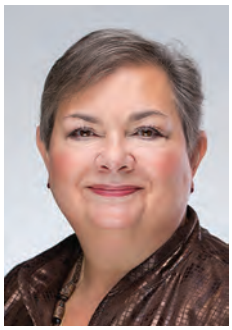

Pairing new science curriculum with professional learning increases student achievement

WHAT THE STUDY SAYS

A randomized trial study, conducted over two school years in 18 high schools in Washington, finds that *An Inquiry Approach*, a three-year, educative curriculum for high school science, has a positive impact on student achievement, teacher practice, and fidelity of implementation of the curriculum when the curriculum is paired with professional development for teachers.

Study description

Taylor et al. used a pre/post-test control group design to assess the efficacy of *An Inquiry Approach*. An external researcher assigned the 18 Washington high schools participating in the study to either treatment or control group. Using measures of student achievement, science teaching practice, and fidelity of curriculum implementation, the research team analyzed the effects of the curriculum and its accompanying professional development that spread over seven days (three in the summer, four during the school year) on student achievement using Washington state's science assessment, the High School Proficiency Exam; on teacher practice using the Reformed Teaching Observation Protocol; and on fidelity of implementation using Fidelity of Implementation Protocol.

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At a glance

Well-designed, educative curriculum and materials, coupled with face-to-face professional development related to the curriculum, lead to more effective implementation of the curriculum, improved teacher practice, and student achievement.

THE STUDY

Taylor, J., Getty, S., Kowalski, S., Wilson, C., Carlson, J., & Van Scotter, P. (2015). An efficacy trial of research-based curriculum materials with curriculum-based professional development. *American Educational Research Journal, 52*(5), 984-1017.

Questions

The study had three main goals: the overall efficacy of the research-based curriculum materials with associated professional development to improve student achievement; the role of teacher practice in the relationship between the use of the materials and student achievement; and the extent to which the treatment effects were equitable across demographic groups. The study addressed these goals with three corresponding research questions:

1. What is the main effect of treatment on student achievement, controlling for various covariates?
2. To what extent does teacher practice mediate the effect of the treatment on student achievement?
3. To what extent do student demographic characteristics moderate the effect of treatment on students?

Methodology

Eighteen high schools that had previously used a traditional science curriculum enrolled in the study in the 2009-10 school year and participated over two years in a program to support implementation of the three-year *An Inquiry Approach.* Biological Sciences Curriculum Study designed the educative curriculum for high school science to align with the Next Generation Science Standards, the Framework for K-12 Science Education, and constructivist instructional practices.

The study addresses the gap that

WHAT THIS MEANS FOR PRACTITIONERS

This study focuses specifically on a single science curriculum for high school students. Yet it confirms common practices for which there is limited empirical evidence. Among those practices, as specified in the **Outcomes** standard, teacher professional learning must align with student outcomes and teaching practices aligned to those outcomes in a coherent and integrated fashion. The professional learning teachers experienced focused on curriculum, curriculum implementation, teaching practices, fidelity of implementation, and increasing student achievement in an integrated fashion.

New programs, such as new curricula, require sufficient professional learning to support implementation. The **Implementation** standard explains that support must extend over time and provide opportunities for feedback and collaborative support. One goal of the professional development in this study was to build collaboration among teachers for implementation support. The description of the professional development program included no information about how or if it included feedback to teachers and classroom-based support outside the daylong sessions that occurred throughout the school year.

In addition, the **Learning Designs** standard states that the instructional practices used in professional learning should model and advance the expected pedagogical practices. Providers modeled lessons and applied pedagogical practices that teachers would use in their implementation of the curriculum.

A noteworthy element of the selection of participants was engaging school principals as advocates for teacher participation in the professional learning. This often-missing element of teacher professional learning aligns with the **Leadership** standard.

Overall, this study clarifies the significance of teacher practice in program implementation and student success. It verifies that teacher practice mediates student achievement and provides confirming evidence that professional learning as a core component of curriculum or program implementation is a worthy investment.

exists between limited empirical evidence about the role of research-based curriculum materials and professional development in achieving the standards and student achievement in science. As a result, the study sought to test the causal connection between curriculum materials with curriculum-specific professional development and student achievement. It used the following theory of change: "The combination of educative curriculum materials for teachers, research-based materials for students, and curriculum-based PD will produce a positive effect on both students and teachers and that the effect on students is in part mediated by positive effects on teachers' practice" (p. 998).

