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Measurement of Mathematics Content, Instructional Practices, and Textbook Use in K-12 Mathematics Classrooms: An Annotated Bibliography

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Mathematics Classrooms: An Annotated Bibliography

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The purpose of this annotated bibliography was to inform an effort to create instruments that would yield indicators of the extent to which the Common Core State Standards for Mathematics or similar standards are implemented in classroom instruction. Reviewed here are instruments reflecting: coverage of classroom content, use of specific instructional practices, and use of textbooks in K-12 mathematics classrooms in the United States.

To identify articles within the parameters, we used the search criteria “mathematics” paired with “instructional practice,” “content,” “curriculum,” or “textbook.” Additional searches paired the terms “reform,” “implementation,” “application,” “measuring,” and “common core,” as well as different variants, with “mathematics”. This extensive search, which was limited to articles in English, yielded 196 articles. We also consulted the references found in these articles.

Of the 196 articles identified in the extensive search, 63 were considered relevant for our interest in classroom content coverage. These relevant articles focused on analyzing and capturing the implementation of mathematics curriculum content, instructional practices, and textbook use. Within this collection of articles, this review utilizes 20 papers that developed instruments to capture one or more of these three aspects of instruction.

The articles reviewed included use of a variety of statistical instruments including cross-national surveys implemented by international organizations (e.g., PISA, TIMSS and TALIS), national evaluations (e.g., the National Council of Teachers of Mathematics (NCTM) and the National Assessment of Educational Progress (NAEP)), and state-level evaluations in the United States. Although many papers based on these large studies are

included in the references, a summary of each one was deemed beyond the scope of this project.

The relevant literature covers a wide variety of education indicators. There were, however, a number of performance measures which were common among the literature. Recurrent performance measures include analysis of the depth of specific curricular reforms, time spent on each practice, instrument validity and reliability, teacher interpretation of standards, appraisal of teacher beliefs, textbook alignment with standards, and teacher preparation.

While we identified a wide variety of instruments implemented throughout the relevant articles, a small number were used most frequently. These instruments included surveys (of teachers, principals, and students), in-depth interviews (of teachers, textbook authors, and math specialists), classroom observations, teacher logs, vignette-based measures, and textbook examinations.

Comprehensive Assessments of Classroom Content, Instructional Practices, and Use of Textbooks

The literature review revealed that teacher surveys are the most commonly applied method to capture mathematics classroom content, instructional practices, and use of textbooks. We also found that almost half of the studies reviewed have simultaneous assessment of classroom content, instructional practices, and/or use of textbooks.

Among the most comprehensive work we found is a series of papers and reports evaluating the implementation of curricular reform. One of the most thorough reports on teacher content, practices, and use of textbooks is Porter, Kirst, Osthoff, Smithson, and

Schneider's (1993) report "Reform up Close: An Analysis of High School Mathematics and Science Classrooms." The study assessed curriculum implementation within six states, 12 districts, and 18 schools. Instruments applied included teacher questionnaires; and interviews with principals, district administrators and agency administrators. These instruments collected detailed information regarding curriculum implementation at the classroom level. For example, one survey question inquired about time and depth of coverage devoted to 80 specific mathematics topics.

Another influential study, "Validating National Curriculum Indicators," was part of the Rand Corporation project (Burstein et al., 1995). This study aimed to improve the quality of information collected on school curriculum. The teacher survey that was implemented collected detailed information regarding math content, teaching practices, and textbook use. The survey was complemented with teacher logs and an evaluation of assignments and exams.

The "Study of Instructional Improvement" conducted by the University of Michigan and Consortium for Policy Research of Education was a large scale longitudinal study of instructional improvement. As part of this project several journal articles and working papers have been published, including Rowan, Harrison, and Hayes, (2004) and Hill (2005). Ball, Cohen, and Rowan (2010) describes the mathematics curriculum and teaching practices in a sample of high-poverty elementary schools that participated in three of the most widely implemented school reform programs in the United States: Accelerated Schools Program, America's Choice, and Success for All. The study evaluated the content coverage and teaching practices within and among 53 schools using instructional logs.

Also stemming from the “Study of Instructional Improvement”, Hill (2005) examined a set of terms often found on survey instruments describing mathematical content. To do so, she used a field pilot of an elementary mathematics daily log to examine terms such as “geometry,” “number patterns,” and “ordering fractions” for rates of agreement and disagreement between teachers and observers. . The study assessed when and how disagreements occurred through the use of interviews and written observations.

Swanson and Stevenson (2002) presented results of a teacher survey focused on classroom content and practices in states that participated in the NAEP. The study examined if there was an association between the structure of the national standards movement and patterns of state-level policy activism.

Porter, Smithson, Blank, & Zeidner (2007) developed procedures to investigate the agreement between content standards, tests, textbooks, and even classroom instruction as experienced by teachers and students. The purpose was to define and illustrate innovative uses of tools, content maps, and a quantitative index of the degree of agreement. This research drew on data from Porter, Blank, Smithson, and Osthoff (2005) that implemented a place-based randomized trial to test the effects on instructional practices of mathematics and science in a professional development program in 50 U.S. middle schools within five large urban districts. They concluded that “a quantitative measure of alignment can be defined at the individual teacher level and used as an important variable in research on teaching” (Porter et al., 2007, p. 46).

Gimbert, Bol, and Wallace (2007) analyzed the influence of traditional and alternative teacher preparation programs on student achievement and instruction in urban

secondary schools. They utilized a mixed-method comparative design to determine if teacher preparation influences the implementation of the process standards established by the NCTM. This study used classroom observations to determine the extent to which the teachers implemented NCTM process and content standards.

