Urban Advantage

Formal-Informal Collaborations to Improve Science Learning and Teaching
How do you work with partners outside the school system?

• Who are your partners?

• How long have you worked with them?

• What do they provide?

• How are they funded to work with you?
How do partnerships help improve
TEACHERS’ PRACTICE
STUDENTS’ LEARNING
The goal of the Urban Advantage program is:

*To improve students’ understanding of scientific knowledge and inquiry through collaborations between public school systems and informal science education institutions.*
Students, teachers, and families do, think, and explore like scientists—both in and out of the classroom.
Metro Denver Urban Advantage is funded by the National Science Foundation's Discovery K-12 research program through grant #1020386
Urban Advantage is about students **doing science**
Scientific and Engineering Practices from the *new* Framework for K-12 Science Education

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics, information and computer technology, and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information
Urban Advantage - NYC Science Investigations

Scientific Investigation Display Board

- Question
- Hypothesis and Background Information
- Investigation Design
- Project Title
- Names of Students School name
- Materials and Procedure
- Results Data Tables Graphs
- Discussion Scientific explanation or argument
- Conclusion
- Literature Cited

Controlled Experiments Secondary Research Projects
Field Studies Design Projects
Question: What is the effect of a rotten apple on the condition of the apples around it?
UA Framework: Six Components

Professional Development
• Workshops for science teachers and school administrators

Classroom Materials and Equipment
• Science materials/equipment for schools, teachers, & students

Access to Institutions
• Vouchers for class field trips, family field trips and visits

Outreach to Families
• Public exhibitions of student work, family science events at institutions, support for school-based family science nights

Capacity-Building and Sustainability
• Lead Teachers, Leadership Institute, Demonstration Schools

Assessment
• Program goals, student learning, and systems of delivery
Teachers
• Immersion in inquiry workshops for new teachers
• Continuing teacher workshops

Administrators
• Science Leadership Breakfats
COMPONENT 2
Classroom Materials and Equipment

- Lighted plant growing environment
- Digital cameras
- Dissecting microscope
- Stopwatches
- Magnifying glasses
- Rock collections
- Field guides
- Thermometers
- Psychrometers
- Aquarium kit
- Designing rockets kit
- Water and soil field-test kits
COMPONENT 3
Access to UA Partner Institutions

- Class field trip vouchers
- Family field trip vouchers
- Student and Family vouchers
- Teacher vouchers
Component 4
Outreach to Families

- Family Science Sundays at Partner Institutions
- Parent Coordinator Workshops
- Family Science Nights at Schools
- Annual UA Science EXPO
COMPONENT 5
Capacity-Building and Sustainability

- UA Lead Science Teachers
- Leadership Institute
- Demonstration Schools
COMPONENT 6
Program Assessment and Student Learning

• Program assessment
  – Longitudinal program evaluation
  – Classroom observations
  – Teacher surveys and interviews
  – School visits

• Student learning
  – Science exit projects
  – New York State 8th grade Intermediate-Level Science Test
Outcomes of our work as partners

- Teacher professional development
- Instructional resources
- Redefining field trips
- Impact on teachers and students
Immersive Professional development
Workshops, field work, teams, place-based
Science Leadership Teams

Teams of teachers, administrators, parent coordinators, and UA partners
Investigation Design Diagram

Title:  
*Sample format:* The effect of (independent variable) on (dependent variable)

Research Question:  
*Sample format:* How will (independent variable) affect (dependent variable)?

Hypothesis:  
*Sample format:* I think (independent variable) will affect (dependent variable) because (explain why you expect/predict this relationship between the variables)

| Independent Variable: (or the “you change it” or “you choose it” variable) |
| Change in independent variable: |
| Number of repeated trials: |

| Dependent Variable: (or the “you measure it” variable) |

| Constant variables: |

Instructional Resources

Making science accessible
Leveraging resources of institutions
Linking science & literacy
RIVER ECOLOGY
Investigating the effect of zebra mussels on the Hudson River

New York State’s Hudson River has seen many changes, but perhaps none more dramatic than the arrival of the zebra mussel in 1991, and its rapid spread. Understanding environmental changes like this one means looking at the whole ecosystem: the web of interactions among organisms and their physical environment. Biologists at the Cary Institute of Ecosystem Studies have been studying the Hudson’s freshwater tidal ecosystem since 1987. They look for patterns and connections in order to understand how the river is changing, and might change in the future.

