Supporting Urban Science Teachers In Making Instructional Decisions To Facilitate Project-Based Learning for All Students

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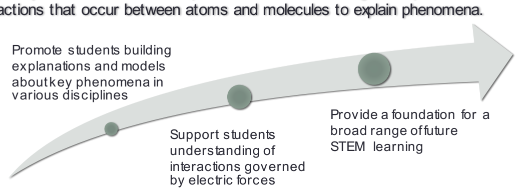
Project Summary

- This work is part of a larger study tasked with developing and testing an interdisciplinary curriculum to support high school students in developing integrated understanding of disciplinary core ideas, scientific practices and crosscutting concepts related to forces and interactions that occur between atoms and molecules to explain phenomena.



- Our study features the development of a multi-phase, blended professional learning program to support teachers in integrating equitable teaching practices with three-dimensional instruction. To address our research question, we follow two teachers who participated in our program while implementing the project-based, three-dimensional curriculum, Interactions.

Research Context

- Our study focuses on two teachers working in different schools in the Los Angeles Unified school district.
  - 10th grade Physics classroom in a public school with predominately Latinx students
  - 10th grade Chemistry classroom in a public school with predominately Latinx students
- Each teacher also participated in a year long professional learning program with two additional LAUSD teachers that included a summer training institute, a collaborative, virtual professional learning community, 3 weekend workshops and in-person instructional coaching sessions.

Interactions Curriculum

- Designed to support high school physical science students in developing an understanding of the forces and energy involved in atomic and molecular forces.
- Students engage with observable phenomena to explore disciplinary core ideas. Students build understanding of these ideas within and across units, and develop/revise models to help explain scientific phenomena. Each unit, investigation, and activity is organized around a driving question to focus student learning.

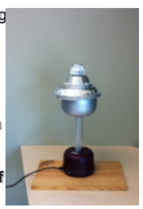


Figure1: Van de Graaff

- **Unit 1: Why do some clothes stick together when they come out of the dryer?**
  Students develop and revise models of electrostatic interactions that help them explain electrostatic phenomena (see figure 1).
- **Unit 2: How does a small spark start a huge explosion?**
  Students add to their electrostatic models by incorporating the relationship between electric potential energy and electric forces.
- **Unit 3: What powers a hurricane?**
  Students use their models of molecular structure to explain and predict observed properties of materials and compare energy transformations that occur during phase changes and chemical reactions.
- **Unit 4: Why is a temperature of 107 degrees deadly?**
  Students explore how molecular interactions in water based environments are important for life and result in shapes necessary for biological functions. Students describe how a fever can disrupt biologically important molecules (proteins).

Research Question

- How can implementation of an educative, project-based, three-dimensional science curriculum paired with a sustained, blended professional learning program impact teacher's instructional decisions and support student learning?

Blended Professional Learning Program

- We grounded the professional learning program in research on effective teacher professional development. Considerable evidence identifies five features of effective professional learning programs including [1]content focus, [2]active learning, [3]coherence, [4]sustained duration, and [5]collective participation.
- Our year long professional learning program included intensive support during the first semester, and moderate support during the second semester (figure 2).

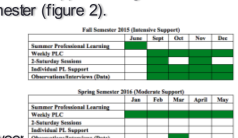


Figure 2: PLS Overview

- Professional learning activities included:
  - **Summer training institute**
    Focus on content, 3D instruction and the Interactions curriculum.
  - **Weekly, virtual PLC**
    Five teachers met weekly and alternated between two activities: each teacher actively participated by presenting student work, and through a weekly book study using *NGSS for All Students* (figure 3). Discussions in the PLC focused on promoting equity.
  - **Weekend workshops**
    Weekend workshops revisited content from the summer institute, and drew upon PLC conversations.
  - **Instructional coaching**
    Each teacher participated in individual instructional coaching sessions after classroom observations during the semester with intensive support.

