Integrating Chemistry and Local Earth Phenomena to Promote Environmental Literacy

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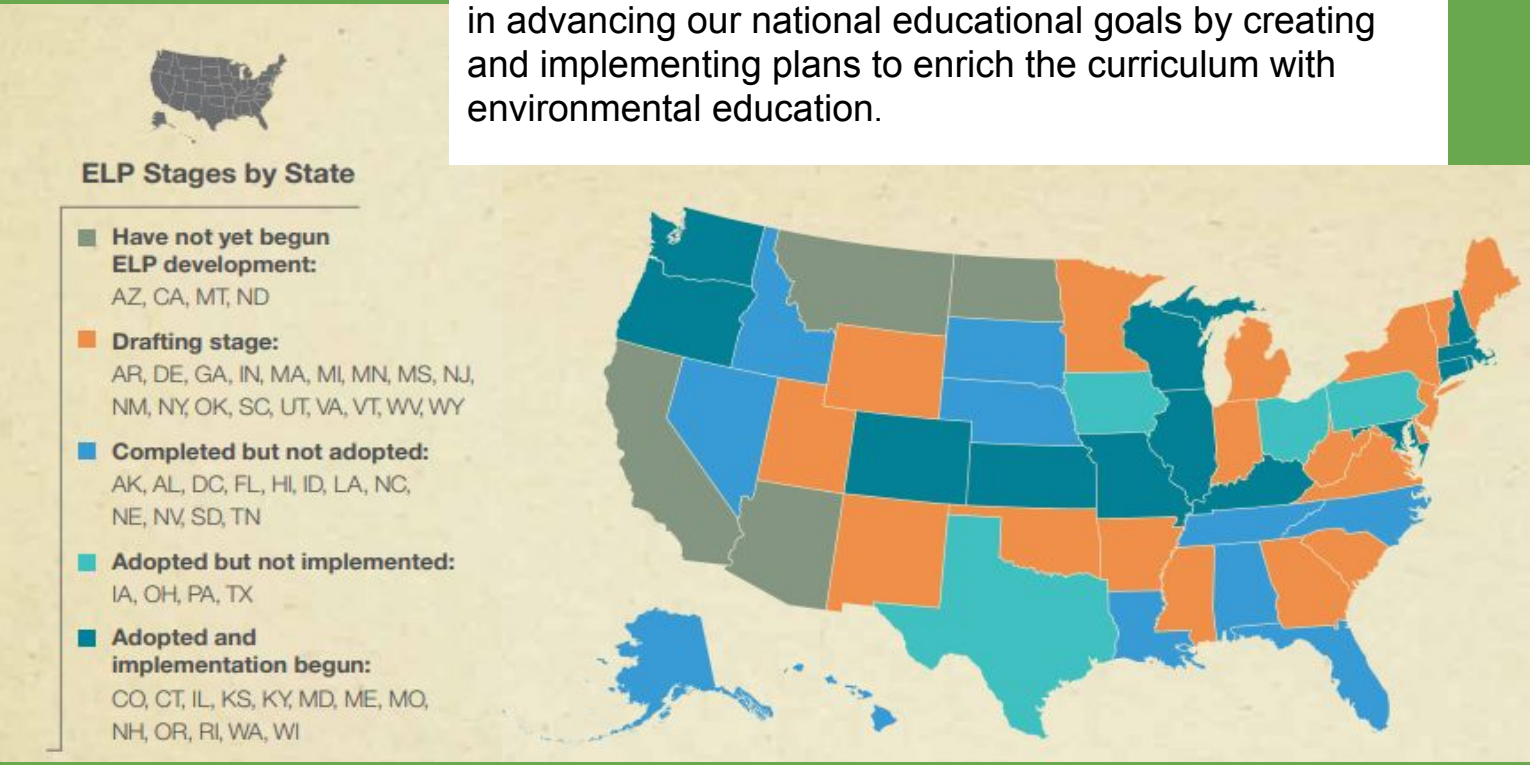
What is Environmental Literacy?

The North American Association for Environmental Education (NAAEE) defines environmental literacy as:

“An environmentally literate person is someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the wellbeing of other individuals, societies, and global environment; and participates in civic life.”

National Environmental Literacy

Across the nation, states are making significant progress in advancing our national educational goals by creating and implementing plans to enrich the curriculum with environmental education.



