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Diversity Conference: Crystal City, Virginia Apr 29

Designing and Implementing Teacher Professional Development that Connects Social Justice and STEM Integration

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ASEE CoNECD Conference
April 30th, 2018

UNIVERSITY OF NOTRE DAME
Center for STEM Education

Goals



- Describe an adaptation of an *Engineering is Elementary (EiE)* unit focused on social justice
- Describe the professional development workshop designed and implemented around the *EiE* adaptation
- Provide formative evaluation findings as well as data from teacher participants who have used workshop materials/ideas in their classrooms
- Discuss implications and future work

Background and Context



- STEM Teaching Fellowship:
 - 2.5 year program, three summers/two years
 - Cohort model; ~30 teaching fellows every year

Background and Context



- STEM Teaching Fellowship:
 - Teachers apply in school teams of 3-4; typical composition includes both science and mathematics teachers, mostly middle school
 - Three main strands: STEM Integration, Core Teaching Practices, Schoolwide STEM Strategic Plan

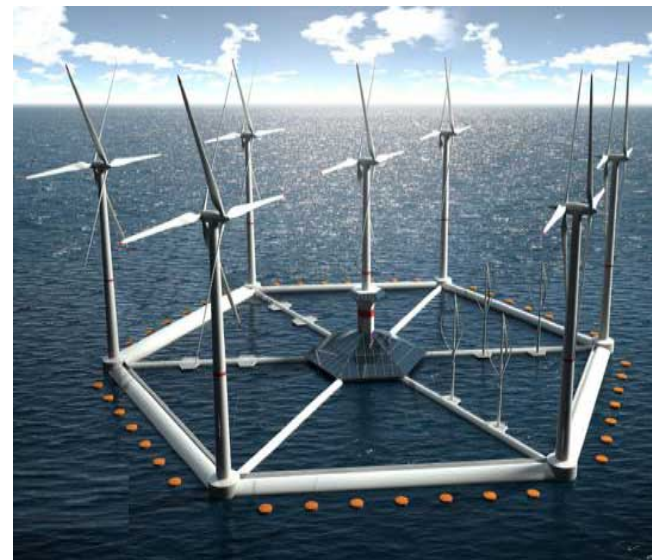
Background and Context



- Approach to STEM Integration Strand
 - Experience STEM integration as learners
 - Reflect and unpack as educators
 - Introduce tools, strategies, and templates to empower teaching fellows to engage their students in STEM Integration
- Summer 1: Platform Design
- Summer 2: Flint Experience

Summer 1: Platform Design

- Based on First Year Engineering project
- Problem Statement: Design, build, test, and revise a floating platform to support a specific weight.
- Context: Verde Industries/ floating wind turbines
- Goal: Immerse STEM Teaching Fellows in a truly integrated STEM experience



Summer 1: Platform Design



- Science concepts: density, forces
- Mathematics concepts: algebraic formulas, measurement
- Engineering concepts: engineering design process, optimization



Summer 2: Flint Experience

- Based on EiE Water Filters Unit
- Problem Statement: Design a whole-house water filter for homes in Flint, MI
- Context: Flint Water Crisis
- Goal: Immerse STEM Teaching Fellows in an authentic, social justice oriented STEM Integration Experience



Summer 2: Flint Experience

- Science Concepts:
Experimental design
- Mathematics Concepts:
Box and whisker plots,
data analysis and
representation
- Engineering Concepts:
engineering design
process, optimization



Flint Experience



- Workshop lasted 6.5 hours
- Session One: Introduce context and explore data from Flint homes
- Session Two: Collaborative calibration table generation
- Session Three: Informed design and iteration

Flint Experience: Session One



- Presentation of Flint story
- Detailed Problem Statement
 - Designing whole-house filters for homes in Flint
 - Design parameters/materials/constraints
 - Working *collaboratively*, not competitively
- Activity: Exploration of actual data from Flint homes



