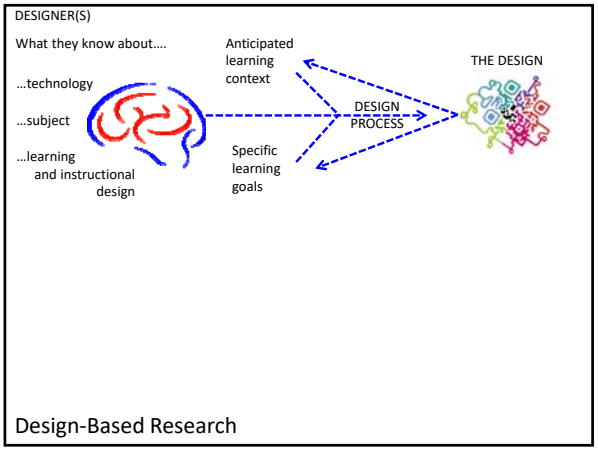

A tension in education research
The cognitive perspective
The situated perspective
Controlled randomized trials
Mixed methods research (and DBR plays a role)
focus on individual cognition and memory
context for learning is tightly controlled
Focus on material and representational resources available
context for learning is inherently social
(Greeno 1997; Anderson et al. 1996, 1997; Cobb & Bowers 1998)

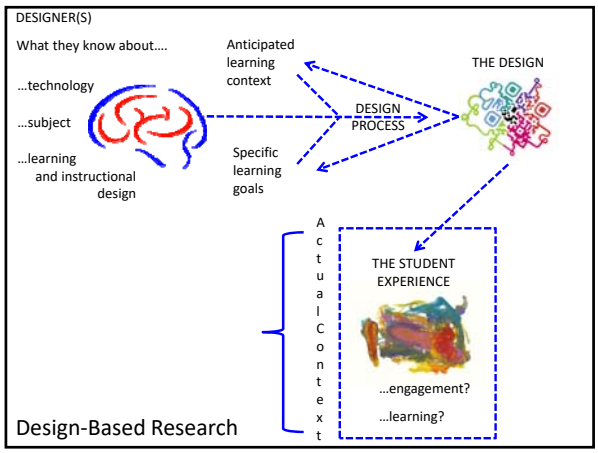
Design intentions ~ Reality?
Design-Based Research


Rapid Prototyping
Prototype
Rapid Prototype
Product
Analysis
Design
Development
Implementation
Evaluation


Design-based Research
TraditionalEducation Research
Rapid Prototyping
DBR resources: Brown 1992, DBR collective 2003, Hoadley 2004, Tabak 2004


DESIGNER(S)
What they know about….
…technology
…subject
…learning and instructional design
Design-Based Research


DESIGNER(S)
What they know about….
…technology
…subject
…learning and instructional design
Anticipated learning context
Specific learning goals
DESIGN PROCESS
THE DESIGN
Design-Based Research


DESIGNER(S)
What they know about….
…technology
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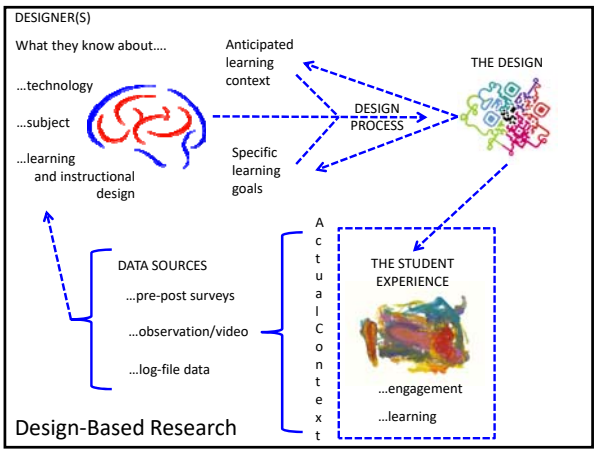
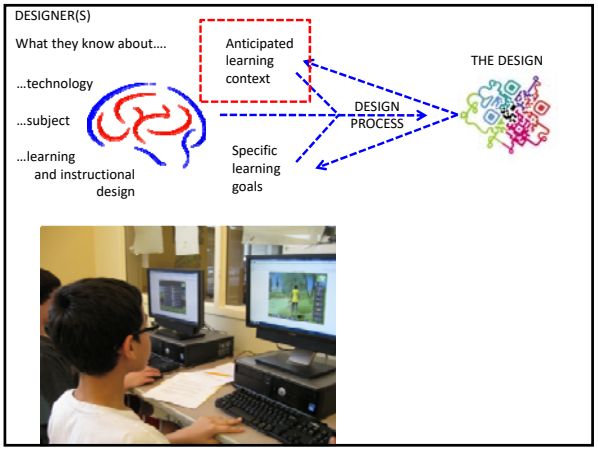
…learning and instructional design
Anticipated learning context
Specific learning goals
DESIGN PROCESS
THE DESIGN
Actual Context
THE STUDENT EXPERIENCE
…engagement?
…learning?
Design-Based Research