These plans to integrate environmental education into the K–12 curriculum will give teachers and students new opportunities to take learning outside; explore their communities; analyze issues; learn about connections between our economy, society, and environment; support economic growth; and become engaged citizens

State Environmental Literacy Plans;2014 Status Report. NAAEE. https://naaee.org/sites/default/files/2014-selp.2.25.15.a

Maryland Environmental Literacy Standards

Proposed Amended Environmental Literacy Standard Language
COMAR 13A.04.17.01

A. Each local school system shall provide in public schools a comprehensive, multi-disciplinary environmental literacy program infused within current curricular offerings and aligned with the Maryland Environmental Literacy Standards.

C. Environmental Literacy Standards

1. Environmental Issue Investigation & Action.
2. Human Dependence on Earth Systems and Natural Resources.
3. Environmental Impact of Human Activity.
4. Consequences of Environmental Change on Human Health and Well-Being.
5. Individual and Collective Responses to Environmental Change.

** May 2020 Proposal ** http://mdrules.elaws.us/comar/13a.04.17.01

Integrating Chemistry and Local Earth Phenomena

NSF funded Discovery in Research Prek-12

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Next Generation Science Standards require Earth science

Curriculum Development

Intensive Teacher Professional Development

Research into successes and challenges with integration:

- Teacher perspective
- Student perspective
- Student learning

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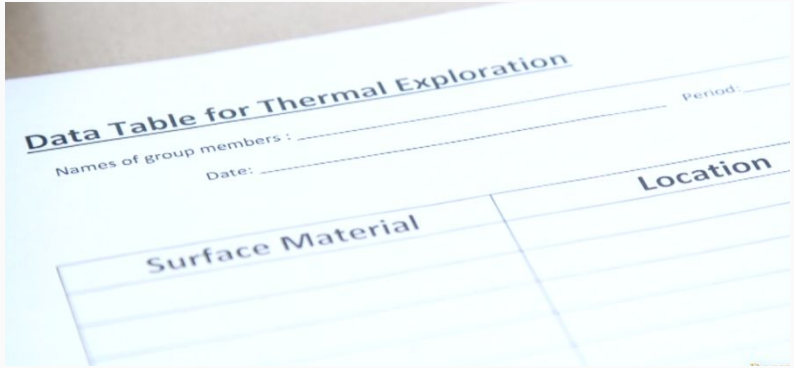
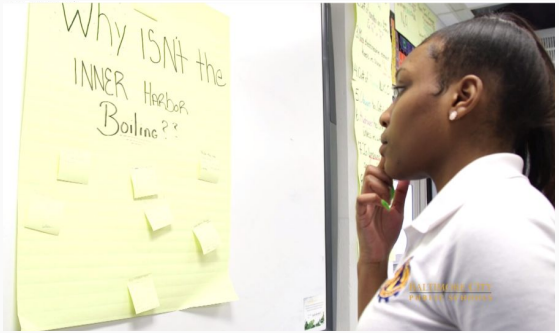
Evolution of Chemistry Curriculum

Pre 2017 –
- 6 unit chemistry course
- No Earth science



2017-2018 SY - ICE YEAR 1
- 7 unit new course
- Earth science in units 6 and 7
- Limited implementation

2018-2019 SY – ICE YEAR 2
- Revised curriculum
- unit 7 unfinished
- Mixed implementation



2019-2020 SY – ICE YEAR 3
- Revised curriculum
- Teacher supports developed
- New culminating activity
- Full implementation

Integrating Chemistry and Local Earth Phenomena Curriculum

Unit 4: Ocean Acidification

Phenomena:

What is happening to our oceans?

Driving Question:

1. What is causing the pH of the oceans to decrease?

Lesson Highlight: Oysters and Ocean Acidification

1. Students design investigation with pH and Carbon Dioxide and apply their findings to the effect of ocean acidification on shell-building organisms

