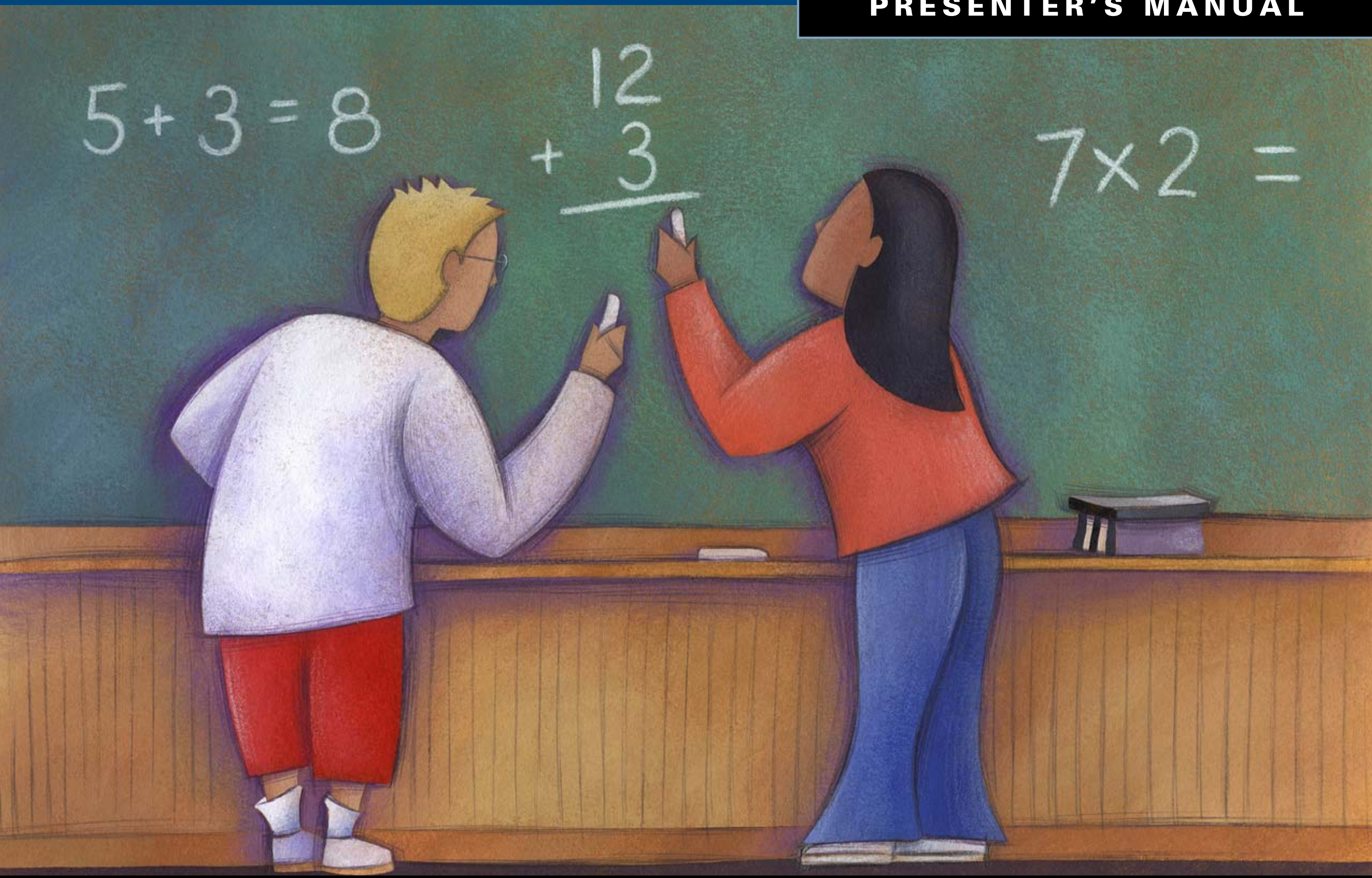
AN INTRODUCTION TO PROGRESS MONITORING IN MATHEMATICS

PRESENTER'S MANUAL



CENTER ON INSTRUCTION

AN INTRODUCTION TO PROGRESS MONITORING IN MATHEMATICS

PRESENTER'S MANUAL

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CENTER ON INSTRUCTION

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CONTENTS

INTRODUCTION

This manual has been developed to support the presentation of *An Introduction to Progress Monitoring in Mathematics*, a professional development PowerPoint created by the Center on Instruction. The presentation provides an overview of mathematics progress monitoring and includes:

- a definition of progress monitoring,
- support in distinguishing progress monitoring from other forms of assessment,
- basic concepts in the development and implementation of progress monitoring tools, and
- examples of progress monitoring tools in mathematics at the elementary and secondary grade levels.

