EarthX – Advancing Earth Science Instruction Across High School Life and Physical Science

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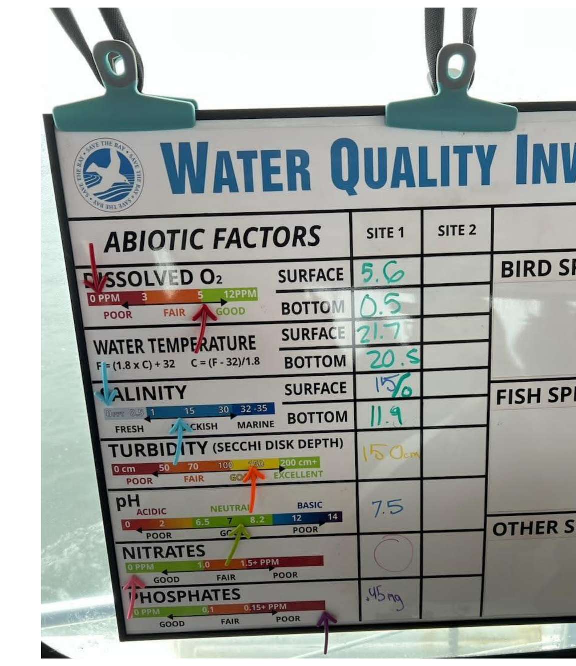

EarthX Overview

Synopsis:
EarthX is a collaboration of school district teachers and administrators, scientists and education researchers helping bring Earth science and compelling environmental phenomena into high school Biology, Chemistry, and Physics courses in Baltimore. *EarthX* is developing, testing, and refining beginning of course, embedded and unit assessments that will provide near-real-time feedback to teachers and students, in support of 3D teaching and learning. Assessment results will be used in the project's professional learning activities and supports, and to answer our research questions about teaching and learning.

EarthX Hypothesis and Questions

Our hypothesis:
Earth Science (ES) and life and physical sciences are complementary. *When provided sustained opportunities to engage in three-dimensional learning experiences, in an integrated Earth science and life or physical science context, students will improve in their ability to demonstrate the coordination of disciplinary core ideas, scientific practices, and crosscutting concepts when solving problems and developing explanations related to scientific phenomena.*

Our questions:

Overarching:
- How can partner collaboration leverage data on student performance and teacher practice to improve NGSS-aligned three-dimensional (3D), phenomenon-based, rigorous and responsive teaching and professional development for Earth science across the disciplines?

About teachers:
- How does teachers' understanding and implementation of phenomena-based, 3D instruction change over a multi-year extended professional learning experience?
- How does supported reflective practice shape teachers' classroom instruction?
- How is teacher instruction shaped by phenomena-based, 3D professional learning experiences?
- How is teacher instruction shaped by analysis of student learning artifacts and data?

About students:
- How do students' 3D, Earth science performances improve over the course of a year and over the Biology, Chemistry, Physics sequence in response to teachers' repeated use of 3D assessments to guide their instruction?

EarthX Advisory Board

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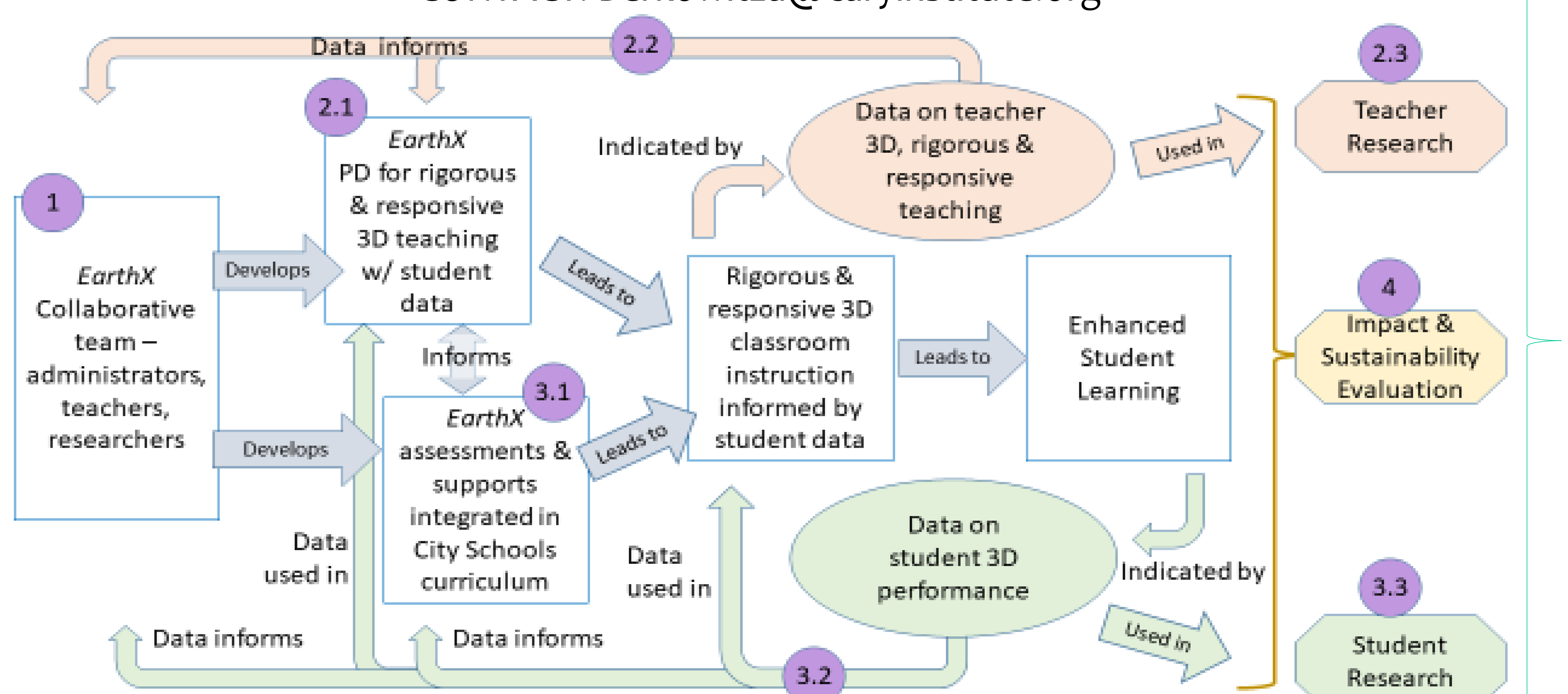