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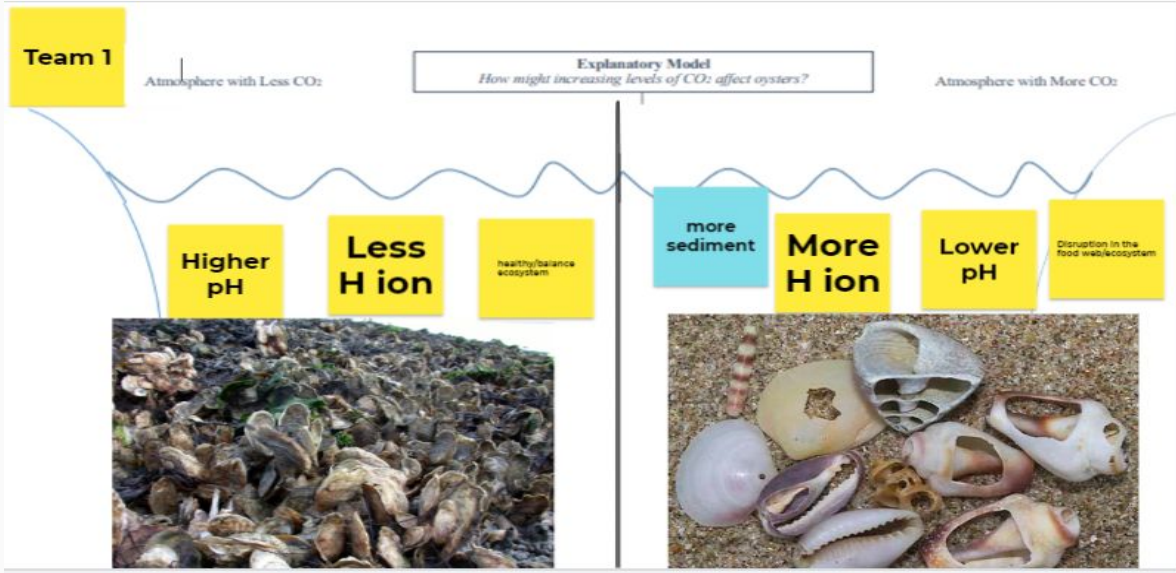
Students build an explanatory model on “How might increasing levels of CO2 affect oysters in the Chesapeake Bay”



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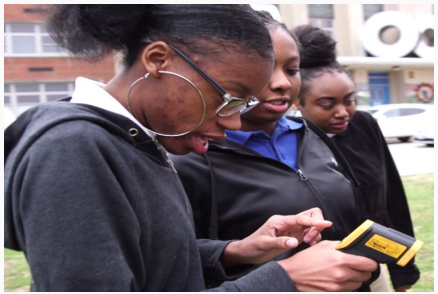
Unit 6: Thermochemistry

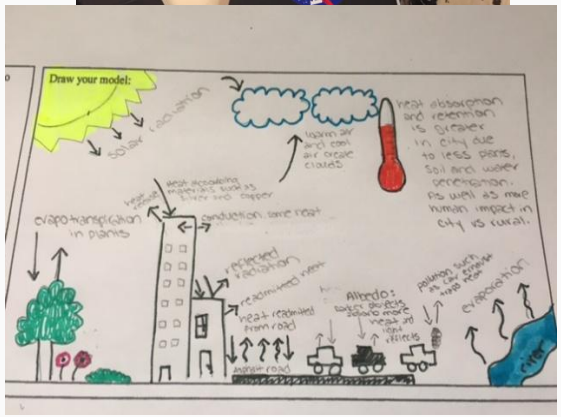
Phenomena:

What determines the temperature in Baltimore?

Driving Question:

1. What determines the temperature in Baltimore?





Lesson Highlight: Phenomenon of the Urban Heat Island (UHI).

1. Students explore temperature differences in the schoolyard with IR thermometers and develop preliminary conceptual models to explain the differences they observe.

2. Students then design investigations to compare the albedo and heat capacity of urban materials, analyze urban and suburban data from a heat wave and revise their conceptual heat budget models.

Students propose ways of decreasing UHI.

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Unit 7: The Life and Death of Baltimore's Mountains

Phenomena:

Why isn't Baltimore flat?

Where did Baltimore's mountains go?

Driving Questions:

1. What forms mountains and the rocks in them?
2. How are mountains weathered and redeposited?

Lesson Highlight: How Chemistry influences the life and death of Baltimore's mountains.

1. Students experiment with physical and chemical weathering of urban materials

2. Students observe evidence of these processes in the schoolyard environment

3. Students analyze local stream Chemistry data

Students then consider ways of slowing these processes based on their growing understanding of the chemical and physical processes involved.

Teacher Professional Development

Development Team Teachers (DTT)

- Year 1-2: 13 DTT's required to implement curriculum.
- Year 3: 4 teacher fellows- required to implement curriculum.
- Teachers provide feedback, student artifacts and data on the curriculum.
- Monthly meetings on research, collaboration and curriculum.
- Participated in ~100 hours of professional learning activities
- In class recordings and observations of curriculum.

County-wide Professional Development

- In just year 3 we offered:
  - 12 After- school PD sessions (~24 hours)
  - 5 Summer PD days (~30 hours)
  - 7 Happy hours PD sessions (~7 hours)
  - 3+ Systemic PD days (~10 hours)

Application to Distance Learning Professional Development

- In the last 3 months we have had weekly "Happy Hour" meetings on curriculum and distance learning platforms with Baltimore teachers.

Research: Challenges? What have we learned?

