Scaling Dynamic Mathematics Reform: Findings from the SunBay Pilot Study

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Abstract: This paper describes the first phase of SunBay Digital Mathematics Project's attempt to improve the middle school mathematics learning ecology of a large, urban district. A dynamic unit incorporating SimCalc MathWorlds® (Roschelle, Knudsen, & Hegedus, 2009) was scaled up to support efforts to teach rate and proportionality. Findings discuss implementation, professional development, and the power of technology to build support for extended programs of change.

Introduction

Teachers are critical to improving the quality of mathematics education, but the ability of educators to teach mathematics varies across classrooms in U. S. schools. Improving the quality of teaching and learning requires changing the work of professionals at many levels of the educational system (Blumenfeld, Fishman, Krajcik, Marx, & Soloway, 2000; Roschelle et al., 2010). If teachers are to work more skillfully, the tools teachers use, their pedagogical practices, and the curricular activities they implement in the classroom must improve (Roschelle, Knudsen, & Hegedus, 2009). One of the major questions that educational reformers face is how to build capacity to engage in this improvement work and to ensure these efforts support beneficial change in the classroom. Thus, the authors assume that the challenge of raising the quality of instruction in U.S. schools is a knowledge problem that requires innovation, professional development, and reflective practice at every level of the system from the classroom, to the district, to the university school of education.

This paper reports on the efforts of the SunBay Digital Mathematics Project (SunBay) to create the links needed to use collaborative digital technology to improve the teaching and learning of conceptually focused middle school mathematics in a large, urban school district (SRI International & University of South Florida St. Petersburg, 2010). SunBay is a partnership among a college of education, a public university, a school district, and a non-profit research organization; each organization providing complimentary expertise to the project. The long-term goal of the project is to implement a dynamic, digital middle school mathematics curriculum that will democratize access to the complex mathematics of change and variation, and create a more coherent and fruitful mathematical experience for all learners, including those who have not traditionally been successful in mathematics. As such, SunBay intends to help pioneer the future of mathematics education by creating a national model where every middle school mathematics teacher in the participating district has the knowledge and support to use technology to become an effective teacher of dynamic mathematics.

Summary and Discussion of Professional Development Findings

The SunBay pilot study asked teachers to implement a dynamic unit that had been field tested in Texas (Roschelle et al., 2010). All professional development (PD) offered to support implementation was based on an "inquiry stance on teaching" (Cochran-Smith & Lytle, 2001, p. 47). The summer workshops were adapted from a designed PD experience intended to immerse teachers in the unit's mathematical and technical demands (Roschelle, et al. 2009). Teachers used their laptops to solve problems, and they discussed the mathematics underlying the software's dynamic simulations. Teachers acted as learners and used digital technology to enact SimCalc MathWorlds® core strategy (Predict, Check, and Explain) and deepen their knowledge of the unit's underlying mathematical concepts. They answered questions in the unit's paper workbooks. During the fall, teachers received technical assistance using the SimCalc MathWorlds® software and participated in monthly PD experiences designed to help them implement the unit and support deeper technological, pedagogical, and mathematical learning. Teachers rated the PD sessions highly, with an average rating of 4.5 on a 5 point scale across summer and fall.

Teachers were found to implement the materials with good effect. Prior to implementation, a pre-test was administered to students; immediately after the unit was completed, a post-test was administered. The average pretest score of the SunBay students was statistically identical to the students (i.e., treatment and control) in the Texas study (Roschelle et al., 2010; SRI International & University of South Florida St. Petersburg, 2010). Gain scores to measure student learning were calculated by subtracting each student's pretest score from their posttest score. A final analysis showed the SunBay students' gain scores were also statistically

identical to the SimCalc gain scores in Texas and both were significantly greater than the Texas control gain scores. There was a large and significant main effect in both studies with an effect size of 0.8 (SRI International & University of South Florida St. Petersburg, 2010). Consistent with previous studies (Vahey, Lara-Meloy, & Knudsen, 2009), there was no significant difference in mean student gain score across ethnicities including African-American, Asian, Caucasian, and Hispanic. These results indicate the curricular materials are effective regardless of student ethnicity or prior math knowledge.

Conclusion and Future Research

The purposes of SunBay go beyond implementing software and replacement units. The collaborators intend to create a broad set of materials that allow the district's students to achieve high rates of growth in their mathematical knowledge by regularly interacting with high quality learning technologies. Whereas the presented results show the promise of this approach, they raise important questions about the nature of professional development that might support such an undertaking both in the district and in other sites.

How might professional development and other forms of implementation support be organized so that every teacher in the district uses high quality digital learning technologies and every teacher uses these tools effectively to teach mathematics well? While there is a great deal of research that sheds light on this question (e.g. Resnick, 2008; Penuel, Fishman, Yamaguchi, & Gallagher, 2007), we believe that the deep relationships between the collaborators at SunBay as well the scale and long term nature of our work will allow us to develop further understandings of this topic. How might computer supported collaborative learning environments be implemented broadly and fruitfully for all students' benefit? At a time when this question remains unresolved, it is our commitment that work on SunBay will speak to the international research community and measurably benefit the public school students of the urban district we serve.

Endnotes

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