Intended Audiences

This presentation has been designed to serve the wide array of individuals who have an interest in the concepts, empirical basis, and concerns relevant to the implementation of mathematics progress monitoring. Among those who may find value in this professional development experience are general education technical assistance personnel; education policy makers at the local, state, and federal levels; and mathematics and mathematics education researchers and teacher educators. Please note that the presentation is not designed to provide a complete, highly detailed training in the actual implementation of progress monitoring.

Organization of the Session

The full presentation contains three sections. The first section describes student progress monitoring and offers a general definition, as well as a sample graph of a student's progress monitoring data. The second section contrasts other assessment approaches that are often mistaken for progress monitoring. The third, and largest, section describes the features of progress monitoring and includes examples of existing measures available for elementary and secondary students. This manual also includes references, a bibliography, and additional potentially valuable resources.

Length of the Session

A presentation of the full set of slides would result in a two hour session. Presenters can select slides to meet particular circumstances and audience needs. The following table provides suggestions for possible adapted presentations. We strongly encourage presenters to draw on their own knowledge of mathematics progress monitoring and audience needs to design an effective presentation.

Possible Adapted Presentations

Audience	Purpose	Slides and Content	Length
Individuals familiar with general progress monitoring concepts	Share specific measures for mathematics	1–4, 43–77 (modify Slide 3 for Overview) Introduction Elementary Measures Secondary Measures Resources	1 hour
Individuals with no background in progress monitoring whose primary interest is in understanding the general concept	Provide foundations in progress monitoring without the complexity of specific measures for specific age/grade levels	1–38, 76–77 (modify Slide 3 for Overview) Introduction PM Foundations Resources	1 hour
Elementary level professionals	Provide background in progress monitoring with an emphasis on elementary measures	1–22, 26–60, 74–77 (modify Slide 3 for Overview) Introduction PM Foundations Math PM Details Elementary Measures Resources	1.5 hours

(continued)

Possible Adapted Presentations *(continued)*

Audience	Purpose	Slides and Content	Length
Secondary level professionals	Provide background in progress monitoring with an emphasis on secondary measures	1–14, 23–42, 61–77 (modify Slide 3 for Overview) Introduction PM Foundations Math PM Details Secondary Measures Resources	1.5 hours
Individuals unfamiliar with progress monitoring and interested in options for available measures at all levels	Provide foundations in progress monitoring and examples of progress monitoring measures in mathematics at both the elementary and secondary levels	1–77 (full presentation) Introduction PM Foundations Math PM Details Elementary Measures Secondary Measures Resources	2 hours

Research Foundations for Mathematics Progress Monitoring

This presentation is based on 30 years of research that dates to the Institute on Research in Learning Disabilities at the University of Minnesota. Originally developed by Stan Deno and his colleagues, a form of progress monitoring coined curriculum-based measurement (CBM) was created to give teachers technically adequate tools to monitor students' progress and inform instructional decisions in a system of formative evaluation. The initial work in CBM focused on reading, which has historically received a greater proportion of researchers' attention than has mathematics.

The research in progress monitoring has been characterized by Fuchs (2004) as occurring in three stages. Stage 1 research examines the technical adequacy of static, or one point in time, indicators of student performance in progress monitoring. In this stage, much of the research involves examining the reliability and criterion validity of measures and determining the degree of correlation between the measures and other indicators of proficiency in mathematics. This research also examines the ability of static measures to predict future outcomes, such as passing a state standards tests. Stage 2 research involves investigations of the slopes produced by repeated administrations of progress monitoring measures over time. These studies explore the technical characteristics of the slopes and the degree to which they reflect student learning in mathematics. Finally, Stage 3 research explores teachers' use of the data to improve student achievement.

The majority of research studies on mathematics progress monitoring measures have been in Stage 1. Published work in this area has been conducted for measures of early numeracy (i.e., Chard et al., 2005; Clarke & Shinn, 2004; VanDerHeyden, et al., 2004; VanDerHeyden, Witt, Naquin, & Noell, 2001), elementary mathematics (i.e., Epstein, Polloway, & Patton, 1989; Fuchs, Fuchs, Hamlett, & Stecker, 1990; Fuchs, Hamlett, & Fuchs, 1998, 1999; Shinn & Marston, 1985), and middle school mathematics (Foegen, 2000; Foegen & Deno, 2001; Helwig, Anderson, & Tindal, 2002; Helwig & Tindal, 2002).