Watersheds

Students not distinguishing the difference between watershed and floodplain

Deposition

Students' responses showed the reverse of the correct deposition pattern

Earth's Heat Balance

Students need more support understanding heat transfer and storage.

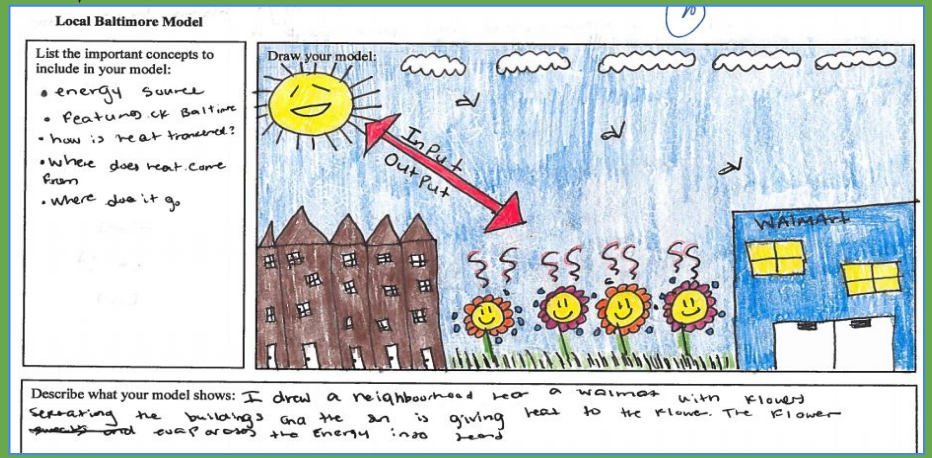
Process vs Mechanism

Difficulty defining the implications as well as differences between processes vs mechanisms

Weathering

- Erosion and weathering are often conflated
- Dissolving-chemical vs. physical weathering

Student Artifact:



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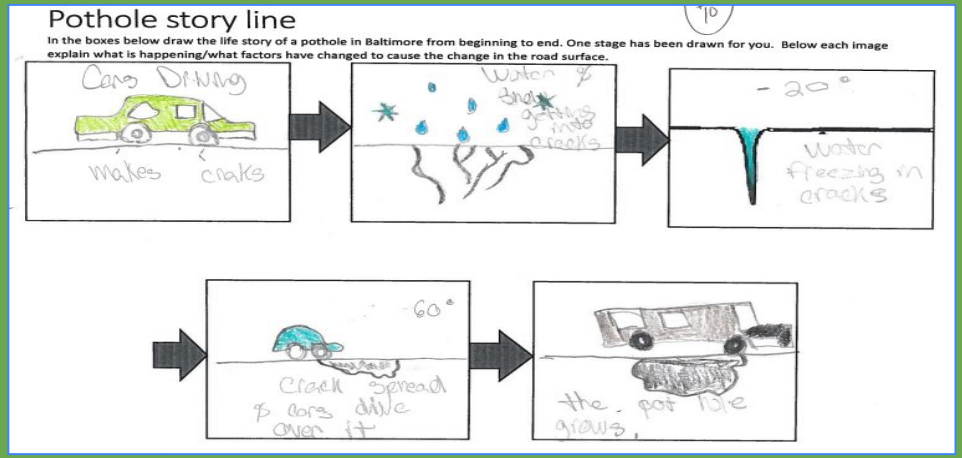

Research Successes with Integration

Interviews with teachers and students suggest that there is a high level of interest among many in the integration of Earth science into chemistry.

Results from 3-D teaching embedded and end-of-unit assessments reveal that students are able to make progress in moving towards mechanistic models and explanations.

The Integrating Chemistry and Local Earth Phenomena Curriculum will continue to be used in Baltimore City Public Schools.

Environmental Literacy and Our Curriculum

Maryland Environmental Literacy Standard	Integrating Chemistry and Local Earth Phenomena Curriculum
1- Environmental Issue Investigation & Action.	Issues discussed in our 3 units: ● Ocean acidification. ● Urban heat island (albedo). ● Impact of impermeable surfaces on water quality.
3- Environmental Impact of Human Activity.	Impacts discussed in our 3 units: ● Ice wedging and cause/effect of pothole formation. ● The chemistry of the matter that makes up the Earth. ● Reactions that cause temperature changes and equilibrium.
4- Consequences of Environmental Change on Human Health and Well-Being.	Consequences discussed in our 3 units: ● Current characteristics of the mountains of Baltimore to determine the conditions that affect stability and control the rates of change. ● Cause and effect of tectonic interactions. ● Chemical and physical weathering, erosion and deposition effects.

Questions?

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