EarthX Assessment Engagement Cycle with Design Team Teachers

1 *Teachers complete assessment*

What Would Happen If We Cut Fossil Fuel Use In Half?

Students in Mr. Yousef's class were learning about how carbon dioxide (CO_2) concentrations in the atmosphere change over time. Mr. Yousef showed students the graph below. The solid line shows global CO_2 concentrations between 1960 and 2016.

He asked students, suppose the world suddenly cut the use of fossil fuels (coal, diesel, gasoline, natural gas, etc.) in half and kept usage at that level. If nothing else changed, what would happen to atmospheric CO_2 concentrations over the next 50 years? Some students shared their ideas—the dotted lines on the graph below.

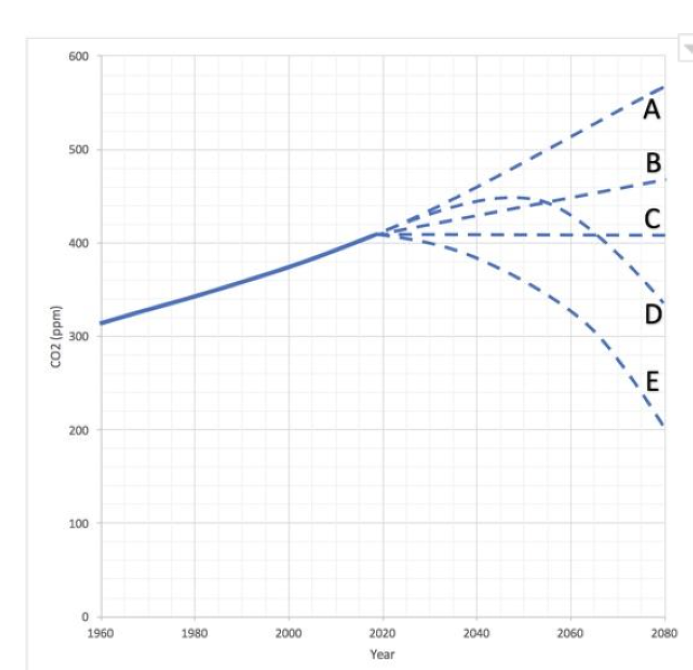
Jin (A on the graph) thinks CO_2 concentrations will continue to increase at a similar rate because of other sources of CO_2 such as deforestation, population growth, and volcanoes.

Latisha (B) thinks CO_2 concentrations will continue to increase, but more slowly, because we will still be releasing CO_2 into the atmosphere, just not as much.

Alana (C) thinks that CO_2 concentrations will level off because there is less pollution.

Maya (D) thinks CO_2 concentrations will continue to increase for a while, then decrease as the CO_2 begins to dissipate in the atmosphere.