This website gives you access to the actual data these scientists have collected about the river: factors like the cloudiness of the water, its temperature, and how many and what types of organisms live in it. Use the graphing tool to look for patterns that connect the dynamic parts of this ecosystem. Can you help the scientists investigate the effects of the zebra mussel invasion?

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Explore the River
Learn about the history of the Hudson River and how scientists monitor the river’s tidal freshwater ecosystem.

Meet the Scientists
Using video and text passages, you can learn about the work of scientists at the Cary Institute who are studying the invasion of zebra mussels in the Hudson.

Graph the Data
Pick which factors you want to study and use this interactive tool to view them in relation to one another.

Analyze the Data
Can you tell which factors are related? Observe any patterns? Figure out how different parts of the Hudson River ecosystem are connected?

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This project is a collaboration between the American Museum of Natural History and The Cary Institute of Ecosystem Studies.

Funding for this web site provided by the National Science Foundation.
River Ecology Teaching Case
amnh.org/education/hudsonriver

Meet the Scientists

These video segments and text passages with discussion questions (listed below) provide a case study of the Cary Institute scientists at work on the river and in their labs. You can watch the video segments and read the passages to help answer the discussion questions. There is also a 7-minute video documentary feature of the Cary Institute scientists' work.

<table>
<thead>
<tr>
<th>Part 1: The Problem</th>
<th>(2:02)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage One: An Unwelcome Newcomer (Teacher</td>
<td>Student)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 2: Observation</th>
<th>(3:29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage Two: Zebra Mussels and the Hudson River (Teacher</td>
<td>Student)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 3: Results</th>
<th>(4:16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage Three: The Short-Term Impact of the Zebra Mussel Invasion (Teacher</td>
<td>Student)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 4: Going Further</th>
<th>(2:55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage Four: Long-Term Monitoring of the Hudson River (Teacher</td>
<td>Student)</td>
</tr>
</tbody>
</table>

**Documentary Feature** | (7:39) |
PASSAGE ONE

An Unwelcome Newcomer

Invasion of the Zebra Mussels

The zebra mussel is a small aquatic animal with two shells like a clam, named for its striped shell. This tiny creature may look harmless, but it can cause big problems. The zebra mussel is an invasive species, a species that’s brought from its native area to a new place where it thrives and causes changes in the local habitats and communities.

Zebra mussels once lived only in freshwater lakes and rivers of Europe and Asia. But in the 1980s, they appeared in the Great Lakes, and since then, they have spread to the Atlantic coast and many other places.
Graph the Data:

Over Time

1. Select a sampling station from the map below.
2. Click "Chart this location" to view data for that location.
First parameter: Zebra mussel (# animals/square meter)

Second parameter: Rotifers (# animals/L)

(Optional) Choose a “Split Date” to average the data:
- No split date (Show line graph, no averaging)
- Split Date #1: 1991.06.01
- Split Date #2: 2005.06.01 (optional)

Kingston

Bar graph showing data for Zebra mussel and Rotifers over different time periods:
- Average for December 31 1973 – May 31 1991
- Average for June 1 1991 – May 31 2005
- Average for June 1 2005 – July 30 2008

Legend:
- Zebra mussel (# animals/square meter)
- Rotifers (# animals/L)
Theory of Teacher Learning and Change

- Learning to use resources
- Learning by doing science
- Learning by watching others
- Teachers’ classroom practice
COMMON CORE STATE STANDARDS FOR

English Language Arts
&
Literacy in History/Social Studies, Science, and Technical Subjects

COMMON CORE STATE STANDARDS INITIATIVE
PREPARING AMERICA'S STUDENTS FOR COLLEGE & CAREER
CCSS Reading Standards 1 & 2

1) Cite specific textual evidence to support analysis of science and technical texts.

2) Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
CCSS Writing Standard 1

Write arguments to support claims with clear reasons and relevant evidence.

– Introduce claim(s) and organize the reasons and evidence clearly.

– Support claim(s) with clear reasons and relevant evidence, using credible sources and demonstrating an understanding of the topic or text.

– Use words, phrases, and clauses to clarify the relationships among claim(s) and reasons.

– Establish and maintain a formal style.