Researchers acknowledge that teachers mediate how curriculum is enacted in the classroom. When there is alignment between the curriculum's design and philosophy and a teacher's understanding, beliefs, and practice, there is likely to be stronger implementation of the curriculum in ways its developers intended. Educative curriculum materials support teachers as learners by integrating aspects that deepen teachers' content and content-specific pedagogical knowledge, providing ideas for presenting complex information to students using reform-based instructional practices, and determining how to assess students. *An Inquiry Approach* integrated these components.

Because an educative curriculum is often complex, researchers hypothesized that curriculum-specific, face-to-face professional development, integrating the elements of effective professional learning and sustained throughout the school year, would support teachers' understanding and implementation of the curriculum. The goals of the yearlong professional development included implementation fidelity, collaboration among teachers based on common experiences and materials, and enhancement of teachers' ability to implement the instructional model integrated into the curriculum.

Providers modeled lessons and incorporated pedagogical methods embedded in the curriculum. The curriculum developers provided the professional development over three days in the summer and four one-day sessions throughout the school year. Principals encouraged participation in the professional development.

Comparison group teachers used extant curriculum materials and participated in the professional development typically provided by their districts or schools. The comparison group schools used a variety of textbooks and supplemental resources for instruction at different levels.

Analysis

Researchers applied multilevel modeling to estimate the effects of the curriculum on student achievement and used as covariates student achievement scores from 8th-grade math and science, 7th-grade writing, and student demographics. The analyses estimated that treatment students' performance was positive different from comparison students' performance at a statistically significant ($p = .035$) level. Researchers

adjusted for missing data and found no systematic bias toward the treatment resulting from the imputation of data.

Researchers also estimated effect using Hedge's g effect size. Using comparison effect sizes for high school, researchers found the .09 standard deviations to be within expectations and a statistically significant positive effect, estimating that students in the treatment group would begin 11th grade after two years of the curriculum about four months ahead of comparison students in science achievement.

Teacher practice was measured using eight observations per teacher — about one per month, conducted by external evaluators — and achieved an outstanding level of interrater reliability. The Fidelity of Implementation measure for 183 independent observations was 2.1 on a 3.0 scale for a resulting score of 71% overall implementation. This level of implementation was consistent with developers' intent.

Results

Researchers report positive effects of the treatment. Student achievement in the treatment group improved. Curriculum implementation occurred at an expected level.

The outcomes analyses provide evidence that the research-based curriculum accompanied by curriculum-specific professional development produced positive and statistically significant effects on student achievement and teaching practice. As noted earlier, students at the end of two years of the curriculum are predicted to enter the third year four months ahead of comparison group students.

The exploratory analyses of mediation and indirect effects produced strong mediational effect among teacher practice and treatment ($p < .001$), between teacher practice and student achievement ($p < .07$), and the estimated effect between the treatment and student achievement ($p = .49$). Researchers estimate that 59% of the total effect of the treatment is explained by the teacher practice. This result strengthens the proposition that educative, research-based curriculum with accompanying face-to-face professional development improves teacher practice and that teaching practice matters more than the curriculum.

A moderation analysis to address the question regarding equitable effects produced mixed results. These results lead researchers to conclude that there aren't more equitable results for students in the treatment group.

Limitations

The research study provides important and essential information about the need for effective curriculum and accompanying professional development, yet the design leaves a number of unanswered questions for future researchers to explore. Questions include identifying the specific effects of treatment features, either in the curriculum or professional development, on student achievement, teacher practice, or program fidelity.

Researchers recognize a potential for observer bias toward the treatment group because of the evidence of treatment materials available in classrooms during observations. They identify the potential for an implementation dip influencing the estimates of treatment effect. This is particularly important to acknowledge in any implementation study.

Comparison group teachers used familiar and comfortable curricula and practices while treatment teachers were using new ones. In some cases, researchers noted that some teachers in the comparison group used reform-based practices and students had some experiences similar to those in the treatment group. These factors, unexamined by researchers, affect overall significance of the efficacy of the curriculum.

As with all long-term studies using students as the unit of change, missing data is problematic. Researchers adjusted for this potential bias, yet they provide no information on the schools other than their location as rural or suburban and the student demographics. No information is provided about the number of teachers implementing the curriculum and any variations among teachers. Because the school is the unit of measure, this gap is understandable, yet additional information might generate questions for further research related to how teachers engage with the professional development and how the professional development is tailored to meet the needs of teachers. ■