DESIGNER(S)
What they know about….
…technology
…subject
…learning and instructional design
Anticipated learning context
Specific learning goals
DESIGN PROCESS
THE DESIGN
DATA SOURCES
…pre-post surveys
…observation/video
…log-file data
Actual Context
THE STUDENT EXPERIENCE
…engagement
…learning
Design-Based Research

DESIGNER(S)
What they know about….
…technology
…subject
…learning and instructional design
Fresh Air
EcoMOBILE – Round 1


DESIGNER(S)
What they know about….
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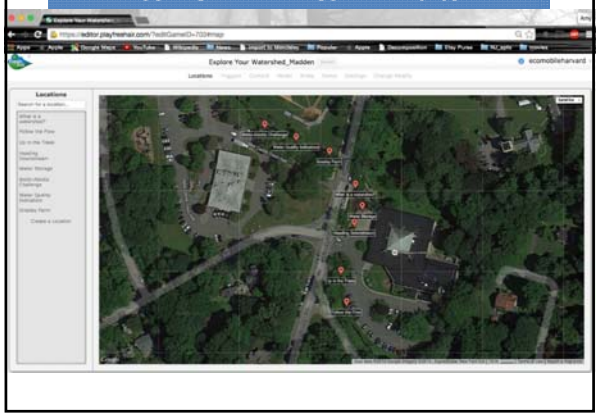
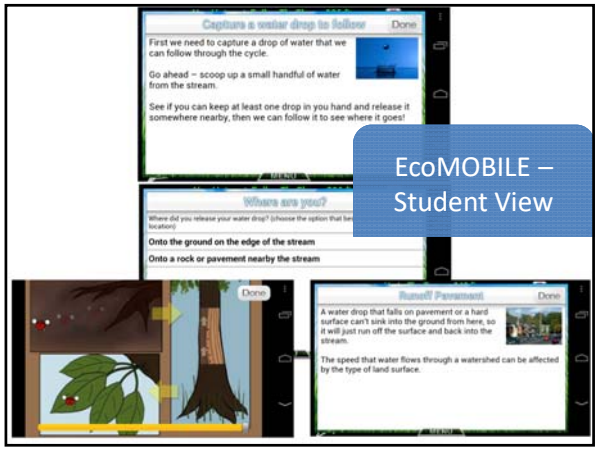
…subject
…learning and instructional design
Anticipated learning context
Specific learning goals
DESIGN PROCESS
THE DESIGN

EcoMOBILE – FreshAiR Editor



EcoMOBILE – FreshAiR Editor



EcoMOBILE – Student View

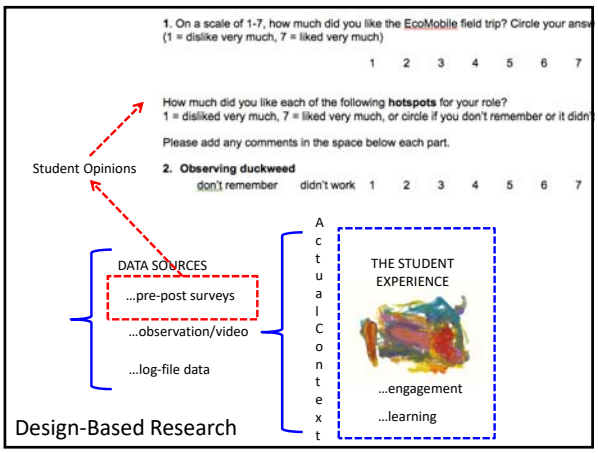
Naturalist	Microscopic Specialist	Water Chemist	Private Investigator
Observe pond for similarities to EcoMUVE	Observe duckweed	Observe pond for similarities to EcoMUVE	Talk to virtual golfer
Observe virtual fish	View 3D model of duck	Measure dissolved oxygen	Observe storm water pipe overlay
Calculate fish population size			Find inlet and outlet of pond
Collect macroinvertebrates			Talk to young girl about what a watershed is
ID macroinverts and calculate tolerance index	Measure pH	Measure phosphates	Measure turbidity
Work together to create video that summarizes the health of the pond based on whole team's observations			