Stage 2 research has included two studies of growth on early numeracy measures (Chard et al., 2005; Clarke & Shinn, 2004), several for elementary measures (i.e., Fuchs, Fuchs, Hamlett, Thompson, Roberts, Kubek, & Stecker, 1994; Fuchs, Fuchs, Hamlett, Walz, & Germann, 1993), and two studies at the middle school level (Foegen, 2000; Helwig & Tindal, 2002). Stage 3 research has been conducted for elementary mathematics measures developed by Fuchs and her colleagues (i.e., Fuchs, Fuchs, & Hamlett, 1989; Fuchs, Fuchs, Hamlett, & Stecker, 1990, 1991). These studies have examined the effects of providing teachers with additional data based on skills analyses and expert system guidance (Fuchs, Fuchs, Hamlett, & Stecker, 1991), as well as strategies to guide their use of progress monitoring, such as consultation or self-monitoring (Allinder & BeckBest, 1995; Allinder, Bolling, Oats, & Gagnon, 2000). Stecker and Fuchs (2000) demonstrated that teachers who used progress monitoring data to design the timing and nature of instructional modifications effected significantly greater overall achievement for students compared to matched partners who received the same instruction and changes but whose progress was not monitored. These studies have repeatedly demonstrated that teachers can effect increased levels of student achievement when they use progress monitoring in mathematics.

The mathematics progress monitoring measures developed by Fuchs and her colleagues (Fuchs, Hamlett, & Fuchs, 1998, 1999) have been studied also in general education settings with peer-assisted learning strategies (PALS). These studies have relied on progress monitoring data to aid teachers in selecting skills for large-group and small-group instruction as well as for pairing students for classwide peer tutoring (i.e., PALS). Although the PALS procedures may be conducted without benefit of progress monitoring data, research has supported the use of math PALS in conjunction with ongoing progress monitoring information to increase achievement among high-, average-, and low-performing students, including students with learning disabilities, in Grades 2–6 (e.g., Fuchs, Fuchs, Bentz, Phillips, & Hamlett, 1994; Fuchs, Fuchs, Hamlett, Phillips, & Bentz, 1994; Fuchs, Fuchs, Phillips, Hamlett, & Karns, 1995). Although an exhaustive review of the research base for mathematics progress monitoring exceeds the scope of this presentation, a list of articles on the topic is provided at the end of this manual.

Implementation Issues

The distinctions between the methods used to develop progress monitoring measures hold important consequences for education professionals who are deciding which measures to select. Presenters of this professional development session should be well-versed in the advantages and disadvantages of each approach in order to best respond to audience questions.

Approaches to the development of progress monitoring measures. One aspect of progress monitoring covered in this presentation is the method used to develop the measures. Fuchs (2004) made a distinction between curriculum sampling and robust indicators as two alternative approaches to the development of progress monitoring measures. Curriculum sampling involves creating measures by sampling the instructional curriculum such that each probe represents a proportional sampling of the annual curriculum. This approach is best represented by the measures developed by Fuchs, Hamlett, and Fuchs (1998, 1999). An advantage of this approach is that students' probe data can be analyzed by skill type to identify particular areas of strength and weakness at both the classroom and individual student levels. These data allow teachers to make more informed decisions about how to modify the content of their instruction. Other advantages include the direct link to the instructional curriculum and the ability to evaluate how well students maintain and generalize previously taught skills and concepts. The limitations of curriculum sampling include the need to create measures for each grade level, the possibility that the measures are specific to a particular curriculum and may not work as well with other curricula, and the fact that the administration durations for curriculum-sampled measures are often substantially longer than those for robust indicators.

The second approach, robust indicators, uses an empirical process to identify tasks or problem types that are correlated with proficiency in the content domain. In elementary mathematics, research on robust indicators has focused almost exclusively on proficiency in basic facts. It is important to emphasize that a robust indicator is just that: an indicator. Clearly, basic facts are not the "whole" of the mathematics curriculum at any grade level. However, to the extent that proficiency with basic facts is correlated with overall proficiency in mathematics, this task can serve as a robust indicator.

The development process for robust indicators involves conducting research to determine whether the proposed measure is correlated with other indicators of proficiency in mathematics. The advantages of the robust indicator approach include the potential to use the measures to monitor student growth across multiple grade levels, the independence from any particular curriculum materials or instructional approach, and the efficiency of administration for these measures. The limitations of this approach include the inability to derive instructional recommendations regarding specific skills, the lack of direct connection to the instructional content, and the inability to use the measures to evaluate the maintenance and generalization of previously taught content.