| SampleID | Zip Code | Water | Pb Bottle 1 (ppb) - First Draw | Pb Bottle 2 (ppb) - 45 secs flushing | Pb Bottle 3 (ppb) - 2 mins flushing | Notes |
|----------|----------|-------|--------------------------------|--------------------------------------|-------------------------------------|-------|
| 1 | 48504 | 6 | 0.344 | 0.226 | 0.145 | |
| 2 | 48507 | 9 | 8.133 | 10.77 | 2.761 | |
| 3 | 48504 | 1 | 1.111 | 0.11 | 0.123 | |
| 4 | 48507 | 8 | 8.007 | 7.446 | 3.284 | |
| 5 | 48505 | 3 | 1.951 | 0.048 | 0.035 | |
| 6 | 48507 | 9 | 7.2 | 1.4 | 0.2 | |
| 7 | 48507 | 9 | 40.63 | 9.726 | 6.132 | |
| 8 | 48503 | 5 | 1.1 | 2.5 | 0.1 | |
| 9 | 48507 | 9 | 10.6 | 1.038 | 1.294 | |
| 10 | 48505 | 3 | 6.2 | 4.2 | 2.3 | |
| 11 | 48507 | 9 | 4.358 | 0.822 | 0.147 | |
| 12 | 48505 | 5 | 24.37 | 8.796 | 4.347 | |
| 13 | 48505 | 2 | 6.609 | 5.752 | 1.433 | |
| 14 | 48503 | 7 | 4.062 | 3.099 | 1.085 | |
| 15 | 48507 | 9 | 2.484 | 0.72 | 0.565 | |
| 16 | 48507 | 9 | 0.438 | 1.046 | 0.511 | |
| 17 | 48503 | 5 | 1.29 | 0.243 | 0.225 | |
| 18 | 48504 | 6 | 0.548 | 0.622 | 0.261 | |
| 19 | 48504 | 2 | 3.131 | 0.674 | 0.683 | |
| 20 | 48504 | 6 | 120 | 239.7 | 29.71 | |
| 21 | 48505 | 1 | 2.911 | 0.406 | 0.237 | |
| 22 | 48505 | 5 | 16.52 | 10.26 | 2.762 | |
| 23 | 48505 | 1 | 1.984 | 1.13 | 0.712 | |
| 24 | | | | | | |

Flint Experience: Session Two

- Water filter models and “contaminated” water introduced
- Each team given a combination of filter materials to test
- Discussion of experimental design and testing protocols



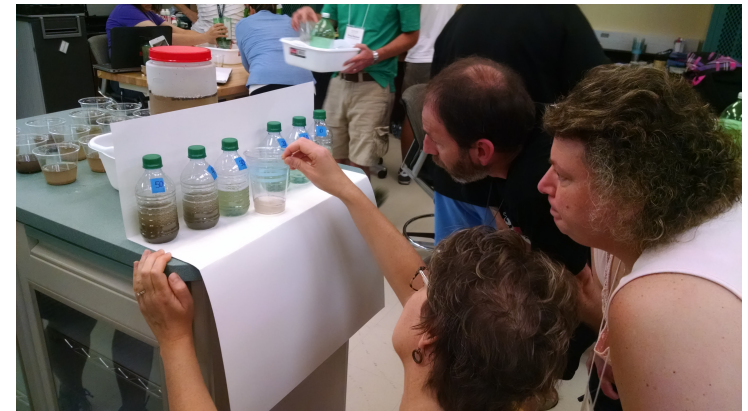
Flint Experience: Session Two

- Run filter material tests, recording flow rate and water quality
- Enter data onto collaborative Google spreadsheet
- Analysis and presentation of data using Box and Whisker plots



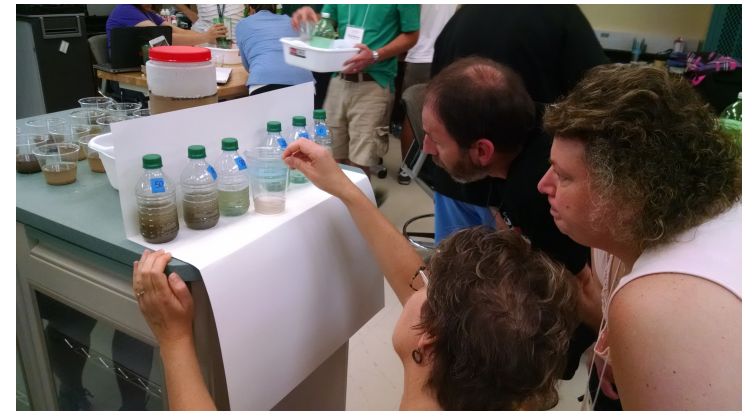
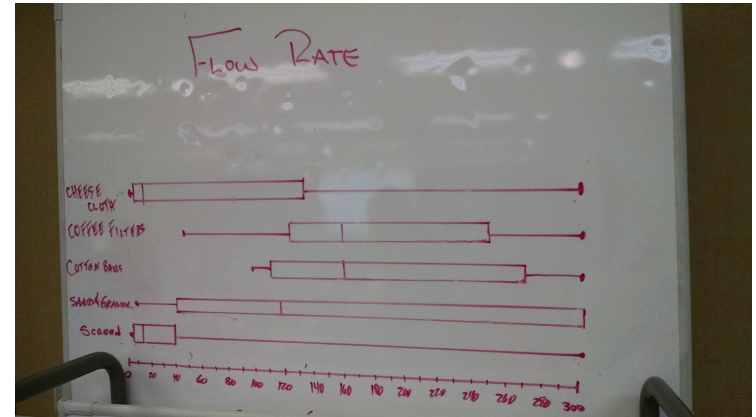
Flint Experience: Session Three