– Provide a concluding statement or section that follows from the argument presented.
Scientific and Engineering Practices

- **Crosscutting Concepts** that unify the study of science and engineering through their common application across fields

- **Disciplinary Core Ideas** in four content areas:
  - Physical sciences
  - Life sciences
  - Earth and Space science
  - Engineering, technology and applications of science
Middle School Life Science

Use a model to support explanations of the effect of resource availability on organisms and populations of organisms in an ecosystem.

<table>
<thead>
<tr>
<th>Science Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Developing and Using Models</td>
<td>• Interdependent Relationships in Ecosystems</td>
<td>• Cause and Effect</td>
</tr>
</tbody>
</table>
Use a model to support explanations of the effect of resource availability on organisms and populations of organisms in an ecosystem.

Emphasis is on cause and effect relationships between resources and populations in ecosystems in terms of changes in the numbers of individuals in the population during periods of abundant resources and scarce resources. Models may include representations of ecosystems and/or graphs and charts showing the flow of matter in food webs or food chains for which students explain the cause and effect of various events and/or conditions.
Developing a Scientific Explanation Tool (DSET)

What is the question?
What effect do zebra mussels have on phytoplankton in the Hudson River ecosystem?

Components of a scientific explanation

<table>
<thead>
<tr>
<th>Claim</th>
<th>Evidence</th>
<th>Scientific Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the answer to your question?</td>
<td>What is the raw data that supports a particular claim?</td>
<td>What are the scientific principle(s) that form a logical argument about the relationship between the claim and evidence?</td>
</tr>
<tr>
<td>Zebra mussels cause the concentration of phytoplankton in the Hudson River to decrease significantly...</td>
<td>Concentrations of phytoplankton in the Hudson River (measured in micrograms chlorophyll-a per liter) prior to the arrival of the zebra mussels in 1992 was between 15 and 17 micrograms per liter. After the zebra mussel became established in 1992, with a long-term average of approx. 1,300 zebra mussels per square meter, concentrations of phytoplankton were less than 5 micrograms chlorophyll a per liter...</td>
<td>Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with non-living factors. Growth or organisms and population increases are limited by access to resources. Zebra mussels are filter feeders that feed on suspended organic particles in the water, including phytoplankton. Based on the fact that zebra mussels depend on plankton for food, and that the graph shows that when the number of zebra mussels increased, the amount of phytoplankton (as indicated by chlorophyll) decreased, this supports our claim that the zebra mussels caused this decrease to occur.</td>
</tr>
</tbody>
</table>
Re-Defining Field Trips

Access to Science Institutions

Four Types of Vouchers
• School Group Vouchers
• Student & Family Vouchers
• Family Field Trip Vouchers
• Teacher Vouchers

AND
• Free Bus Transportation for Family Field Trips
RE-DEFINING FIELD TRIPS

METRO DENVER URBAN ADVANTAGE
MIDDLE SCHOOL SCIENCE
From an ill-defined free-for-all...

..to a way to spark inquiry and investigation.
Local science-rich institutions not just destinations—places for learning science
How can the museum, zoo, and gardens provide the *scaffolding* teachers need to connect back to the classroom?

Metro Denver Urban Advantage is funded by the National Science Foundation’s Discovery K-12 Research Program through grant # DRL 1020386.
Orientation Video

Demystifying
Clarifying
Fun

Metro Denver Urban Advantage is funded by the National Science Foundation’s Discovery K-12 Research Program through grant # DRL 1020386.
Field Trip Template

Scaffolding the experience—yet still open-ended and free choice.

Metro Denver Urban Advantage is funded by the National Science Foundation’s Discovery K-12 Research Program through grant # DRL 1020386.
Impact on Teachers & Students

Denver Efficacy Study
NYU Impact Evaluation
RESEARCH QUESTIONS

1. Impact of Urban Advantage on students
2. Impact of Urban Advantage on teachers
3. Impact of Urban Advantage on families
RANDOM ASSIGNMENT OF SCHOOLS

Urban Advantage

Comparison

THE METRO DENVER URBAN ADVANTAGE
MIDDLE SCHOOL SCIENCE
EFFICACY STUDY
Data Collection Efforts

- Standardized Student Science Assessment
- Pre-Post Student Science Assessment
- Pre-Post Student Surveys
- Pre-Post Teacher Surveys
- Post-only Parent Surveys

