Building Long-term Research Projects and Collaborations

Fellows: Nick Ballew, Alycia Lackey, Liz Schultheis, Tomomi Suwa
Partner Teacher: Marcia Angle
Leadership: Tom Getty (PI) and Robin Faghihnia (Project Manager)

A central goal: create a collaborative research network of schoolyard science research sites.

Why a schoolyard research network?
- serve as arenas for inquiry science activities
- mimic aspects of KBS and fellows’ thesis research
- highlight Fellows’ skills as researchers
- address MI Science standards
- allow K-12 classes to develop research initiatives
- facilitate cross-district research collaboration

W.K. Kellogg Biological Station’s K-12 Partnership – a long-term collaboration
- Established 10+ years ago,
- 80+ participating teachers
- 13 SW Michigan districts
- Trusting relationships with KBS scientists

Today, we will:
- Outline our experience building the “BEST” research network
- Provide three case studies highlighting how we bring Fellow research skills to bear on the research network
- Liz: Bringing Fellows’ Thesis Research to the Network
- Nick: Cultivating Scientific Thinking Skills
- Tomomi and Alycia: Enhancing Students’ Research Initiatives
- Consider the benefits and challenges of this type of work

Identifying a Project Theme: “STEM Dimensions of Bioenergy Sustainability”
- KBS expertise
- Regional interest
- Linked to Fellow research

KBS GK-12 Project
Establishing a research network

“Can we grow our fuel and have our flowers and butterflies too?”

Basic experimental block:

- Manipulate diversity, fertilization, and harvesting

Summer Institute 2010:
- Fellows introduce Teachers to native prairie and switchgrass treatments – 2 potential biofuel crops studied at KBS

GK-12 Fellow Nikhil and teacher John Edgerton check out a native prairie plot at the GLBRC.

Partner teacher Sandy Erwin observes a switchgrass plot at the GLBRC.

As early as possible, established a structure giving everyone project ownership and important roles –

Successful partnerships play on strengths that all Fellows and Teachers bring to the table!

2010 School year: designed and tested research protocols and teaching materials with students and teachers

Three theme-teams and sets of protocols:
- Biodiversity and Biomass
- Soils
- Landscape-level

Team: Biodiversity

- Protocol: Experimental design
- Materials: PVC frames, marking materials, etc.
- Timeline: Fall

Team: Energy

- Protocol: Harvesting
- Materials: Harvester, bags, etc.
- Timeline: Fall

Team: Landscape

- Protocol: Soil sampling
- Materials: Soil probe, etc.
- Timeline: Fall

Team: Science

- Protocol: Data analysis
- Materials: Computers, software, etc.
- Timeline: Winter
Establishing a research network

Fall 2011: Data Collection begins on the BEST plots
- Participants in all districts collect the same data using standardized protocols

Fall 2011: Data Collection begins on the BEST plots
- Data submitted to GK-12 leadership through Google docs web forms.
- Teachers and students have access to data from across the research network

Students and teachers can access data from across the research network to ask their own questions:

Here we show preliminary evidence from two districts suggesting that soil properties impact ecosystem productivity and diversity.

Districts are working to align curriculum with the BEST plots research network:

Example:
- Elementary – collect prescribed data, and draw simple conclusions based on evidence
- Middle school – pose questions, and conduct experiments designed largely by Fellows and teachers
- High school – develop questions and experiments utilizing techniques learned in previous years of research

Research network success relies on the strengths of both Fellows and Teachers:

- Fellows use research strengths to tailor our research question to teacher and student needs
- Teachers use expertise in pedagogy and grade-level content to ensure topics and teaching strategies are relevant and realistic
- By the end of our project (and 5 years of data collection) teachers will have the experience and resources to continue engaging students in authentic research

Workshop Goals

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A central goal: Bringing Fellow Research into the Classroom

- Opportunity to share my research with a diverse audience
- Think about the major ideas behind my research
- Think about the broader context of what I study