- Use Box and Whisker plots to inform design decisions for filter materials and set up
- Teams built filters and tested them
- Data recorded, discussed as whole group, then teams went on to design a second iteration



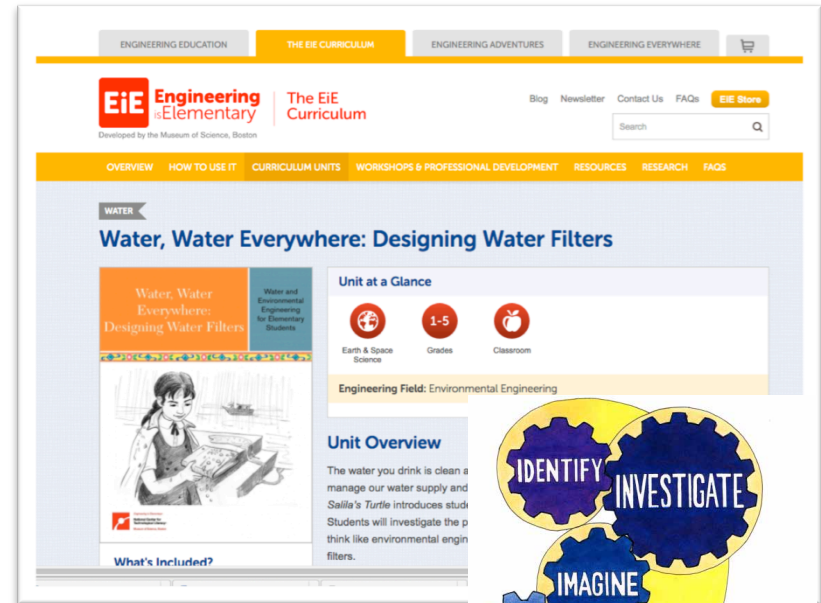
Flint Experience: Session Three

- Each team made a final recommendation to the City of Flint
- Each engineer completed an Engineer's Reflection at the end of the experience



Developing the Flint Experience

- Context: Salila's Turtle and water purification
- Leveraged materials, activity structures, and other ideas from the EiE unit
- Drew on the middle school version of the EiE Engineering Design Process
- However, changed context to be potentially more engaging for middle school students



Developing the Flint Experience



- Flint Water Study
 - Citizen science effort that helped prove the water in Flint was dangerous
 - FWS shared the actual data spreadsheet from their study
 - Teachers engaged with the spreadsheet to ask a question, generate a data visualization (graph), and tell a story with the data.

Developing the Flint Experience



- Authentic STEM Integration
 - Authentic science practice: experimental design
 - Authentic mathematics practice: generating box and whisker plots, and using the information to inform decisions
 - Authentic engineering practice: design, build, test, revise filter design