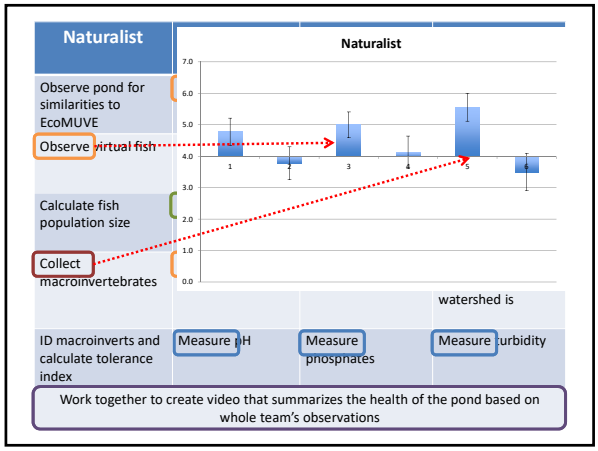
Students were given their own phones and roles

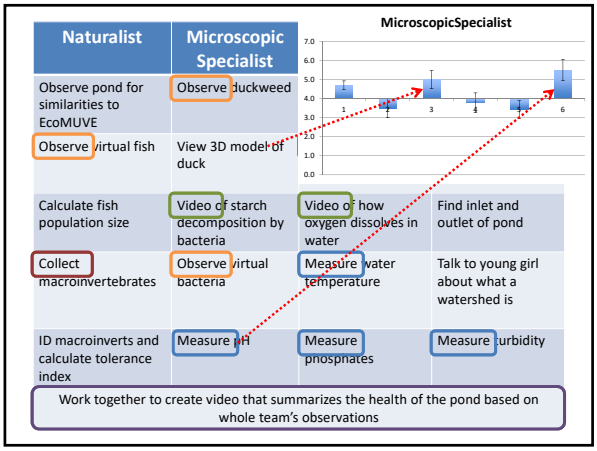
EcoMOBILE – Round 1

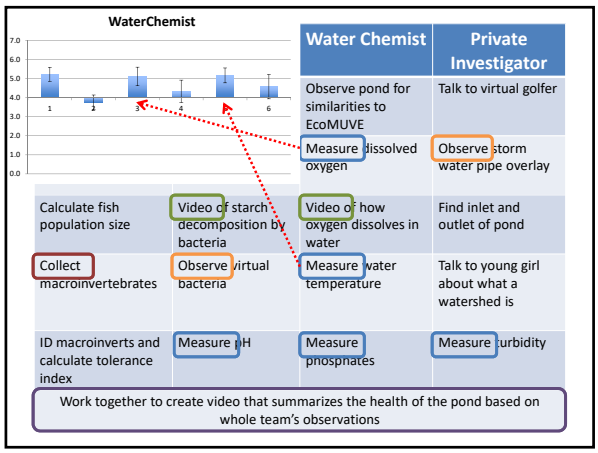
PAUSE

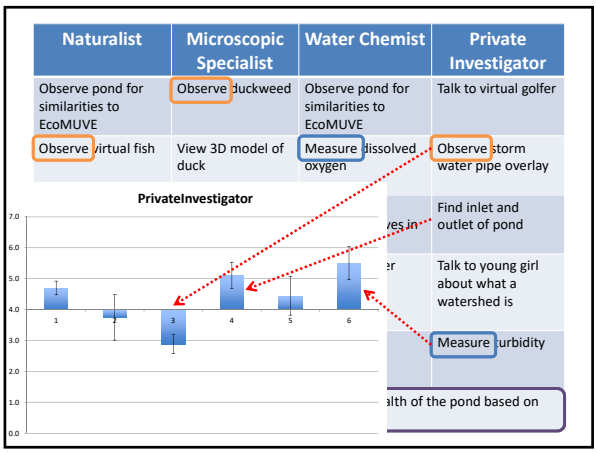
pH


1. On a scale of 1-7, how much did you like the EcoMobile field trip? Circle your answ
(1 = dislike very much, 7 = liked very much)
1 2 3 4 5 6 7
How much did you like each of the following hotspots for your role?
1 = disliked very much, 7 = liked very much, or circle if you don't remember or it didn't
Please add any comments in the space below each part.
2. Observing duckweed
don't remember didn't work 1 2 3 4 5 6 7
Student Opinions
DATA SOURCES
...pre-post surveys
...observation/video
...log-file data
Actual Context
THE STUDENT EXPERIENCE
...engagement
...learning
Design-Based Research