Responding to progress monitoring data. Although this presentation focuses on the core concepts of progress monitoring and the options available among measures for progress monitoring in mathematics, it does not address how teachers should respond to progress monitoring data. This topic is beyond the scope of this presentation, but presenters must be aware that instructional decision making lies at the very heart of progress monitoring. Teachers who begin to use a progress monitoring system will produce data showing that some students are not making acceptable progress. Teachers must have support (in the form of consultation or professional development) that prepares them to respond in this situation. Some types of progress monitoring data (e.g., those developed using curriculum sampling) may illustrate which skills or concepts might be most beneficial for additional instruction. Other types of progress monitoring measures indicate problems but offer less direction for solving them. Administrators, professional development experts, and consultants need to be prepared to provide teachers with scientifically based methods or promising practices that have the greatest likelihood of improving the achievement of low-performing students.

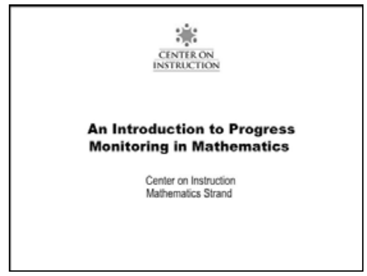
A Caveat

Session presenters must have a thorough understanding of the concepts underlying mathematics progress monitoring and the tools (measures) used to implement it. The talking points and reference citations in this manual can not substitute for a rich background knowledge and/or extensive experience in implementing progress monitoring. This manual is not sufficient for use in isolation. Presenters with limited expertise should read widely about mathematics progress monitoring and engage with practitioners and other professionals using mathematics progress monitoring to learn about the logistical issues and challenges that practitioners face.

Therefore, this presentation should be used for informational, rather than training, purposes. It describes the foundations of progress monitoring and the options available for measures at the elementary and secondary levels. More thorough training would be needed to prepare individuals to implement a system of progress monitoring. Such training can be found through the U.S. Department of Education's National Center for Student Progress Monitoring (http://www.studentprogress.org). This website includes the training materials (PowerPoint presentations, manuals, and handouts) that accompanied progress monitoring workshops and institutes conducted in 2005, 2006, and 2007. This information is updated periodically. Web articles on progress monitoring and presentation materials for national conferences also can be located on this website.

Note: Portions of this presentation have been adapted from slides taken from mathematics training materials (from the Summer Institutes) located on the National Center for Student Progress Monitoring website: http://www.studentprogress.org.

SLIDE 1



Background Information

Presenters should be well versed in progress monitoring systems. The purpose of presentation may vary depending on targeted audience. (Refer to table of possible adapted presentations on pages 2–3 in this manual.)

Talking Points

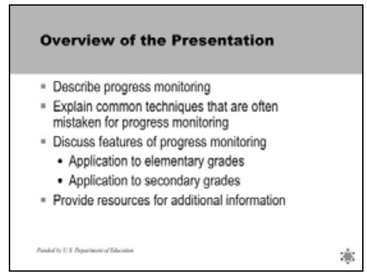
This presentation focuses on progress monitoring principles and practices in the area of mathematics.

SLIDE 2

Background Information

This slide indicates the source of this presentation—the Center on Instruction—and lists the Center's partner organizations. You may want to display this slide during "down times" in your presentation to provide some context for the participants.

SLIDE 3

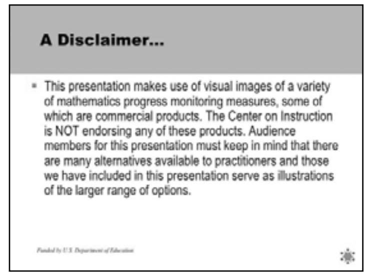


Talking Points

The purpose of this presentation is to provide participants with an overview of mathematics progress monitoring that includes the following elements:

- a definition and description of progress monitoring,
- support in distinguishing progress monitoring from other forms of assessment,
- basic concepts in the development and implementation of progress monitoring tools,
- examples of progress monitoring tools in mathematics at the elementary and secondary grade levels, and
- a brief list of resources that provide additional information about progress monitoring.

SLIDE 4



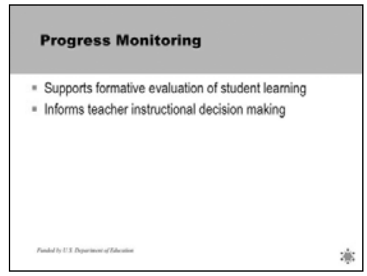
Background Information

This slide must be included in ALL presentation variations of this material.

Talking Points

The use of specific measures as illustrations throughout this presentation is intended as a means of increasing participants' comprehension of the material being presented and not as an endorsement of any specific products.