The Metro Denver Urban Advantage Middle School Science Efficacy Study
In FY13, 22% of all NYC middle schools participate in UA
Demographic Data:
UA Schools vs. non-UA Schools

Demographic Data - NY Citywide (FY2010) (Percent)

- Asian: 14.0
- Black: 30.0
- Hispanic: 15.0
- White: 1.0
- Other: 0.0

Demographic Data - UA Schools (FY2010) (Percent)

- Asian: 13.3
- Black: 40.2
- Hispanic: 12.3
- White: 0.4
- Other: 33.9

UA New York City
Language and Free/Reduced Lunch: UA Schools vs. non-UA Schools

<table>
<thead>
<tr>
<th>Limited English Proficiency</th>
<th>Free + Reduced Lunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA 11.5</td>
<td>UA 77.6</td>
</tr>
<tr>
<td>non-UA 14.0</td>
<td>non-UA 74.0</td>
</tr>
</tbody>
</table>

UA New York City
Raw performance data suggests UA is effective

Student Weighted Mean Achievement, 8th Grade Intermediate Level Science (ILS) Test – Percent Proficient

<table>
<thead>
<tr>
<th>Year</th>
<th>UA</th>
<th>Non-UA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>38.2</td>
<td>44.3</td>
</tr>
<tr>
<td>2005</td>
<td>44.0</td>
<td>44.0</td>
</tr>
<tr>
<td>2006</td>
<td>40.0</td>
<td>39.3</td>
</tr>
<tr>
<td>2007</td>
<td>44.2</td>
<td>40.5</td>
</tr>
<tr>
<td>2008</td>
<td>57.7</td>
<td>48.5</td>
</tr>
<tr>
<td>2009</td>
<td>55.5</td>
<td>46.2</td>
</tr>
<tr>
<td>2010</td>
<td>56.3</td>
<td>53.2</td>
</tr>
</tbody>
</table>
## Linear Probability Coefficients, High School Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β/s.e</td>
<td>β/s.e</td>
</tr>
<tr>
<td>Attending a STEM School</td>
<td>0.014*** (0.003)</td>
<td>0.008* (0.004)</td>
</tr>
<tr>
<td>Attending a Partial STEM School</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Taking Living Environment Regents in 8th or 9th Grade</td>
<td>0.255*** (0.012)</td>
<td>0.246*** (0.012)</td>
</tr>
<tr>
<td>Passing Living Environment Regents</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Passing Living Environment Regents with 65 or higher</td>
<td>0.040*** (0.006)</td>
<td>0.032*** (0.006)</td>
</tr>
<tr>
<td>Passing Living Environment Regents with 85 or higher</td>
<td>0.062*** (0.005)</td>
<td>0.054*** (0.005)</td>
</tr>
<tr>
<td>Taking Earth Science Regents in 8th or 9th Grade</td>
<td>0.039*** (0.007)</td>
<td>0.033*** (0.007)</td>
</tr>
<tr>
<td>Passing Earth Science Regents</td>
<td>0.029*** (0.0006)</td>
<td>0.012* (0.0006)</td>
</tr>
<tr>
<td>Passing Earth Science Regents with 65 or higher</td>
<td>0.059*** (0.007)</td>
<td>0.037*** (0.008)</td>
</tr>
<tr>
<td>Passing Earth Science Regents with 85 or higher</td>
<td>0.062*** (0.005)</td>
<td>0.054*** (0.005)</td>
</tr>
<tr>
<td>School Fixed Effects</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

* p<0.05, ** p<0.01, *** p<0.001

Robust clustered standard errors in parentheses

Control variables not shown are: Black, Hispanic, Asian, Female, Poor, Special Education, LEP, and for Model 1 lagged_zmath.
Post 8\textsuperscript{th} Grade Outcomes

- Students at UA schools were found to be 25.5\% more likely to take the Living Environment Regents exam in 8\textsuperscript{th} or 9\textsuperscript{th} grade and showed significantly higher levels of proficiency than students in non-UA schools.

- There is an increased probability of UA students attending STEM high schools.
Table Discussions

1. Choosing the “right” STEM partners to collaborate
2. Determining the curricular focus of a STEM partnership
3. Building and sustaining a STEM partnership program
4. Funding a STEM partnership program
5. Designing a STEM partnership program for scale
6. Assessing the impact of a STEM program on student learning and teacher practice