Naturalist
Observe pond for similarities to EcoMUVE
Observe virtual fish
Calculate fish population size
Collect macroinvertebrates
ID macroinverts and calculate tolerance index
Measure pH
Measure phosphates
Measure turbidity
watershed is
Work together to create video that summarizes the health of the pond based on whole team's observations


Naturalist
Microscopic Specialist
MicroscopicSpecialist
Observe pond for similarities to EcoMUVE
Observe duckweed
Observe virtual fish
View 3D model of duck
Calculate fish population size
Video of starch decomposition by bacteria
Video of how oxygen dissolves in water
Find inlet and outlet of pond
Collect macroinvertebrates
Observe virtual bacteria
Measure water temperature
Talk to young girl about what a watershed is
ID macroinverts and calculate tolerance index
Measure pH
Measure phosphates
Measure turbidity
Work together to create video that summarizes the health of the pond based on whole team's observations


WaterChemist
Water Chemist
Private Investigator
Observe pond for similarities to EcoMUVE
Talk to virtual golfer
Measure dissolved oxygen
Observe storm water pipe overlay
Calculate fish population size
Video of starch decomposition by bacteria
Video of how oxygen dissolves in water
Find inlet and outlet of pond
Collect macroinvertebrates
Observe virtual bacteria
Measure water temperature
Talk to young girl about what a watershed is
ID macroinverts and calculate tolerance index
Measure pH
Measure phosphates
Measure turbidity
Work together to create video that summarizes the health of the pond based on whole team's observations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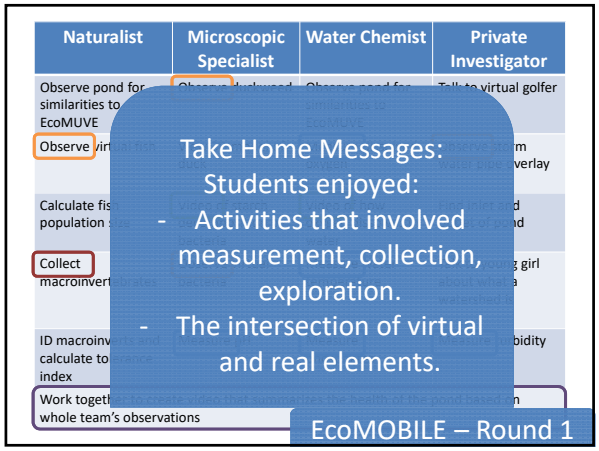
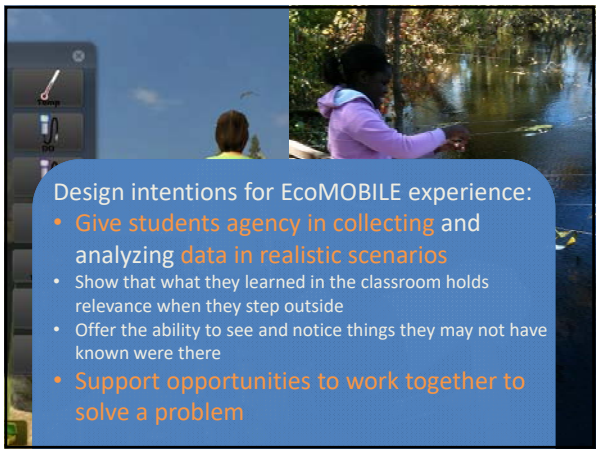

Naturalist
Microscopic Specialist
Water Chemist
Private Investigator
Take Home Messages:
Students enjoyed:
- Activities that involved measurement, collection, exploration.
- The intersection of virtual and real elements.
EcoMOBILE – Round 1

