Collaborative Research: PROfessional Development and Uptake through Collaborative Teams (PRODUCT) Supporting Inquiry Based Learning in Undergraduate Mathematics

PROJECT OUTCOMES REPORT—December, 2021

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For five years, the PRODUCT project has offered high-quality professional development (PD) workshops about teaching to college mathematics instructors across the US. The workshops focused on inquiry-based learning (IBL), an approach to mathematics that engages students in thinking about rich, open-ended mathematical tasks, sharing ideas and solutions with peers, and refining their ideas through discussion. As a teaching approach, IBL offers instructors flexibility to adapt its core principles or "four pillars" to diverse student audiences, classroom settings, and personal teaching styles. The benefits of IBL for students have been demonstrated by prior research, and the professional development workshops were carefully designed in alignment with research on PD. In this way, good professional development that effectively prepares instructors to teach with these research-proven methods can have a powerful and positive effect on college students' success in mathematics courses and on their ability to achieve their goals, earn college degrees, and enter STEM and other professions.

Our collaborators from the Academy of Inquiry Based Learning (AIBL) planned and provided the professional development. Fourteen intensive summer workshops reached 359 instructors, and 24 traveling workshops reached about 500 instructors at conferences or individual institutions. The AIBL team included 29 skilled IBL instructors. Our team gathered and analyzed data for evaluation and research. These data were used in many ways: to provide feedback to improve the workshops, to document the outcomes of the workshops for participants and facilitators, to capture insights about how the IBL workshops generated these outcomes, and to understand how PD and other factors may influence instructors' teaching practices.

For the intensive workshops, data from longitudinal surveys and pre/post-workshop classroom observations of participating instructors show statistically significant changes in their teaching practices toward greater use of IBL-associated practices (Figure 1). At least 65% of all participants implemented some form of IBL in the first year after attending a workshop, reaching an estimated 17,500 students in just the first year. Four strands of workshop content address instructors' needs to develop a mental model of IBL teaching, learn IBL facilitation skills, develop supportive beliefs about students and learning, and plan an IBL course. Four core practices of the facilitators are identified as contributing to the workshops' high impact: fostering interaction and building community; organizing resources and planning ahead; modeling inquiry teaching and learning; infusing equity and inclusion into classroom and PD practice.

The data from this project were combined with prior data sets to form a large sample of workshop data across a ten-year timespan. This large data set allowed our research team to develop a statistical model to explain the impact of intensive professional development on teaching (Figure 2). While there was variation in how people implemented IBL practices, both surveys and observations show a degree of change, measured by the effect size, that is considered large for an educational intervention (0.8-1.2). Importantly, IBL implementation was strong across all demographic groups and across institutional types. The data also show that instructors' prior experience with IBL, and the class size and support available when they first implement IBL, enhance their ability to put what they learned at the workshop into practice in their own classroom.

For the traveling workshops, survey data show that the workshops raised awareness, fostered interest in IBL, and supported some instructors to implement IBL in their own classrooms. The traveling workshops expanded the project's reach and served instructors from groups often less well served by PD, such as non-tenure-track instructors and those at two-year institutions.

Preparation of professional development leaders was an explicit goal of the project, with the intent to build PD capacity in mathematics higher education. Success in this goal is a second important outcome of this project. The workshop leaders were already skilled in IBL teaching, but not all had prior PD experience. They developed broader perspectives on IBL teaching and how it can be adapted to a variety of teaching circumstances; they built flexible toolkits of teaching approaches useful in workshops, and they expanded their own collaborative and professional networks. Many of them continue to offer PD about IBL and other topics related to teaching, learning, equity and justice in education.

The project has already generated many publications that variously target instructors, professional developers, and scholars; these products include posters, talks, articles, and handbooks. Our research team continues to identify new findings, analyze data, and share results. The project has also generated new insights about research methods that can be used to characterize teaching and thus to characterize changes in teaching that occur as a result of professional development. The research will help others adopt these professional development methods and strengthen college teaching in math and other STEM fields.

For additional publications describing the project and detailing the evidence discussed here, see

https://www.nsf.gov/awardsearch/showAward?AWD_ID=1525077



<u>https://www.colorado.edu/eer/research-areas/professional-development</u> \rightarrow IBL workshops