Blank, Porter, and Smithson (2001) was part of a project to develop and test Surveys of Enacted Curriculum in mathematics and science. The survey was designed to address broad questions about standards-based reform by testing a survey approach to analyzing the enacted curriculum in mathematics and science. More than 600 teachers across the 11 participating states completed self-report surveys about the subject content and the instructional practices used in their classes.

Gagnon, and Maccini (2007) assessed teachers' definition of math, familiarity with the course topics, effectiveness of methods courses, preparation to use and frequency of use of effective instructional strategies, and factors contributing to the use of instructional strategies. They used mail-based surveys of special and general education high school teachers that teach math to students with emotional and behavior disorders and learning disabilities. This paper emphasized the need for better preparation for instructional strategies that are consistent with the goals of the NTCM standards and empirically-validated teaching practices (Gagnon & Maccini, 2007).

McCaffrey et al. (2001) examined how student achievement is related to the degree to which teachers' use of instructional practices align with reforms. The study drew on findings from teacher surveys and components of the Stanford achievement test for tenth grade students. The analysis controlled for student background characteristics and past

achievement. Particular focus was placed on how curriculum reforms might influence the relationship between instructional practices and student outcomes. Results from all sites were combined to produce a single coefficient estimate for instructional practices.

Lane and Parke (2008) examined the extent to which mathematics classroom activities in Maryland were aligned with state learning outcomes and the Maryland School Performance Assessment Program. The authors collected information on activities related to instruction, assessment, and test-preparation from a statewide stratified random sample of teachers. Seven types of teachers' classroom activities were analyzed: (1) mathematics process outcomes; (2) mathematics content outcomes; (3) student response types; (4) interpretation of charts, tables, and graphs; (5) use of manipulatives and calculators; (6) integration with other subject areas; and (7) overall agreement with the Maryland State Performance Assessment Program. Most classroom activities were aligned with aspects of state assessment and standards.

Stecher et al. (2006) used vignette-based measures of reform-oriented instruction, which is one aspect of mathematics instructional practice. Teachers read contextualized descriptions of teaching practices that varied in terms of reform-oriented instruction, and then rated the degree to which the options correspond to their own likely behaviors.

Ross, McDougall, Hogaboam-Gray, and LeSage (2003) evaluated instruments that measure teachers' instructional practice. To examine the extent to which teachers implement mathematics education reforms, they developed a twenty-item survey based on nine dimensions of standards-based teaching. They provide evidence of the reliability and validity of the instrument using correlations of survey scores with a mandated performance

assessment in Grade 6 mathematics and classroom observations of a small sample of teachers. The study also demonstrated that teachers who were similar in their claims about using a standards-based text series differed in how they used the text in the classroom in ways predicted by the survey. Similarly, Mayer (1999) examined the reliability and validity of using survey instruments to capture instructional practices. The study inspected if the portion of time devoted to established practices in algebra classes were consistent with NCTM professional standards.

Spillane and Zeuli (1999) investigated teacher math practices in the context of the current reform effort in the United States. The study developed a conceptual framework for examining reform proposals “in terms of the intersection of classroom tasks and discourse patterns with principled and procedural mathematical knowledge” (p. 1). The student identified which teacher practices were most responsive to reform through use of classroom observation and teacher interviews.

Hamilton et al. (2003) analyzed the relationship between academic achievement and classroom practices established by the National Science Foundation's Systemic Initiatives (SI) program. The study collected data from eleven SI sites and investigated relationships at the site level and pooled across sites using a planned meta-analytic approach. The study found a small but consistent positive relationship between teachers' reported use of standards-based instruction and student achievement.

Jitendra et al. (2005) examined the extent to which teaching the recommended methods for problem-solving recommended in mathematic textbooks adhered to the NCTM standards and instructional design criteria. They analyzed lessons on addition and subtraction

on five textbooks at the third grade level that break “each lesson in six parts, including preview, warm-up/introduction, teach, practice, assess, and review” for evaluating the standards (p. 322). They found great discrepancy across textbooks in meeting the standards.

We reviewed several journal articles that evaluated changes in teaching practices based on recent curricular reforms in countries beyond the United States. Ampadu (2014) examined the impacts of a mathematics curriculum introduced in Ghana in 2007. This reform aimed to shift from a teacher-centered approach to more student-centered style that emphasized participatory teaching and learning. Using a semi-structured questionnaire for teachers and class observations, the study investigated teacher beliefs about their teaching, differences between these beliefs and curriculum requirements, and the relationship between beliefs and teaching practices. The paper found that “the movement towards a more constructivist approach as outlined in the curriculum was not fully evident in most of the classrooms observed” (p. 79).

Bobis and Anderson (2006) evaluated the implementation of reform-oriented approaches promoted through the Working Mathematically curriculum for primary school children in New South Wales, Australia. Using teacher surveys (based on Ross, et al., 2003), they examined which reform-oriented teaching practices primary school teachers reported using and the particular teaching practices used for each of the processes of Working Mathematically. The study also identified the knowledge and beliefs that were associated with teachers who successfully implement Working Mathematically. Following a similar line of research, Cavanagh (2006) evaluated the implementation of the new reform-oriented syllabus in secondary schools in New South Wales.

Huntley (2009) described different methods of measuring curriculum implementation. The study used the Concerned-Based Adoption Model, “premised on the notion that implementation of an innovation (such as a new textbook) can take on many different operational forms” (p. 357). An example of a tool is teachers using a textbook's table of contents to identify chapters, units, or topics they plan to teach during the academic year.

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