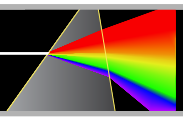

PRISM

Programming
Remediation &
Intervention for
Students in
Mathematics

Connecting Practice and Research in Mathematics Education

Research Instruments

PRISM Research Instruments – Introduction

Why measure teacher change when our goal is improved student achievement?

A consensus is emerging from recent research that:

- student achievement is influenced more by classroom teachers than any other factor;
- school improvement is linked to professional development; and,
- worthwhile knowledge for teachers has expanded and changed since teachers were, themselves students,

thereby making it important to know whether or not certain strategies and uses of resources are resulting in positive teacher change.

> Teacher quality will always be at the heart of education policy and reform. Policymakers who want to influence student achievement know that teachers are where the "rubber hits the road." Student learning takes place in the classroom, not in departments of education or on Capitol Hill.
> (*EDPolicy Update*, November 2005, Volume 4, Number 10)

> Virtually all of the effect that any combination of policy instruments exerts on students' learning – if any – will be filtered through teachers, mediated by what teachers believe and know and are able to do.
> (*Teaching as the Learning Profession: Handbook of Policy and Practice*, 1999, p. 349)

PRISM research projects explore ways to improve student achievement by providing for their teachers, professional learning opportunities that are based on research-based classroom materials.

PRISM Research Instruments

In the spirit of sharing what works, the following one-page quick-fact sheets describe the research instruments used to gather information about the effectiveness of PRISM projects in changing teachers' beliefs, skills, and practices, as well as corresponding changes in students' beliefs, skills, and understandings about mathematics.

Included in the list below is an indication as to whether the instrument is used with teachers or students.

- CKT-M (Content Knowledge for Teaching Mathematics) - teachers
- POM (Perceptions of Mathematics) - teachers
- *PRIME* Number and Operations Diagnostics Tools - students
- Student Characteristics Survey: Beliefs about Mathematics - students
- Student Characteristics Survey: Self-Efficacy - students
- Student Characteristics Survey: Negative Affect for Failure - students
- Teacher Attitude and Practices to Teaching Mathematics: Teacher Efficacy - teachers
- Teacher Attitude and Practices to Teaching Mathematics: Mathematics Teaching Practices - teachers

CKT-M (Content Knowledge for Teaching Mathematics)

CKTM measures were developed through the Learning Mathematics for Teaching (LMT) Project at the University of Michigan. This project investigates the mathematical knowledge needed for teaching, and how such knowledge develops as a result of experience and professional learning. The measures are designed to compare **groups** of teachers' mathematical knowledge, or examine how a group of teachers' knowledge develops over time and in conjunction with professional development experiences. These tools are large-scale survey-based measures of the mathematical knowledge required for teaching.

Designed to

- measure the effectiveness of professional development as defined by group growth
- measure the mathematical knowledge needed for teaching, and how such knowledge develops as a result of experience and professional learning

Developed by

- Deborah Loewenberg Ball, Heather C. Hill, Hyman Bass through the *Learning Mathematics for Teaching (LMT) Project* at the University of Michigan

Format

- multiple choice questions that assess mathematical content knowledge for teaching with respect to two key elements: "common" knowledge of mathematics that any well-educated adult should have and mathematical knowledge that is "specialized" to the work of teaching and that only teachers need know
- large-scale survey-based measures

Cost and conditions for use

- distributed through one-day Instrument Dissemination Workshops offered in Ann Arbor, Michigan at no charge for either the workshop or the materials
- see the Study of Instructional Improvement (SII) http://www.sii.soe.umich.edu/
- generally best applied to groups of 60 or more participants, although big changes can be found to be significant even with a small sample size

Time to administer

- approximately one hour for one of two levels (Grades 1 through 9)

Scoring and reliability

- scoring guides are provided during workshops
- scores are norm referenced
- scaled scores are given in standard deviation units or "standardized" scores

Considerations

- Federation issues concerning assessment have not been a problem since individual teachers' identities are protected in developing group scores.
- Significant changes may not be found if duration of the professional development is too short, e.g., less than 20 hours.

POM (Perceptions of Mathematics)

This instrument was designed to examine knowledge as well as beliefs about knowing and teaching mathematics. Specifically, procedural and conceptual knowledge are separated. A *Profile* graph of individuals' scores is provided by the instrument to encourage participants to self-reflect about the relative positions of their belief in the value of conceptual learning compared with their own knowledge in this domain.