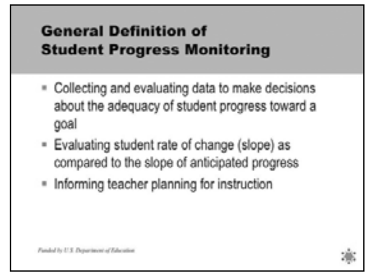
SLIDE 5



Talking Points

Progress monitoring data are used to assess student learning across time. That is, formative evaluation allows teachers to judge student learning in an ongoing fashion. This information is used to help teachers formulate decisions about the adequacy of student progress and the necessity of making instructional modifications.

SLIDE 6



Talking Points

Teachers use test results for a variety of decision-making purposes. Formative evaluation informs teachers' decision making in an ongoing manner. One well-known type of formative evaluation is progress monitoring.

Progress monitoring involves ongoing data collection to determine the adequacy of student progress toward a specified long-term goal. Although any of the progress monitoring scores may be compared to the level of the goal, progress monitoring procedures also involve examination of the rate of student improvement. Drawing a line of best fit through the student's data provides a trend line that can be compared to the expected rate of improvement that would be required for achieving the goal at the specified time.

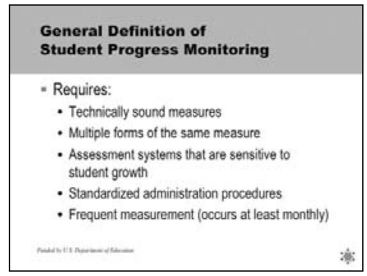
Using progress monitoring data requires that teachers make decisions on a periodic basis about whether student progress is sufficient to ultimately meet academic goals or whether progress appears insufficient to meet the goal. If the student is not progressing well, the teacher would decide to modify the instructional program.

Progress monitoring can be used on a frequent basis to judge the overall effectiveness of instruction for particular students. Teachers use progress monitoring information to modify instructional practices, regroup students for instruction, change motivational strategies, and so forth, and then they evaluate the result of those instructional changes on student performance. In this manner, teachers formatively develop instructional programs to better meet particular student needs.

Supplemental Information

Examples for drawing trend lines and setting goals can be found in Summer Institute materials at the National Center on Student Progress Monitoring: http://www.studentprogress.org.

SLIDE 7



Talking Points

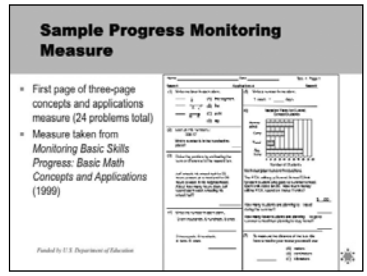
For measures and procedures to qualify as progress monitoring, several features must be addressed. They must be technically adequate, showing strong reliability and validity. Students should not have the opportunity to memorize the actual items used on the tests, so equivalent alternate forms of the measures must be used over time. The short measures must be sensitive enough to capture student change (i.e., either growth or deterioration). Procedures are standardized, so that measures are given in the same way each time and for the same length of time. Standard rules are applied for scoring, so student responses are evaluated the same way regardless of the person who performs the scoring. Progress monitoring involves the administration of relatively brief measures that can be given frequently. By definition of the Technical Review Panel for the National Center on Student Progress Monitoring, progress monitoring measures should be given at least monthly with decisions made about the adequacy of student progress in order to qualify as "true" progress monitoring measures. For students who are at academic risk, measurement can occur as often as once or twice weekly. Measures are designed to be relatively brief, so they can be given often without sacrificing much instructional time for assessment.

Supplemental References

Seminal article and historical perspective of development of curriculum-based measurement (a research-validated form of progress monitoring):

Deno, S. L. (1985). Curriculum-based measurement: The emerging alternative. *Exceptional Children, 52,* 219–232.

SLIDE 8



Background Information

This measure illustrates only one example of progress monitoring in mathematics. Other examples of mathematics tools are provided later in the presentation.

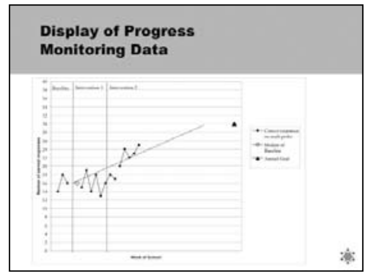
Talking Points

This measure illustrates one way to assess student progress in mathematics problem solving. This is the first page of a three-page measure that could be administered to students in Grade 4. The items on this measure represent the types of concepts and application skills that would be taught across the year. Students take alternate forms of these same types of items on a frequent basis. As teachers address more of the content and as students make progress in mathematics, student scores should increase across the year. Other examples of mathematics progress monitoring measures are provided later in the presentation.