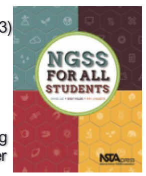


Figure 3: Study Book

Data Collection and Analysis

- **Data collection**
  - During Intensive support, data included video recorded professional learning sessions, video recorded classroom observations, audio recorded interviews and audio recorded instructional coaching sessions. The instructional coach also recorded field notes during observations.
  - Data collected was organized into "teaching episodes" which included a pre and post observation interview, and 250 minutes of continuous instruction.
- **Data Analysis (Curriculum)**
  - We first conducted an analysis of the Interactions curriculum using section I of the EQuIP rubric to determine whether the curriculum was truly aligned to all three dimensions, and supported coherence within and between units
  - We also evaluated the curriculum for instructional supports that may promote equity using the *Framework for Inclusive, Three-dimensional Science Classrooms.*
- **Data Analysis (Instruction and Professional Learning)**
  - Classroom video was analyzed using *The Framework for Inclusive Three-dimensional Science Classrooms* and for features of Project-Based Learning. Summaries were developed for each lesson where these instructional techniques were integrated.
  - Audio-recorded interviews and professional learning sessions were analyzed for changes in how teachers talked about their instruction, and for reflections on integrating project-based learning with inclusive science instruction.
  - Chronological case-studies were developed for each teacher based on these summaries, and excerpts from each teacher's final fall teaching episode were selected for presentation in the findings section.

Evidence-Based Results

Nathan:

- Nathan's goal in improving instruction was to elicit knowledge from students and support them in generating thoughtful questions.
- In this lesson, Nathan engaged students in two aspects of project based learning: 1) Centering instruction around a driving question, and 2) engaging students in scientific practices.
- In developing his own digital, anonymous Driving Question Board, Nathan was able to elicit ideas and questions from students by giving them voice in an online space.
- To elicit further ideas and experiences from students, Nathan prompted students to ***"Think of one piece of evidence that you have from your life that you have observed to support that claim".***

Nathan's Instructional Goal:

"That's where I think I've been disappointed in the past is trying to get students to ask questions. They are not used to having to express ideas in words. I have to keep pushing to try to get more out of them, and it's kind of a new experience for them"

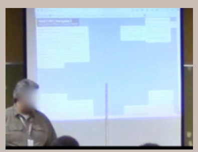


Figure 5: Nathan – Demonstration

Figure 4: "*Does air have mass?*" The Syringe Activity

Mark:

- Mark goal in improving his instruction was to center students in discussions by becoming a strong facilitator.
- In this lesson, Mark engaged students in two aspects of project based learning: 1) engaging students in scientific practices, and 2) facilitate collaborative activities.
- By asking students to review the work of peers and facilitating a class discussion of "what constitutes evidence?" Mark centered student ideas, validated their contributions, and allowed them to develop classroom knowledge as a community.
- The Mystery box lesson facilitated understanding of evidence-based explanations and positioned students as generators of knowledge by allowing them to determine *"What is evidence?"*

Mark's Instructional Goal:

"I want to show the class I am a strong facilitator they can depend on" "In my traditional teaching - when it was silent it meant… I needed to fill it. But now if I am supposed to build off their knowledge and I don't have a question already prepared, I feel like a fool"

Figure 6: "*What is evidence?*" The Mystery Box

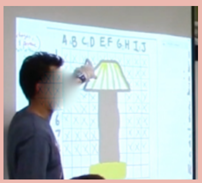


Figure 7: Mark – Class discussion

Implications and Impact

- We know that both curricular materials and professional learning opportunities can influence the instructional decisions that teachers make. Aligning goals of professional learning programs with research-based curriculum can support teachers in making instructional decisions that support their individual student's science learning needs.
- Scale-up: In 2017, Nineteen additional teachers from LAUSD and twenty teachers across Michigan participated in our professional learning support during Interactions implementation. Currently, our curriculum and professional learning support is being implemented with two-hundred and fifty K-12 teachers in the Detroit Public Schools Community District.