Fresh Air
EcoMOBILE – Round 2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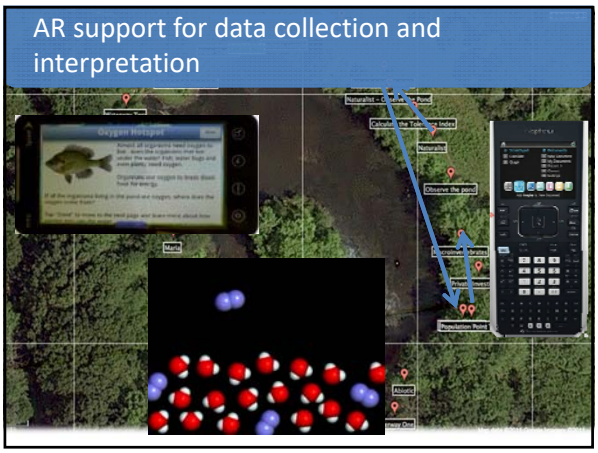
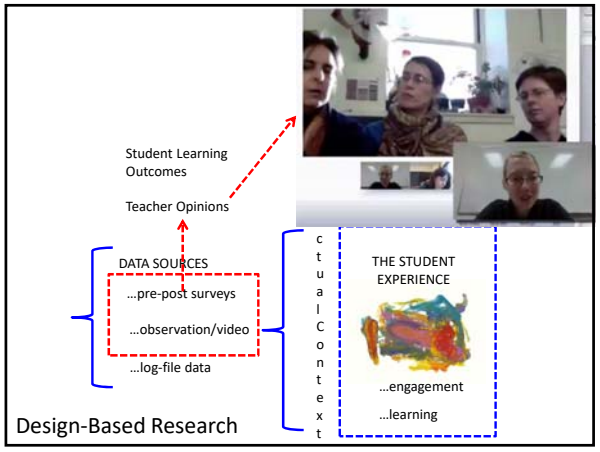
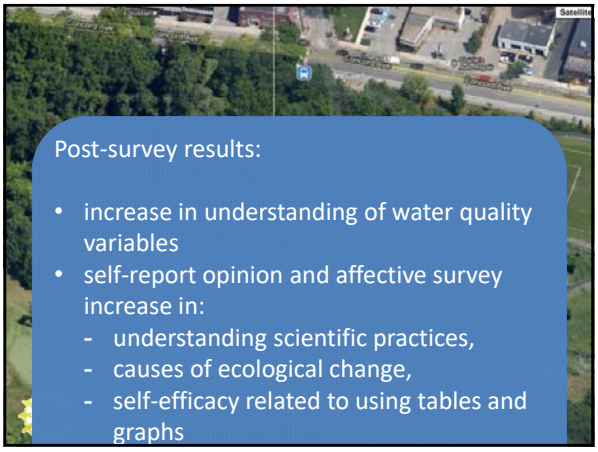

AR support for data collection and interpretation


Student Learning Outcomes
Teacher Opinions
DATA SOURCES
…pre-post surveys
…observation/video
…log-file data
Contextual
THE STUDENT EXPERIENCE
…engagement
…learning
Design-Based Research


Post-survey results:
• increase in understanding of water quality variables
• self-report opinion and affective survey increase in:
- understanding scientific practices,
- causes of ecological change,
- self-efficacy related to using tables and graphs

The TEACHERS' experience

"It felt like 90% of the time they were at the pond environment, they were working on interacting with the pond and their partner, whereas previous times it felt like it was maybe 60 or 50% of their time they were independently interacting."

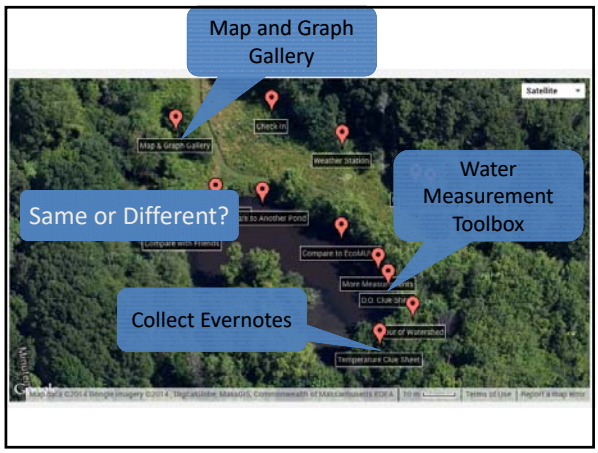
"They're getting to see parts of the world that they don't see, like the microscopic creatures, what the pH level is, they're getting to see things that they didn't know existed"