Supplemental Information

This example of progress monitoring illustrates the curriculum-sampling approach in contrast to the robust-indicator approach. These two types of approaches used in the development of progress monitoring tools are described later in the presentation.

SLIDE 9



Background Information

This graph was generated through the Excel spreadsheet program.

Talking Points

This graph shows progress monitoring data for one student. Round dots indicate the number of correct student responses on each progress monitoring assessment. Here, scores for correct responses are provided for two instructional interventions across about 17 weeks. Three baseline scores were collected during the first week. The diamond indicates the median score for baseline performance. In this example, the end-of-year goal was set at 30 (the triangle). The diagonal line connecting median baseline performance (i.e., the diamond) with the end-of-year goal (i.e., the triangle) is the goal line. The goal line illustrates the anticipated rate of growth this student needs to demonstrate throughout the year in order to meet the year-end goal.

After collecting baseline performance, the teacher devised an instructional program for this student. Initial implementation is indicated by the first vertical line on the graph. The teacher administered and graphed the scores from the progress monitoring measures once a week. During this first intervention phase, the student did not perform at the desired rate. The teacher determined that he would fall short of the year-end goal if instruction remained static. The teacher made another instructional modification (shown by the second vertical line).

The teacher continued to monitor student progress weekly to assess the effectiveness of the second intervention. The student appeared to be improving dramatically. Teachers typically use standard decision-making rules to interpret graphed data, allowing them to formatively develop more effective instructional interventions for each student.

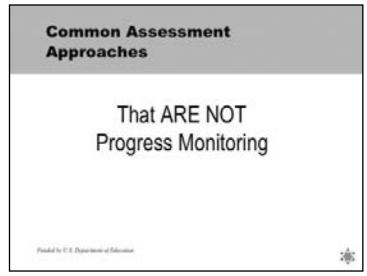
Supplemental Information

Although beyond the scope of this presentation, goal-setting strategies typically involve the use of normative information about student performance levels and growth rates. More specific information about goal setting can be obtained from mathematics presentation materials (Summer Institutes) on the National Center for Student Progress Monitoring website: http://www.studentprogress.org.

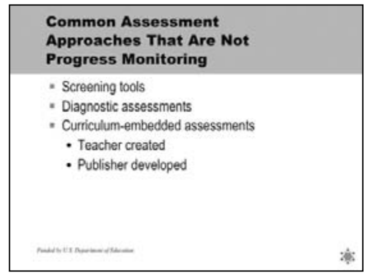
SLIDE 10

Talking Points

Progress monitoring is often confused with other types of evaluation procedures. Consequently, this next section discusses the differences between progress monitoring and other common forms of assessments. First, we begin by describing assessment practices that teachers use frequently but that are not considered to be progress monitoring.



SLIDE 11



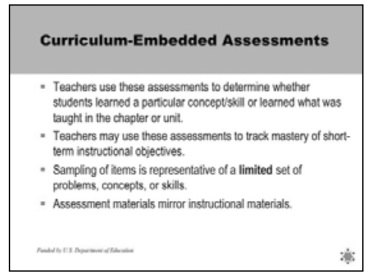
Talking Points

Three types of assessments that are not progress monitoring are screening tools, diagnostic assessments, and curriculum-embedded assessments. Screening tools are typically broad-based and are used to target students who could be potentially at risk for developing difficulties in that domain. Scores typically are compared to pre-established benchmarks, often a particular percentile or cut score. If the student does not score at or above this criterion, it is unlikely that he or she will develop typically in that academic area without some type of intervention. Most screening instruments are given only once or several times during the year (e.g., fall, winter, spring). Although some screening tools also may be used for progress monitoring when alternate forms are provided, by definition, assessments must be used on at least a monthly basis for decision making to be considered progress monitoring measures.

Diagnostic assessments provide more in-depth information about a student's performance in particular conceptual or skill areas. For example, a diagnostic assessment may help a teacher to determine that a student has difficulty with subtraction with regrouping when 0s are used in the minuend.

Curriculum-embedded tests examine student performance on the content that has been taught. Examples of curriculum-embedded tests include teacher-made tests and tests that are published as a part of curricular series. Although screening, diagnostic, and curriculum-embedded assessments may yield useful information, none of these types of measures are considered to be progress monitoring tools.