Developing the Flint Experience

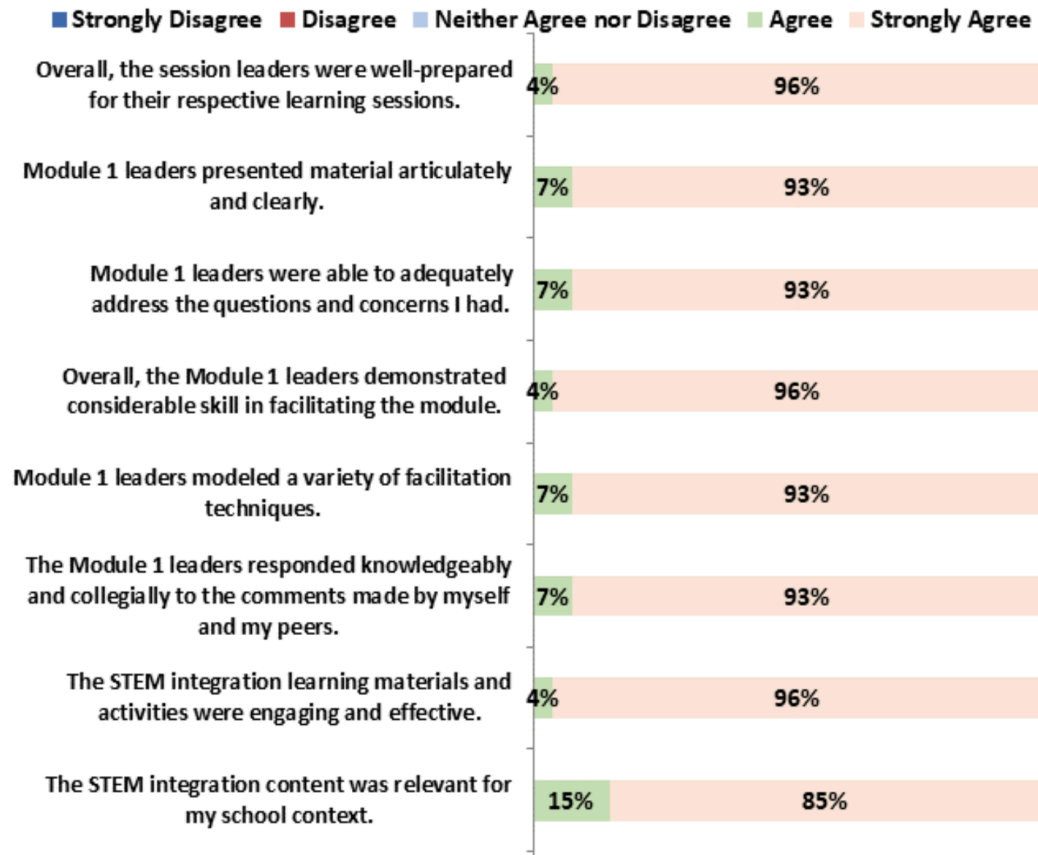


- Collaboration, not competition
 - In Summer 1, there was definitely more competition with the Platform Project
 - Profound reaction to the collaborative effort to improve lives and make a difference in Summer 2

Formative Evaluation Data



- STEM Teaching Fellows found the workshop overwhelmingly effective.



Formative Evaluation Data



- STEM Teaching Fellows found the workshop overwhelmingly effective.

“It was really awesome to partake in a STEM Integration that was structured differently (collaborative rapid prototyping was amazing and really pushed for collaboration with the entire class for a common goal).”

Formative Evaluation Data



- STEM Teaching Fellows found the workshop overwhelmingly effective.

“It was very clear that our facilitators were well-prepared to facilitate the STEM integration module in Summer 2. Providing the real-world context, and taking us through the process first as learners, then breaking it down as teachers worked really well and helped me learn new strategies to engage students in a real-world problem-solving scenario. Specifically, one new technology strategy I hope to use in the future is the collective/collaborative data sheet in Google Docs. I also think the connections made to the other modules and general sessions was useful (connecting to CRP, and focusing on assessment).”

Formative Evaluation Data



- STEM Teaching Fellows found the workshop overwhelmingly effective.

“I really enjoyed how [the instructor] makes things hands-on and really did a good job getting us to connect to the problem in order for us to take on more ownership of the work we did. I think once we were able to put things into perspective, it made the issue mean that much more to us. By implementing the culturally relevant study into our exploration, we were able to step outside of where we are, live, and comfort zones in order to see how blessed we are and ways in which we can make someone else's experience better through STEM.”

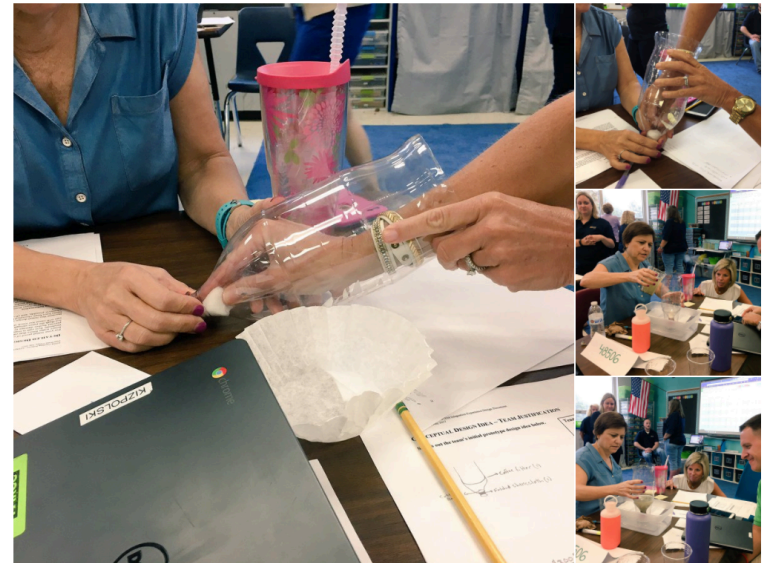
Follow up with Teaching Fellows



- Two school teams had done the Flint experience with their faculty as a PD

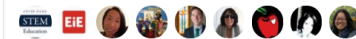
 **Sean F. Sweeney**
@MrSweeneyCBE Follow ▼