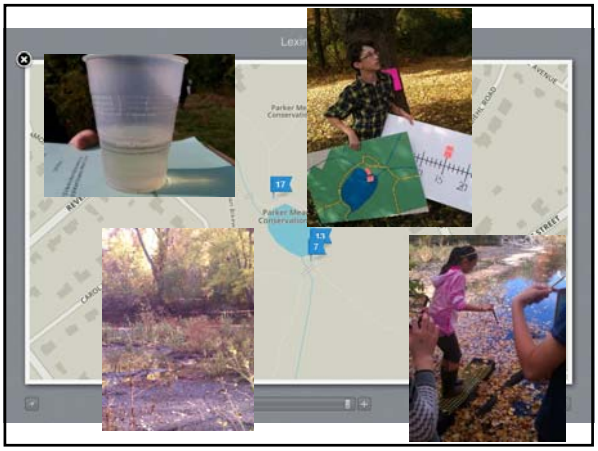
(Photo: Alan English)

The TEACHERS' experience

"I was able to work a little more one-on-one and with small groups, I just traveled around and checked in with kids, I wasn't directing things, that felt really different to me, and I really liked it… It felt more like what I like to think of teaching as being - not just directing top-down."

(Photo: Alan English)



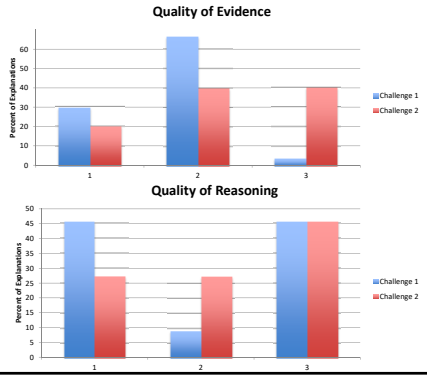


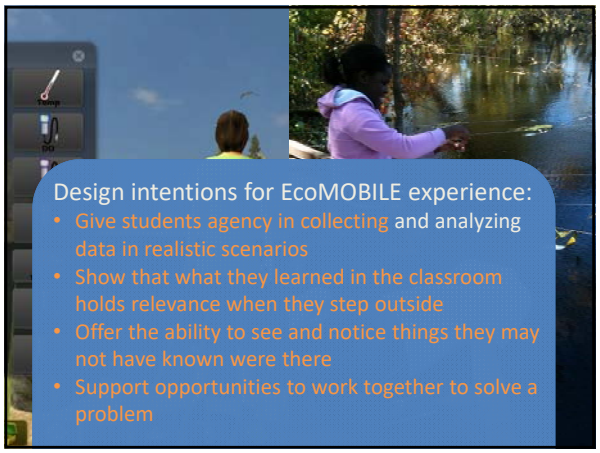
Quantitative Results from Pre-Post Survey

Construct	Mean (Pre) SD	Mean (Post) SD	Effect Size	T-test, p-value
Describing Data	10.5 (±0.41)	10.8 (±0.32)	NS	$T_{73} = -0.88$, $p = 0.38$
Understanding Variability	**21.5 (± 0.42)**	**22.4 (± 0.37)**	**0.26**	**$T_{72} = -2.28$, $p = 0.025$**
Supporting Claims with Evidence	**15.9 (± 0.49)**	**17.4 (± 0.47)**	**0.37**	**$T_{66} = -2.61$, $p = 0.011$**
Context (near)	**0.38 (± 0.49)**	**0.77 (± 0.66)**	**0.67**	**$T_{66} = -4.67$, $p < 0.001$**
Context (far)	0.88 (± 0.43)	0.9 (± 0.44)	NS	$T_{78} = -1.34$, $p = 0.19$

(Cooke, Kamarainen, Bressler, Metcalf, Grotzer & Dede, NARST 2016)

