What Professional Development Program Features Influence Teacher Knowledge?

PD INVENTOR (Professional Development Inventor Models and Outcomes for Science Teachers)

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Background and Introduction

- Teachers have single largest effect on student academic gains
- Specifically, the teacher knowledge
- Need both SMK and KOSM to be effective
- KOSM is an essential component of PCK
- Teachers undergo PD to become more effective than before
- Hundreds of millions of dollars spent towards goal
- Does it achieve the desired goal?
- Very few large-scale studies of PD program effectiveness
- Tend toward small-N sizes, local effects
- Outcome measures are tailored to specific programs, limiting generalizability

Data Collection Methods

Surveys was administered during the summers of 2015 and 2016 to 18 participants of PD programs aimed at K-12 science teachers.

1858 geographically distributed participants responded to the pre- and post-survey, representing 227 different PD sessions from a total of 63 different providers.

Home Zip Codes of Participants in Analysis

Measured participant SMK and KOSM with a series of multiple choice questions covering the subjects and grade-relevant K-12 NRC science standards:
- Received credit for their SMK for correctly answering the question.
- Received credit for their KOSM for correctly answering the question (as above) and also correctly identifying the most common student misconception (defined as the single incorrect answer chosen by more than 50% of students who got it wrong).

The pre-survey also asked about the participants’ educational history and teaching experience. The post-survey included questions about how the PD program was conducted, with a large focus on the frequency of various common features.

Does attending a PD program help participants increase their SMK and/or KOSM, on average?

Linear Model of Gains

Constructing the model: Regression models for SMK and KOSM gains were constructed in parallel, constrained to use the same predictors. Starting with the previous non-significant predictors were iteratively removed until all remaining predictors were significant for at least one of SMK and/or KOSM. This process was then repeated with the provider-controlled variables added. The overall model was parsed down to the final form, below.

Participant-level vs Provider-controlled: The top half of the model describes variables which the participant, their background, and other factors that a prospective PD provider cannot easily control. The bottom half (below the dashed line) describe variables which the provider can directly and easily adjust, such as the content of the PD and how it is delivered.

Things that were not found to be significant:

- Participant-level: whether participant degree or certification was in a related field to the subject of the PD program; the highest level of achieved degree (i.e., Bachelor’s vs. Masters, etc.).
- Provider-controlled: whether the program was conducted as an online, outright, or day program; who was involved in presenting the PD program; and whether the perceived goal of the program was to increase participant knowledge of SMK, PCK, or curricular knowledge. Notably, program duration (in days, from 1-20) was not found to have any significant association with either SMK or KOSM gains.

PD features: including learning reformed pedagogies like Inquiry-Based Learning techniques, Active Learning activities, or Modeling Method of Instruction activities; learning strategies for incorporating science content, cross cutting concepts, or science and engineering practices into the science curriculum; participating in lectures or workshops led by either research scientists or science educators; learning strategies for using simulations, collecting and analyzing data, or accessing and interpreting information from the internet with students in the classroom; conducting scientific research; or collaborating with colleagues in the same domain, grade, or geographic area.

Program effectiveness:

- Does attending a PD program help participants increase their SMK and/or KOSM, on average?
- Tend toward small-N sizes, local effects
- Outcome measures are tailored to specific programs, limiting generalizability
- Key Findings:
  - Focus on teaching foundational concepts in the sciences
  - Improve teacher SMK and KOSM through PD by maintaining a focus on foundational concepts throughout the program.
  - Strive for creating new content that allows PD to be more meaningful and effective.

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