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10:41 AM - 9 Oct 2017

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Follow up with Teaching Fellows



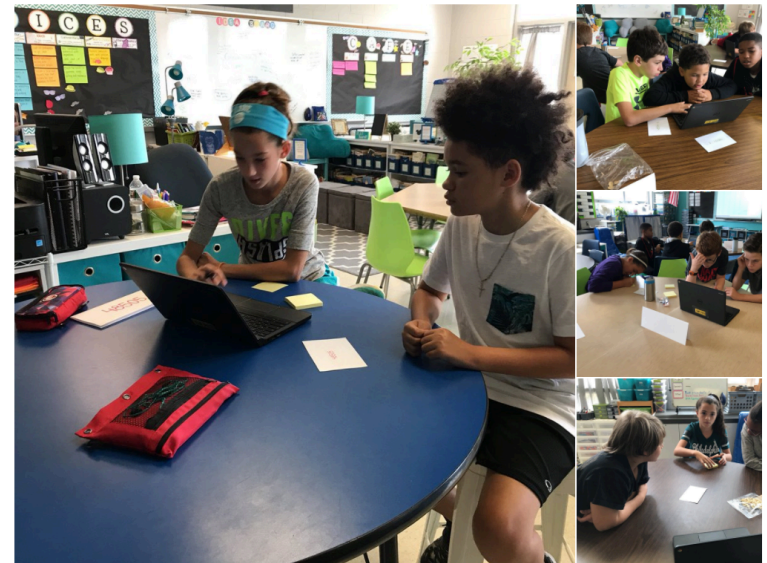
- Two school teams had done the Flint experience with their faculty as a PD
- At least three school teams have implemented the Flint experience with their students, with three more planning to do so in the spring semester (over 50% of the cohort)



Jenn Taylor
@CBE_MrsTaylor

Follow

Investigating Flint Water Study data and asking questions @STEMatND @ClaraBartonElem



10:32 AM - 23 Oct 2017

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Follow up with Teaching Fellows



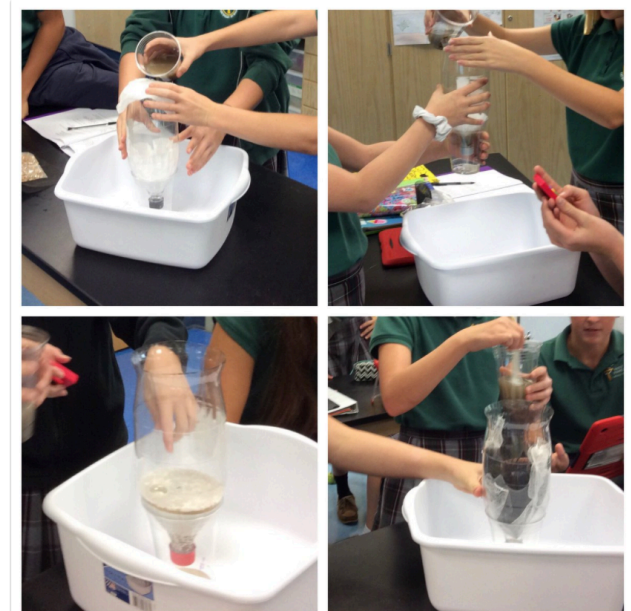
- Two school teams had done the Flint experience with their faculty as a PD
- At least three school teams have implemented the Flint experience with their students, with three more planning to do so in the spring semester (over 50% of the cohort)
- At least two teachers have also re-contextualized the Flint experience with local water quality stories (in Coastal Florida and in Coal Country) to make it more relevant to their students



YSalom
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Designing a pollution control technology to limit pollutant discharges from industries: Saving Florida Sea Turtles
[@STEMatND](#) [@EiE_org](#)



7:13 PM - 23 Oct 2017

1 Retweet 12 Likes



- The value of engaging teachers as learners as part of a Professional Development session
 - Remembering what it's like to be a student
 - Feeling an emotional connection to the context
 - Seeing the integration of STEM disciplines as a force for good
 - Reflection on activities as educators is much more meaningful

- A social justice context for STEM integration can be powerful
 - Ownership of learning
 - *Changing the Conversation (NAE, 2008)*
 - Empowered agents of change

Future Work



- Continuing to explore social justice oriented contexts for EiE units
- Advancing a framework that weaves together social justice and STEM Integration
- Continuing to follow up with STEM Teaching Fellows

Thank you!

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