Qualitative Coding of Student Explanations

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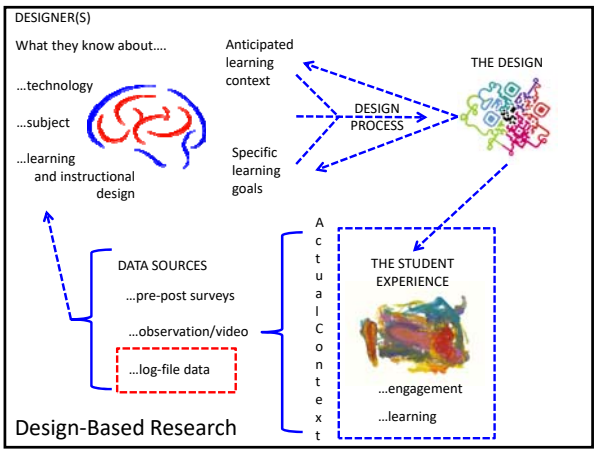
DESIGNER(S)
What they know about….
…technology
…subject
…learning and instructional design
Anticipated learning context
Specific learning goals
DESIGN PROCESS
THE DESIGN
DATA SOURCES
…pre-post surveys
…observation/video
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Actual Context
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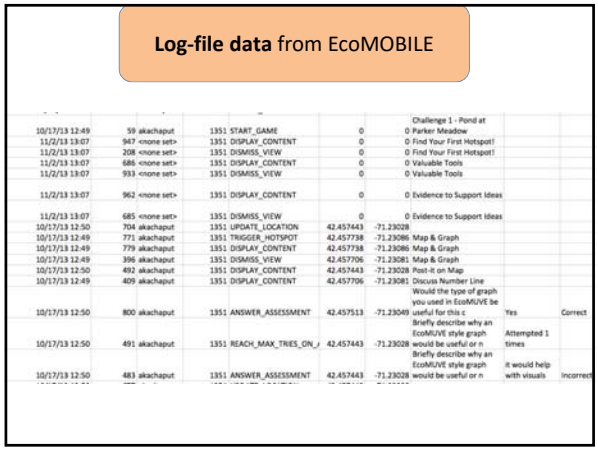
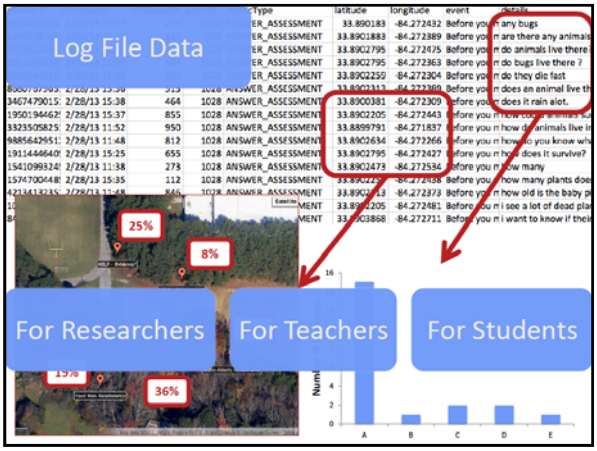
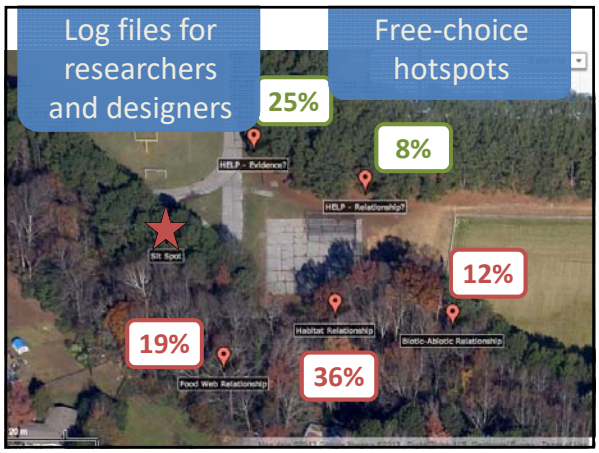
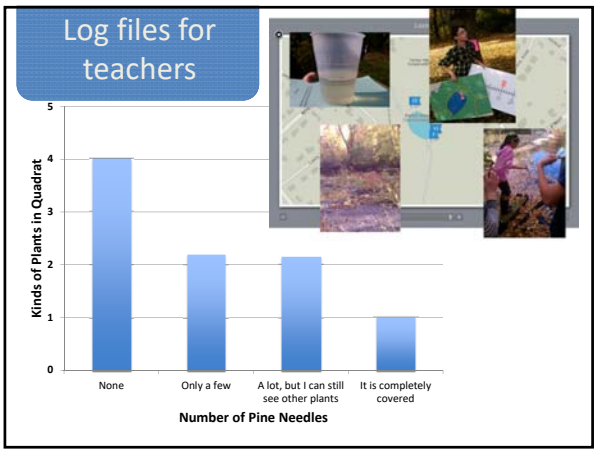
Design-Based Research