GK-12 Fellow Liz Schultheis

Invasive Species Activity
Sharing my research with elementary and middle school students

GK-12 Fellow Liz Schultheis

Invasive
Purple loosestrife
Native
Pickerelweed

Invasion facilitation

Invasion resistance

Lythrum salicaria
Purple Loosestrife

Move forward:
Growth: 
Seeds: 
Disperse: 
Move backward:
Herbivory:
Disease:
Fire:
Drought:
Human disturbance:

Some actions harm native species more than invasive species
These actions facilitate invasion

Pickerelweed

Move forward:
Growth: 
Seeds: 
Disperse: 
Move backward:
Herbivory:
Disease:
Fire:
Drought:
Human disturbance:

Some actions harm invasive species more than native species
These actions resist invasion

Activities of the Session

1. Introduction
   a. Ask the students about their prior knowledge on invasive species. Can they name any invasive species? Do they know the issues caused by these species or what people are doing to control them?
   b. Give examples of invasive species in Michigan (e.g., Point Pelee National Park, Lake Michigan), and invasive species' characteristics.
   c. What characteristics does an invasive species have? Ask students to pull together what they can remember of their examples and the ones in the presentation. See if they can come up with their own list of characteristics of invasive species.
   d. Tell students that they will now be participating in activity to learn about the characteristics of invasive species and how they are successful.

2. Activity
   a. Introduce the rules of the activity. Give species cards, stages, and events. Describe how students will move backwards and forwards based on the card that the student who crosses the finish line will be "in the community" and will have to describe to the class how they got there.
   b. Gather students in a large, open room.
   c. Students line up, shoulder to shoulder on the start line.
   d. Give each student a species card (you will not use whole set; ratio of invaders to natives should be about 1:2).
   e. Explain that students will move forward for stages (growth, seeds, reproduction) when the appropriate stage card is held up. They will...
Think about broader context of my research
Can do basic ecology in the classroom – the Network and classroom inquiry activities

Cultivating critical thinking skills: implementing a lesson structure that focuses on critical thinking.

Cultivating critical thinking skills: a condensed example to demonstrate the general lesson structure.

Question: How does N fertilization affect switchgrass production?

Claims:
1. Nitrogen fertilization does not affect productivity.
2. Nitrogen fertilization usually helps, but never hurts switchgrass productivity.
3. Nitrogen fertilization can help, but too much can harm switchgrass productivity.

Connecting my research to the Research Network: Bringing Fellow Research into the Classroom

Research Network:

Integrating Fellow Research:

GK‐12 Fellow Nick Ballew

Culminating critical thinking skills: implementing a lesson structure that focuses on critical thinking.

Culminating critical thinking skills: a condensed example to demonstrate the general lesson structure.

GK‐12 Fellow Nick Ballew

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Source: Critical thinking skill definitions are from APA Report: Expert Consensus Statement on Critical Thinking. (ERIC ED 315-423)
Cultivating critical thinking skills: a condensed example to demonstrate the general lesson structure.

Biomass yield (Mg ha⁻¹)

2009

N rate (kg N ha⁻¹)

2010

2011

N rate (kg N ha⁻¹)

Using real data in the classroom

Practicing the ENTIRE scientific process

Communicate results & conclusions

Develop questions & hypotheses

Analyze data

Design experiment

Collect data

Tomomi Suwa
Ecology and evolution of plant – rhizobia mutualism

GK-12 Fellow Tomomi Suwa

Alycia Lackey
Evolution, Ecology, & Behavior of Speciation

GK-12 Fellow Alycia Lackey

GK-12 Fellow Nick Ballew

Cultivating critical thinking skills: the benefits of implementing this critical thinking lesson.