SLIDE 12



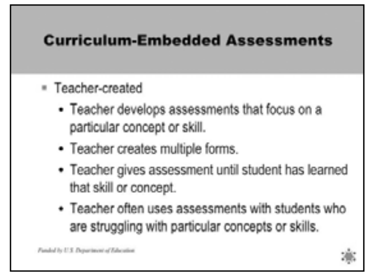
Talking Points

Teachers probably use curriculum-embedded assessments most frequently as a part of their instructional program. Curriculum-embedded tests help determine whether students have learned the critical skills in the curriculum. The curricular program may include its own version of chapter/unit/book tests, or teachers may make their own tests. Teachers use curriculum-embedded tests to track whether students have mastered particular skills and knowledge. Typically, the set of items on the test represents a limited number of problems, concepts, or skills, and decisions are made about student mastery of short-term objectives. These assessments often look much like the materials used during instruction.

SLIDE 13

Talking Points

When teachers develop their own curriculum-embedded tests, they typically follow a particular sequence of steps. If they decide to check student performance during instruction, they first determine the skill and/or concept to be instructed and assessed. They develop multiple assessment forms that reflect those particular skills or concepts. Then the teacher administers an alternate form of the assessment on a frequent basis to check whether the student is learning the skill. When performance indicates that the skill has been mastered, the teacher moves on to a new skill for instruction and devises a new set of tests to assess mastery of this new skill. This type of teach-and-test routine is probably used most frequently with low-achieving students to determine when mastery occurs and when a new skill(s) can be taught.

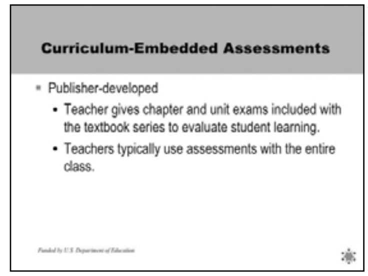


Note: an example of another type of curriculum-embedded assessment (publisher developed) is described on the next slide.

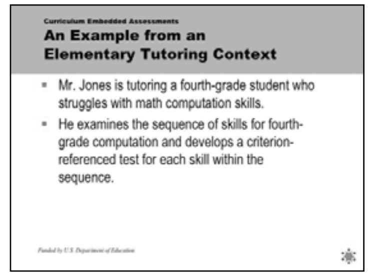
SLIDE 14

Talking Points

Teachers frequently use curriculum-embedded tests (i.e., chapter or unit tests) that are provided by the publisher of the basal or textbook series utilized in the classroom. Teachers typically use these types of tests with the entire class to evaluate whether students have learned the content covering a particular portion of the curriculum.



SLIDE 15



Background Information

Slides 15–22 illustrate how teacher-developed, curriculum-embedded assessments play out in an individualized tutoring context. A fictitious fourth-grade teacher is tutoring a low-achieving student on computational skills.

Talking Points

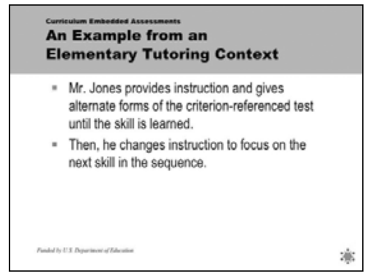
This example illustrates a curriculum-embedded approach to assessment within a tutoring context. Mr. Jones is tutoring a student who is experiencing difficulties with fourth-grade computational skills. Mr. Jones first determines on which skills within an instructional sequence his student is weak. He creates alternate forms of criterion-referenced tests that contain multiple problems of this type. He then sets a benchmark, or criterion, for mastery of the skill or concept. Additional instruction is provided, and alternate forms of these criterion-referenced assessments are given frequently to determine student mastery of the skill. When his student reaches the criterion for mastery, Mr. Jones moves to a new skill for instruction and develops a new set of criterion-referenced tests to match the new skill being instructed.

This is NOT an example of progress monitoring, however, because it is specific to one skill or concept.

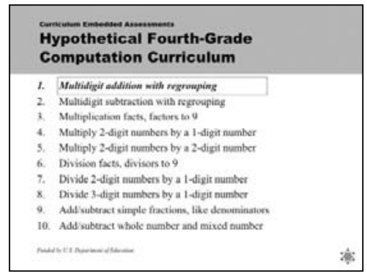
SLIDE 16

Talking Points

Mr. Jones delivers instruction on a skill and gives an alternate form of the criterion-referenced test every day or a couple of times per week to check mastery. When the student reaches the criterion for mastery, he moves to a new skill for instruction.