Designed to

- measure and compare procedural knowledge and conceptual understanding of fundamental mathematical concepts for elementary teaching
- measure and compare beliefs about the value of procedural and conceptual learning
- provide a visual model that is suitable for individual teacher reflection and shared discussion of goals for growth

Developed by

- Ann Kajander, from the *Teachers' Evolving Mathematical Understandings* project at Lakehead University

Format

- beliefs survey using Likert scale to measure values about mathematics itself and how it should be learned
- knowledge survey containing mathematics questions to examine procedural and conceptual knowledge separately

Cost and conditions for use

- survey available from Lakehead University, published research instrument (no cost)
- training required for scoring of knowledge portion, contact Dr. Ann Kajander
- pre-service and in-service versions are available from ann.kajander@lakeheadu.ca

Time to administer

- approximately one hour

Scoring and reliability

- no special skills required for scoring beliefs portion
- some mathematical understanding required for knowledge portion; training required
- acceptable reliability for beliefs portion established at post-test as well as in other studies

Considerations

- Beliefs portion of the instrument is suitable for all experience and grade levels of teachers.
- The mathematics portion of the survey was designed for pre-service teachers or beginning teachers. It may not have a sufficiently high ceiling or strand-specificity to show significant change in high capacity teachers. Modifications are possible.

Provincial capacity

- Approximately six graduate students at Lakehead University have participated in scoring as well as the researcher.
- Scoring workshops (one day) are provided upon request.

PRIME Number and Operations Diagnostic Tools

PRIME Number and Operations Diagnostic Tools relate directly to the research mapping how students develop mathematically, both conceptually and procedurally, in elementary grades. The Number Developmental Map includes indicators in each phase of development for five concepts and three skills. The Operations Developmental Map includes indicators for three concepts and three skills. Research across Canada shows that, in each grade level, there will be a range of phases represented. As well, for each phase, a range of grades is represented. For example, in Phase 4 there are mostly students in Grades 4-6. Quick descriptors of the phases include: Phase 1 – beginner; Phase 2 – concrete; Phase 3 – whole number comfort; Phase 4 – more abstract; Phase 5 – flexible. PRISM research has shown that many struggling students in Grades 7-10 are in Phases 2 and 3; this is more typical of students in Grades 1-5.

Designed to

- confirm the developmental phase of students with respect to the *PRIME* Number Developmental Map and the *PRIME* Operations Developmental Map so that teachers can plan instruction more effectively

Developed by

- Small, Marian (2005) along with a research team at the Ontario Institute of Studies in Education/University of Toronto headed by Doug McDougall and John Ross

Format

- Open-ended response items that can be used in a one-on-one interview situation (Tools A, B, and C suggested for K-3 students) and as pencil-and-paper tests (Tools D, E, F, and G)
- Seven tools made up of items that reflect two or three developmental phases each, and labelled as to suggested grade

Cost and conditions for use

- Only available to teachers who participate in the *PRIME* Number and Operations course. Provided, along with other materials, to course participants.
- Information is available through the Thomson Professional Learning, Thomson Nelson

Time to administer

- 15-30 minutes, depending on the tool and the student

Scoring and reliability

- Scoring guides are available for each item, and scoring charts for each tool in *PRIME* Number and Operations Diagnostic Tools.
- I is appropriate to administer the same tool to a student more than once, as long as there is a reasonable time between testing, e.g., three-to-four month spread.

Considerations

- Some of the items require the use of manipulatives and other commonly available materials.

Student Characteristics Survey: Beliefs about Mathematics

Student beliefs about mathematics and mathematics learning have a substantial impact on student motivation and achievement. For this study, we selected 19 items from Schoenfeld's inventory. The items identify a variety of dysfunctional beliefs about the nature of mathematics, e.g., "everything important about mathematics is already known by mathematicians, that conflict with NCTM conceptions of the discipline. Other items measure beliefs about mathematics learning that impede exploration, e.g., "when you get the wrong answer to a math problem…it's absolutely wrong, there's no room for argument," or that encourage deeper processing, e.g., "when the teacher asks a question in math class…there are lots of possible right answers you might give."

Designed to

- measure a variety of dysfunctional student beliefs about math and math learning
- measure beliefs about mathematics learning that encourage deeper processing

Developed by

- Schoenfeld, A. H. (1989). Explorations of students' mathematical beliefs and behaviour. *Journal for Research in Mathematics Education*, 20(4), 338-355.

Format

- The KPR PRISM project selected 19 items from Schoenfeld's inventory.
- The responses were a six-point scale anchored by 'not true at all' and 'very true' or 'never' and 'always.'

Cost and conditions for use

- none

Time to administer

- 10 minutes

Scoring and reliability

- Successful attempts to construct scales from Schoenfeld's have not been reported.
- In the KPR PRISM project a reliable 14 item scale, labelled dysfunctional beliefs about mathematics learning was created; in addition individual items were analyzed.

Considerations

- developed for group assessment purposes
- should not be used to make judgments about individual students

Student Characteristics Survey: Self-Efficacy

Math self-efficacy measures student confidence in their ability to succeed on mathematical tasks. Previous research has demonstrated that students who believe they will be successful are more likely to be so because they spend longer on the task and are not discouraged by obstacles. There is evidence to indicate that self-efficacy is a better predictor of mathematics achievement than closely associated variables such as math anxiety and mathematical self-concept. In this study, math self-efficacy will be measured with six items measuring expectations about future mathematics performance, e.g., "as you work through a math problem how sure are you that you can…understand the problem?"