GK-12 Fellow Nick Ballew
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Invertebrates in our research plots

- ants, bees, wasps
- hymenoptera
- snails & slugs
- gastropods
- butterflies & moths
- lepidoptera
- flies & mosquitoes
- diptera
- spiders, ticks, daddy long legs
- centipedes

Trapping invertebrates

- Sticky Trap
- Pitfall Trap

Collecting data:
count & categorize

Entering data:
Google forms

KBS GK-12 BEST Plot Data Form:
Invertebrate Biodiversity

Data Collection Method

- Sticky Trap
- Pitfall Trap

Prairie, unFertilized, unHarvested

Invertebrate orders present. Remember: count or lab. NOT ENTER RETURN if data is not available for this plot. Enter an "x" for missing in each field.

If Ants, Bees, Wasps (Hymenoptera); Prairie, unFertilized, unHarvested * enter 0 if none were present
Using real data in the classroom

Viewing data:
Google spreadsheets

Using real data in the classroom

Simplifying & Organizing data:
Automated spreadsheets

Using real data in the classroom

Simplifying & Organizing data:
automated spreadsheets

Using real data in the classroom

Analyzing and Interpreting data:
multiple levels of skill development

• Level 1
  – Graph given, Interpret

• Level 2
  – Graph given, Redraw graph, Interpret

• Level 3
  – Summary data given, Draw graph, Interpret

• Level 4
  – More complex data given, Calculate summary data, Draw graph, Interpret

Using real data in the classroom

Practice analyzing & interpreting data:
benefits of our approach

• Varied skill levels

• Focus on skills that need development

• Authentic research experience

Using real data in the classroom

Practicing the ENTIRE scientific process

Communicate results & conclusions

Develop questions & hypotheses

- Multiple hypotheses and predictions

Collect data

Design experiment

- Randomization
- Replication
- Control

Analyze data

- Graphs
- Statistics

Collect data

- Creating data sheet
Questions to ask on BEST Research Network

- How does productivity vary among treatments?
- Does insect diversity differ among treatments?
- How will legumes be affected by fertilization?
- After several years, which treatments will have more nitrogen in the soil?

An example at the Middle School/High School Level

Do some habitats have more insects than other habitats?

Hypotheses

Do some habitats have more insects than other habitats?

Design Experiment

Collect Data

Woods

Wetland

BEST Plots

Parking Lot

Data Analysis and Interpretation

Habitat | # Sticky Traps | Total Insect Abundance | Total Insect Richness
---|---|---|---
Woods | 10 | 468 | 10
Wetland | 11 | 948 | 7
Best Plots | 16 | 512 | 9
Parking Lot | 6 | 130 | 2

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**Fellows’ Perspective**

**Benefits**
- Comfortable with talking about our research
- Self-confidence
- Working in a collaborative team
- Become better scientists!

**Challenges**
- Unknowns in Science
- Low germination
- Weedy plots
- Data management in collaborative work
- Establishing long-term network within the framework of GK-12 funding period

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**Teachers’ Perspective**

**Benefits**
- Learn first-hand what is new and ongoing in science research and have engaging conversations with fellows.
- Increased enthusiasm for learning and teaching science, while changing the way teachers think.
- Most teachers are comfortable with science content. Many are able to perform “cookie-cutter” science labs. With the help of fellows, mentoring teachers become proficient using inquiry and relax with the unknowns.
- Teachers need more exposure to these relationships not less as the next generation of science standards calls out for greater student understanding of evidence and ability to reason claims.

**Challenges**
- Few are comfortable with the uncertainty of inquiry
- Incorporate BEST plot project in school curriculum K-12

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**Student and District Perspective**

- Students learn to see scientists as accessible people and have opportunities for adding to the science community as they begin to see themselves as scientists.
- Students gain renewed interest in “their” science through new inquiry lessons and heighten their ability to state claims, give evidence and reasons.
- School districts find GK-12 to be a time worthy investment and benefit from the newly generated curriculum, added materials, time spent in the community.

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**Project Materials Available:**

[Project Materials Available](kbsgk12project.kbs.msu.edu)

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**Michigan State University**

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