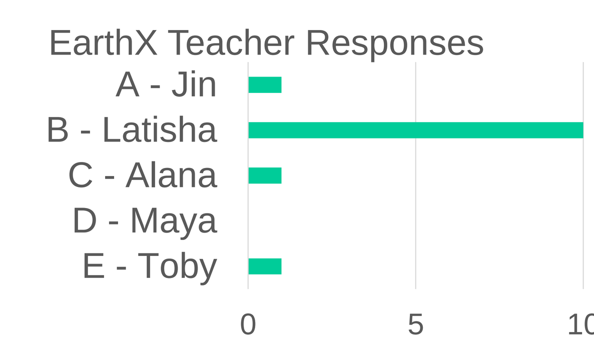
Toby (E) thinks CO_2 concentrations will decrease by half (to around 200 ppm) because cutting emissions by 50% will lead to CO_2 concentrations decreasing by 50%.



A: Jin, B: Latisha, C: Alana, D: Maya, E: Toby

Which student's answer do you agree with the most? Explain why you think their answer provides the best prediction for what would happen to atmospheric CO_2 concentrations over the next 50 years.

2 *Teachers consider their responses*



3 *Teachers sort student responses*

Inform	Novice	Intermediate	Goal
(Maya, D) We would be producing less CO_2.	(Alana, C) Reducing our fossil fuels would help reduce pollution which would help.	(Jin, A) I think it would help if the use of fossil fuel was cut in half but there would be other factors like factories and cars that would still contribute to the cause so it would help but it wouldn't have a major impact.	(Latisha, B) The combustion of fossil fuel will continue to add CO_2 in the atmosphere. Reducing it will not stop combustion adding CO_2 in the air.
(Toby, E) They should decline about as fast as they rise if they are cut in half.	(Maya, D) It won't start to decline after one day because we really need to completely cut fossil fuel for it to start to decline.	(Maya, D) Damage has already been done but after a long time it will decline and the earth will return back to a somewhat natural state.	(Latisha, B) Although we're reducing our use of fossil fuel. It's still burning the fossil fuel. The CO_2 will grow slowly but not decline.

4 *Teachers discuss next instructional moves*

5 *Teachers identify assessment and teacher guide design, implementation and support specifications.*

EarthX Goals and Objectives

Goal 1. Build and nurture a strong Research-Practice Partnership

Goal 2. Develop and test disciplinary and cross-disciplinary professional learning (PL) strategies for supporting effective Earth science teaching in high school Biology, Chemistry, and Physics classes.
- Objective 2.1 - Develop intensive and extensive PL strategies through several cycles of implementation and improvement.
- Objective 2.2 - Collect data on teachers' practices and classroom discourse for: 1) use in PL, 2) assessing the impact of PL on teacher practice for improving PD, and 3) scale-up and sustainability at the district level.
- Objective 2.3 - Address our teacher research questions about teacher practice.

Goal 3. Develop learning progression-aligned, embedded and summative 3D assessments of student performance that can support rigorous and responsive teaching about phenomena in the local-to-global environment at the interfaces between Earth science and Biology, Chemistry, and Physics.
- Objective 3.1 - Develop assessments through several cycles of implementation and improvement.
- Objective 3.2 - Support use of assessments for informing 1) rigorous and responsive instruction, 2) PL strategies and supports, and 3) scale-up and sustainability of District student assessment.
- Objective 3.3 - Address our student research questions about students' Earth science learning across time.

Goal 4. Bring EarthX strategies to scale, resulting in transformative, phenomena-based 3D instruction across the District.
- Objective 4.1 - Document how data on student performance, teacher practice, and PL outcomes are used by the District for district-wide adoption of innovation.
- Objective 4.2 – Document what supports are needed at the teacher, school, and District levels to implement EarthX effectively across the District.
- Objective 4.3 - Examine research questions about the sustainability of the EarthX innovations.

EarthX Assessment Targets x Courses

Topic	Biology	Chemistry	Physics
Global change	Fossil fuel formation	Heat capacity & albedo of urban materials	Geoscience data for predicting climate
	Baltimore resource use past, present, future		
Natural resources	Soil quality in different Baltimore neighborhoods		Baltimore then & now – energy sources & impacts
Water quality	N vs. P sources & inputs to receiving waters (eutrophication)	Ocean acidification, oyster growth & decay	Forces & movement of streambed rocks & sediments
		Weathering of urban surfaces & stream chemistry	
The air & the land	Carbon cycle & trophic structure of ecosystems	local & global weather systems driven by density and pressure	Physics of radiation transmission, reflection & absorption
	Oxygenation of the atmosphere by plants		
Landforms	Water budgets & pathways in local watersheds	Maryland igneous rocks dated using half-lives of radioactive isotopes in them	Meteor impact & formation of Chesapeake Bay
	Formation of soils by land plants, animals, microbes	Plate tectonics and Baltimore's earth history	S and P waves reveal the structure of the inner earth

Cary Institute of Ecosystem Studies | GW | University of Montana | Baltimore Ecosystem Study | Berkeley University of California | Baltimore City Public Schools | NSF

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