Professional Development of Science Teachers in Underserved Communities: an Initial Report from the Field

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Abstract: This paper presents a preliminary study regarding the first phase of a large project that aims to develop a constructionist-based teacher training for public school settings in Sobral, Brazil. We illustrate the initial change that four science middle-school teachers went through after participating in training and co-designing lesson-plan's for their classrooms. The goal of this study was to explore teachers' initial changes in the form of instructional practice, by the end of the training phase.

Introduction

In the past few years, major international and national efforts have been made to develop new science standards (e.g. NGSS, Common Core in the US, and more recently BNCC in Brazil). Although the new standards emphasize a series of higher order goals and learning expectations essential for effective K-12 STEM learning (Glenn, 2002; Wise, 2001), they offer few suggestions on how teachers are to achieve these skills, leaving teachers feeling like they are missing instructions. Studies have shown that if the goal is to develop a sustainable innovative curriculum, the process of implementation must be prioritized (Fishman et al., 2003). In addition, it is important to involve teachers in designing learning materials for their own classrooms (Kali et al., 2015). Using the co-design approach, teachers can be supported in the design and implementation of educational innovation in "a highly-facilitated, team-based process in which teachers, researchers and developers work together" (Penuel, Roschelle, & Shechtman, 2007). In this work, we present a preliminary study of the first phase of the "Sobral Science Project," a program aiming to develop a curriculum and improve science learning as part of the city's commitment to achieve levels of excellence in basic education. We describe here the proof-of-concept phase, intended to become a prototype that will be scaled up to the entire city's educational system.

Context of the study

Sobral science project

The city of Sobral is located in the state of Ceará, Brazil (population ~ 200,000 people). The public school system includes 55 schools, serving 22,000 students. This project was initiated by the secretariat of education of Sobral to redesign the science curriculum of the city's K-9 public schools. In 2017, a collaboration with a US-based research university team was established to reform the curriculum and teaching of science in Ceará.

Timeline of the "Sobral science project" initial phase

The first phase of the project included 4 main stages, summarized in the following timeline:

- ***Stage 1.*** *Training at a US research institution* (May/17): Sobral's secretary of education, a professor from a local university, and a teacher who leads teacher trainings in the city attended a 1-week training in the US, focused on "Strategic Planning, Design and Implementation of Educational Makerspace Programs."
- ***Stage 2.*** *Introductory workshop in Sobral* (August/17): Researchers led a 2-day workshop for teachers and policy makers in Sobral. During the workshop, teachers defined a curricular unit to be redesigned using the co-design approach and then implemented in the classroom during the last quarter of the year.
- ***Stage 3.*** *Weekly redesign meetings* (August-November/17): The process of redesigning the units was supported by researchers through online meetings. Using the Backward Design framework (Wiggins et al., 2011), teachers identified "big ideas," learning goals, and alignment with science curricular standards.
- ***Stage 4:*** *Implementation of the redesigned curricular units in the classroom and reflection* (November/17): During this phase, teachers were encouraged to discuss the implementation of the unit in their classroom and reflect on the new presented approach.

Methods: Setting and data sources

Researchers worked in collaboration with four teachers (two male and two female) from different schools in the municipality of Sobral. Teaching experience ranged from six to fifteen years. Data presented here refers only to teachers who participated in Stages 2-4. Data was collected from periodic conversations with teachers and self-assessment instruments. Data was analyzed using standard techniques in the field (e.g. theory-driven top-down verbal analysis) (Chi, 1997).

Preliminary findings and discussion

Preliminary results focus on how teachers changed, based on two categories: 1. instructional practices and 2. assessment practices. Below, we provide examples of teachers' change in a continuum between traditional and constructionist practices.

- *Change in teachers' instructional practices from traditional to constructionist:* Teachers reported that they usually started the lesson by reading the textbook or presenting a lecture, followed by exercises. When a practical activity took place, there was usually a "cookbook" procedure to be strictly followed, where teachers demonstrated an experiment and students observed. After the experiment, students copied the experimental procedures and conclusions written by the teacher on the blackboard. After the first phase, teachers unexpectedly started to try more action-based activities in their classrooms. For example; Teacher #4, who started to pose open-ended questions for students' reflection instead of asking them to copy from the blackboard.
- *Change in teachers' assessments practice from traditional to constructionist:* Assessment of students' learning was originally based mainly on homework activities and students' performance in prescribed tasks, such as answering textbook questions after instruction, or taking standard exams. In this first phase, we observed teachers beginning to transition towards more progressive, formative assessments, where they would assess students' previous knowledge or pose questions, so that students could construct their knowledge with the teacher's mediation, rather than by instruction only.

Conclusion

Our preliminary results suggest that an initial impact on teachers' practices was illustrated mostly with the resources they used to teach, and on how they assessed students' learning. We observed changes in teachers' classrooms, including transitions from focusing on readings, lectures and exams, to a more constructionist approach, based on inquiry and reflection. These observations are consistent with theories about teachers' change after professional development programs, indicating that there is a continuum in teachers' change that includes a few steps: changes initially occur in teachers' classroom practices, followed by changes in student learning outcomes, which ultimately leads to a change in teachers' beliefs and attitudes (Guskey, 2002).

Endnotes

(1) The two first authors contributed equally to the work.

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