Designed to

- measure student confidence in their ability to succeed on mathematical tasks

Based on research by

- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman.
- Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543-578

Format

- The version used in the KPR PRISM study consisted of six items measuring expectations about future mathematics performance, e.g., "as you work through a math problem how sure are that you can…understand the problem?"
- Response options consisted of a six-point scale anchored by ‘not sure’ and ‘really sure.’

Cost and conditions for use

- none

Time to administer

- 5 minutes

Scoring and reliability

- Self-efficacy is the average of the six items.
- A high score equals high self-efficacy.

Considerations

- developed for group assessment purposes
- should not be used to make judgments about individual students

Student Characteristics Survey: Negative Affect for Failure

Negative affect for failure measures students' fear of failing – a powerful inhibitor of mathematical achievement. Students who worry about the consequences of failure are less likely to persist in a task and be successful in it. In this study, negative affect for failure will consist of six items drawn from previous research, e.g., "I worry a lot about making errors in my math work."

Designed to

- measure students' fear of failing – a powerful inhibitor of mathematical achievement

Developed by

- Turner, J. C., Meyer, D. K., Midgley, C., & Patrick, H. (2003). Teachers' discourse and sixth graders' reported affect and achievement behaviors in two high-mastery/high-performance mathematics classrooms. *Elementary School Journal*, 103(4), 357-382.

Format

- Six items of the form: how true each statement is of you, e.g., "I worry a lot about making errors in my math work."
- Response options are a six-point scale anchored by 'not at all true' and 'very true.'

Cost and conditions for use

- none

Time to administer

- 5 minutes

Scoring and reliability

- Fear of failure is the average of the six items; a high score is negative: high fear of failure is negatively associated with student achievement.
- See Turner et al. (2003) for evidence of validity and reliability.

Considerations

- developed for group assessment purposes
- should not be used to make judgments about individual students

Teacher Attitude and Practices to Teaching Mathematics: Teacher Efficacy

Teacher efficacy measures the extent to which teachers believe that they can bring about student learning in their classroom. Teachers with high teacher efficacy scores set higher goals for themselves and their students and persist through obstacles. Teachers who believe they will be successful are more willing to adopt standards-based mathematics teaching and have higher student achievement. In this study, teacher efficacy is measured with 12 items adapted for mathematics from a standard instrument. The items produce three scales: (1) *Efficacy in student engagemen*t, e.g., "how much can you do to motivate students who show low interest in mathematics?"; (2) *efficacy in instructional strategies*, e.g., "how well can you implement alternate Mathematics strategies in your classroom?"; and (3) *efficacy in classroom management*, e.g., "how much can you do to calm a student who is disruptive or noisy in Mathematics class?"

Designed to

- measure the extent to which teachers believe they are able to bring about student learning

Developed by

- Tschannen-Moran, M., & Woolfolk - Hoy, A. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education,* 17, 783 - 805
- Items available at http://www.coe.ohio-state.edu/ahoy/researchinstruments.htm#Sense

Format

- Exists in long and short versions
- 12 items in the short version; each with a six-point scale; anchors vary among the items

Cost and conditions for use

- no cost

Time to administer

- approximately 10 minutes

Scoring and reliability

- see website for scoring guide
- produces three scores: efficacy in student engagement; efficacy in instructional strategies; efficacy in classroom management
- evidence of validity and reliability in Tschannen-Moran, M., & Woolfolk - Hoy, A. (2001)

Considerations

- Teacher efficacy is subject and situation specific and hence a teacher may be highly efficacious in one subject area yet not in another. Thus the survey should be adapted for mathematics from the standard instrument.
- The instrument was developed for group assessment purposes and should not be used to make judgments about individual teacher competence.

Teacher Attitude and Practices to Teaching Mathematics: Mathematics Teaching Practices

Mathematics teaching practices measures the extent to which teachers believe they have implemented core elements of standards-based mathematics teaching. In this study self-reported mathematics practices will be measured with 20 items aligned to the ten dimensions of standards-based mathematics teaching that characterize the Ontario curriculum. The 20 items, e.g., "I like to use math problems that can be solved in many different ways," produce a single score. (Ross, J. A., 2003) Previous use of this scale has demonstrated that it produces a consistent (reliable) score. Teachers with higher scores on this measure tend to have students who achieve higher scores on EQAO mathematics assessments. There is also evidence that this self-report measure correlates with observations of classroom teaching.

Designed to

- measure the extent to which teachers believe they have implemented core elements of standards-based mathematics teaching

Developed by

- Ross, J. A., Hogaboam-Gray, A., McDougall, D., & LeSage, A. (2003). A survey measuring implementation of mathematics education reform by elementary teachers. *Journal of Research in Mathematics Education*, *34*(4), 344-363.

Format

- self-report on 20 Likert items: 6-point response scale anchored by strongly agree and strongly disagree
- based on ten dimensions of standards-based mathematics teaching that characterize the Ontario curriculum

Cost and conditions for use

- none

Time to administer

- 10 minutes

Scoring and reliability

- produces a single score
- see Ross et al. (2003) for scoring guide and evidence of validity and reliability

Considerations

- developed for group assessment purposes
- should not be used to make judgments about individual teacher competence