# Learning to Teach with Phenomenon-based Lessons in the High School Science Classroom

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**Abstract:** This study explores a teacher professional development program for high school science teachers. Teachers participated in collaborative planning tasks to learn about phenomenon-based instruction. The goal of the study is to understand the extent to which teachers' conceptions of phenomenon-based instruction were influenced by their participation in these tasks. We report themes that emerge from changes in teachers' thinking after participating in the program.

## Introduction

*A Framework for K-12 Science Education* (the Framework) and the *Next Generation Science Standards* (NGSS) have led to a series of shifts in science education across dozens of states in the US (National Research Council [NRC], 2012; NGSS Lead States, 2013). Among the changes promoted in these documents is the use of science phenomena to support students with developing an understanding of three dimensions of science: 1) disciplinary core ideas, 2) science and engineering practices, and 3) cross-cutting concepts (Osborne, Rafanelli, & Kind, 2018). In what has been coined "phenomenon-based teaching", educators enacting *NGSS*-aligned instruction are expected to use real-world, observable events or processes to anchor their lessons and support students with using the three dimensions to construct explanatory models (Penuel et al., 2019). Phenomenon-based teaching has the potential to engage students' sense of wonder (Hadzigeorgiou, 2012), promote student sensemaking (Odden & Russ, 2018), and support culturally relevant science teaching (Brown, 2019).

While teachers are expected to plan lessons that promote sensemaking about real-world phenomena, research suggests that teachers face significant challenges when planning to anchor their lessons with phenomena. Lo et al. (2014) found that teachers tended to select phenomena to teach discrete science topics rather than phenomena that would require the use of multiple science ideas and practices to construct explanatory accounts of the phenomenon under study. These findings are in line with research that suggests that instructional practices can be notoriously difficult to change, especially when shifting from teacher-centered to more student-centered approaches (Cohen, 1988).

This study explores the extent to which high school science teachers' conceptions of phenomenon-based teaching change after participation in a comprehensive professional development (PD) program. The two-week program introduced teachers to the concept of phenomenon-based teaching, had teachers participate as learners in a phenomenon-based learning experience, and placed teachers in content specific groups to collaboratively plan phenomenon-based learning sequences for their students. This process allowed for teachers to learn from interactions with their collaborating teachers (Bannister, 2015) while engaging in an activity that was situated in the authentic practice of teacher planning (Putnam & Borko, 2000).

## Methods

This study took place at a large, private research university located on the West Coast. The PD program spans two-years, with teachers participating in two weeks of full day, on-site learning for each summer in the program. Teachers also participate in individual coaching sessions with an experienced coach and collaborative sessions with their coach and fellow content teachers throughout the school year. This study examines the first two-week on-site summer session with 21 high school science teachers from various regions across the United States. All participants had 2-7 years of teaching experience and identified as working in urban school contexts. Data sources include video-recorded observations of program activities, open-ended surveys that were completed by the teachers at the beginning and end of the two-week experience to capture their conceptions of phenomenon-driven instruction, program artifacts like presentations and documents prepared by session leaders, and photographs of all teacher-produced artifacts. The author is currently still in the process of analyzing the data. This process included a thematic analysis of pre and post open-ended survey items. After reading through each survey to get a sense of responses as a whole, an inductive codebook was created and each survey was subsequently coded (Glaser & Strauss, 1967). Themes from the pre and post survey codes are currently being generated in order to identify patterns in teachers' conceptions of phenomenon-based teaching before and after the learning experience. Following survey analysis, the author plans to use video data to study how teachers' conceptions of phenomenon-driven instruction may have been influenced by their interactions, including discourse and gesture, during collaborative group planning with peers.

 

## Preliminary findings

Preliminary coding of the teachers' pre and post surveys have indicated a number of changes in teachers' responses about phenomenon-based instruction. Major themes that emerged from the data are *changes in teachers' definitions of phenomena, changes in rationale for phenomena use,* and *changes in types of phenomena selected.*

Changes in teachers' definition of phenomena: When asked to define science phenomena, teachers initially provided a range of answers, including phrases like phenomena are "proved in science", are "difficult to explain," or "I do not understand." After their experience in the program, teachers had a much more unified vision about science phenomena, with a large majority of the teachers defining phenomena as an "observable event" or "process" that allowed students to apply or "use science concepts" to construct explanations.

Changes in rationale for phenomena use: In their pre survey, teachers frequently described that they use phenomena in order to "cover" the science ideas that they needed to teach in their curriculum or to uncover student "misconceptions". After their experience in the professional development program, teachers described that they believed phenomena could be used to engage students using culturally relevant, interesting, or familiar phenomena to foster student sensemaking.

Changes in types of phenomena selected: When teachers were asked to select phenomena that they would use in their instruction, many teachers responded with science topics or concepts, like endosymbiotic theory, or tasks, like engineering challenges, instead of observable science phenomena such as an apple falling from a tree. After their participation in the program, many teachers were able to name science phenomena that were relevant to the science ideas that they were hoping to teach in their courses, such as a soda can imploding after transferring from a hot to cold water bath. Additionally, many teachers mentioned that they were able to learn about new phenomena by collaborating and sharing ideas with their peers in the program.

## Conclusions and implications

As the author continues with data analysis, interactions from the video data will be used to elaborate on changes in teachers' thinking about phenomenon-based instruction as they engaged in collaborative planning tasks. The results of this work have implications for both teacher education and professional development as science educators work to align classroom instruction with the NGSS.

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