Examining the Role of Unpacking 3-Dimensional Teaching and Learning in Museum-Based Professional Development

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Abstract: The purpose of this study is to examine changes in teachers' attitudes and behaviors towards three-dimensional instruction after participation in a Museum-based professional development program. The study design includes a pre- and post-survey measuring attitudes towards three-dimensional instruction along with observation rubrics and facilitators' field notes. A preliminary analysis of early data is used to describe implications of applying the "backwards design" model in professional development.

Introduction

The international shift towards three-dimensional (3D) teaching and learning (NGSS Lead States, 2013), requires using and applying knowledge, skills, and abilities to make sense of scientific phenomena and/or design solutions to problems (National Research Council, 2012). Central to this transition is the view that disciplinary core ideas, science and engineering practices, and crosscutting concepts are intertwined and work together to advance students' learning through 3D instruction. Accordingly, teachers need guidance to (re)develop their classroom pedagogy to better align with the newer demands of teaching science. To address this need, a large, urban science museum has developed and facilitated professional development (PD) courses for teachers to (1) gain information about 3D instruction and (2) develop strategies directly relevant to the process of unit/lesson planning for a next generation science classroom. The purpose of this study is to better understand the change in participants' attitudes and behaviors towards teaching aligned with three-dimensional practices, upon participating in the PD. Our research question is, "What impact does participation in a science-museum based PD program have on its participants' attitudes towards key concepts and subsequent behaviors aligned with three-dimensional instruction?"

Literature review

Science-focused PD for teachers is central to student achievement and ensuring overall successful science education reform. High quality professional development will produce superior teaching in classrooms, which will, in turn, translate into higher levels of student achievement. Informal science education institutions, such as museums, are increasingly active in providing teacher PD (NRC, 2009). Providing teachers a space to construct knowledge and develop skills and abilities that align with new reforms is important for achieving successful student outcomes. While there are a few professional development opportunities being developed to support 3D teaching and learning, many offer educators resources without a process/strategy to achieve lasting changes in teachers' practical knowledge.

The Understanding by Design framework provides guidance for curriculum planning process/strategy through a three-staged approach also commonly known as *backwards design* (Wiggins & McTighe, 2005). This process emphasizes (1) identifying desired results, (2) highlighting acceptable evidence, (3) planning learning experiences and instruction to meet the goals. Engaging in these steps allows educators to align activities and assessments with learning performances, as learning goals, to gain a better understanding of "knowledge in use", a key idea in the learning science (Krajcik, McNeill & Reiser, 2007)

Methods

The studied teacher PD program takes place at a large urban science museum for six day-long sessions spread across an academic school year. Participants were selected according to school need and requested to attend in groups. This cohort consists of 3-4 teachers and one school administrator from 12 primary schools in the USA. The PD focused on unpacking 3D learning standards and then rebuilding domain and practical knowledge into three-dimensional, conceptually coherent unit and lesson plans using the principles of backwards design. An example of the process used to model this approach with participants appears in Figure 1.

Data collection

A pre survey addressing science related attitudes, teaching behaviors, and three-dimensional (3D) instruction was administered prior to the start of the course. Items related to 3D instructional practices were taken from an instrument developed by Hayes et al. (2016) to measure the use of 3D teaching and learning with in-service teachers (hereafter: 3D scale). Attitude and behavior specific items on the survey were adopted from the Dimensions of Attitude towards Science (DAS) instrument (van Aalderen-Smeets & van der Molen, 2013). All four sections of the survey consist of items in a five-point Likert format. A post survey will be administered after the last session in March and data will be analyzed prior to the conference proceedings. Additionally, observation rubrics were designed to understand the facilitators' process of explaining the unpacking model during the PD and to identify potential learning barriers. The rubric included categories associated with each item in the Hayes, et al. (2016) survey. A researcher observed the first 2 sessions and took field notes. (The final session will be observed prior to the conference proceedings.) Following a design-based research (DBR) process (Barab & Squire, 2004), data from the observation rubrics and facilitators' notes informed an iterative design process employed by the program facilitators who made continuous research based design changes to the PD. The notes were open coded to identify themes in the changes made in the iterations.

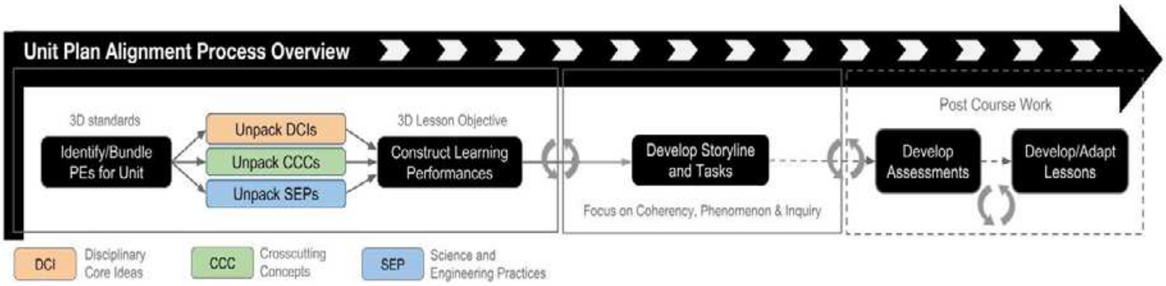

Figure 1. PD model to explain unpacking process.

Preliminary results

The observation rubrics and field notes reflect five major themes in the changes made during the course iterations: increasing scaffolds, tapping into prior knowledge, modeling instruction/providing examples, increasing collaboration within teams and outsourcing additional resources. Each of these evidence-based ideas are known to reinforce learning and may improve teachers' ability to understanding and apply the process described in Figure 1. in their classroom.

Fifty-four participants completed the pre-survey, representing 12 schools. 7 were administrators and 47 were teachers. Pre-survey composite scores were aligned with the prior year's study of a similar PD course that did *not* have a focus on 3D instruction, indicating the population of this program is similar to traditional PD populations at this institution. With the post-survey results in hand, we will be able to determine what impact the 3D-specific changes described here had on overall attitudes of teachers.

Implications

3D teaching and learning presents a challenge for supporting teachers through PD, and little research exists on that specific PD focus (Hayes, et al., 2016). In this paper we report on a PD that was iteratively developed using backwards design methods, and which is aimed at providing teachers with the skills to use backwards design with 3 D standards. We expect that once we collect post-survey data, findings from this study will show how unpacking 3D standards to (re)build aligned unit/lesson plans using a backwards design approach can promote 3D instruction. This PD model may provide a principled approach for addressing the complexities called for by new visions for science education.

References

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