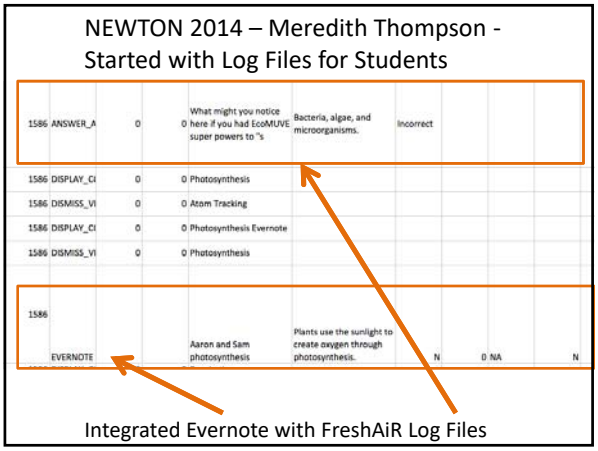

Log-file data from EcoMOBILE

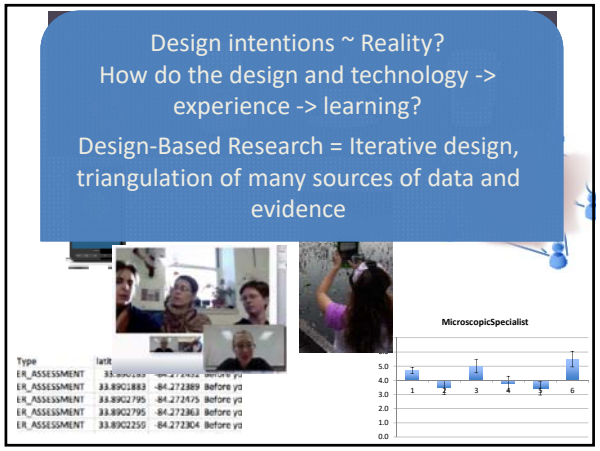

Log File Data
For Researchers
For Teachers
For Students
25%
8%
36%

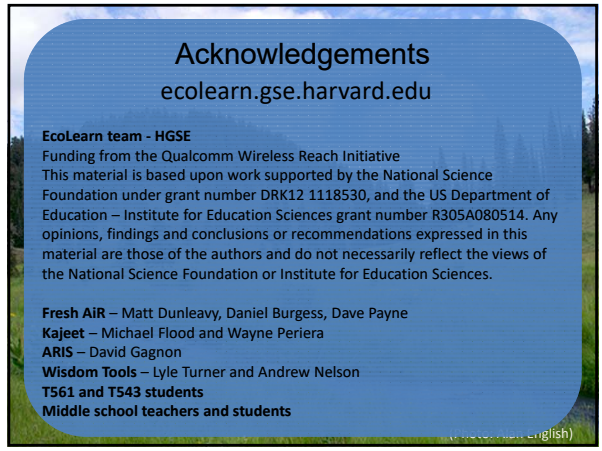

Log files for researchers and designers
Free-choice hotspots
25%
8%
12%
19%
36%
HELP - Evidence?
HELP - Relationship?
Habitat Relationship
Biotic-Abiotic Relationship
Food Web Relationship


Log files for teachers
Kinds of Plants in Quadrat
0
1
2
3
4
5
None
Only a few
A lot, but I can still see other plants
It is completely covered
Number of Pine Needles

GoPro data from EcoMOBILE


NEWTON 2014 – Meredith Thompson - Started with Log Files for Students
1586 ANSWER_A 0 0 What might you notice here if you had EcoMUVE super powers to "s Bacteria, algae, and microorganisms. Incorrect
1586 DISPLAY_CI 0 0 Photosynthesis
1586 DISMISS_VI 0 0 Atom Tracking
1586 DISPLAY_CI 0 0 Photosynthesis Evernote
1586 DISMISS_VI 0 0 Photosynthesis
1586 EVERNOTE Aaron and Sam photosynthesis Plants use the sunlight to create oxygen through photosynthesis. N 0 NA N
Integrated Evernote with FreshAiR Log Files


Design intentions ~ Reality?
How do the design and technology -> experience -> learning?
Design-Based Research = Iterative design, triangulation of many sources of data and evidence
MicroscopicSpecialist
Type
ER_ASSESSMENT
ER_ASSESSMENT
ER_ASSESSMENT
ER_ASSESSMENT
ER_ASSESSMENT
33.8901883
-84.272389
33.8902795
-84.272475
33.8902795
-84.272363
33.8902259
-84.272304
Before yo
5.0
4.0
3.0
2.0
1.0
0.0
1
2
3
4
5
6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ecolearn.gse.harvard.edu
EcoLearn team - HGSE
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Kajeet – Michael Flood and Wayne Periera
ARIS – David Gagnon
Wisdom Tools – Lyle Turner and Andrew Nelson
T561 and T543 students
Middle school teachers and students