SLIDE 17



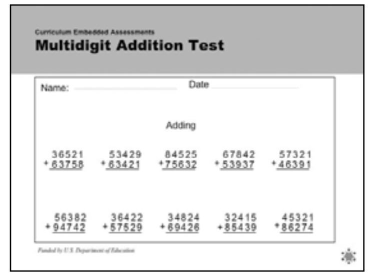
Talking Points

This example provides a hypothetical sequence of mathematics computational skills in a fourth-grade curriculum. Mr. Jones determines that his student has difficulty with multi-digit addition with regrouping, so he focuses instruction on this skill.

Supplemental Information

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

SLIDE 18



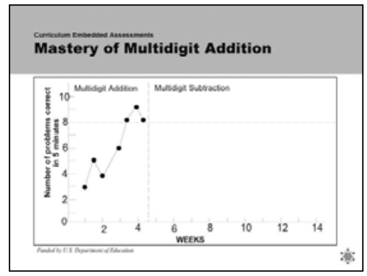
Talking Points

Here is an example of a criterion-referenced test that Mr. Jones developed to check whether his student was mastering multi-digit addition with regrouping. He gives an alternate form frequently (e.g., daily or a couple of times per week) to evaluate student mastery of the skill. He sets at least 8 of 10 problems correct on three successive occasions as the criterion for mastery of this skill. All of these problems assess addition with regrouping even if the particular difficulty level of the items varies somewhat, depending on the number of regroupings required or their placement within the problems.

Supplemental Information

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

SLIDE 19



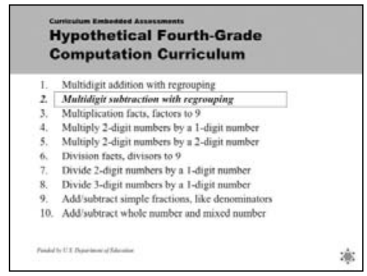
Talking Points

Mr. Jones teaches multi-digit addition with regrouping and assesses his students' performance a couple of times each week until they student reach the set criterion. Here a student has met the criterion for mastery (i.e., at least 8 of 10 problems correct on three, successive occasions), so the teacher changes the focus of instruction to the next skill.

Supplemental Information

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

SLIDE 20



Talking Points

The teacher targets the next skill in the sequence for instruction. In this curriculum, Mr. Jones plans instruction for multi-digit subtraction with regrouping next.

Supplemental Information

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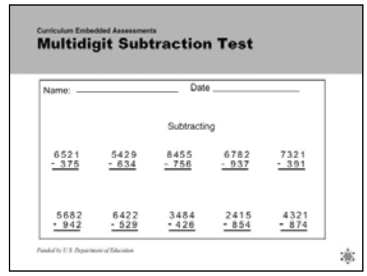
SLIDE 21



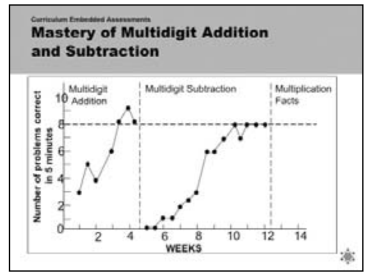
Talking Points

First, Mr. Jones develops a new set of alternate measures to assess student performance on multi-digit subtraction with regrouping. Again, he sets the criterion for mastery as at least 8 problems correct out of 10 on three successive occasions and gives his student an alternate form of this test on a twice-weekly basis.

Supplemental Information

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

SLIDE 22



Talking Points

Mr. Jones has organized his tutoring sessions to insure that the student is progressing through the skills of the fourth-grade curriculum. Once the student has achieved mastery of multi-digit addition, Mr. Jones begins instruction in multi-digit subtraction with regrouping. He gives a "curriculum-embedded measure" twice weekly until his student reaches the criterion for mastery. By examining this graph, we see that, although the student has now supposedly learned two skills, the measurement task has changed from one skill to another. Mr. Jones doesn't really know with this evaluation system whether the student has maintained mastery of the first skill (multidigit addition with regrouping).

Now that Mr. Jones's student has reached the criterion for mastery on multidigit subtraction with regrouping, he moves to instruction in basic multiplication facts. However, Mr. Jones must devise a new set of curriculum-embedded tests to assess proficiency on this skill. One of the critical features of curriculum-embedded assessment is that a close link exists between the instructional content and the content that is assessed. As the instructional content changes, so does the assessment content.

Although Mr. Jones is using teacher-developed, curriculum-embedded tests to determine successive mastery of specific skills (problem types), he is not really able to judge whether the student is on-track toward accomplishing the year-end goal. Curriculum-embedded assessments for different skills vary in their level of difficulty, so performance cannot be compared from one skill to the next. Consequently, Mr. Jones is not able describe his student's overall progress through the curriculum toward the year-end goal. He is able to gauge student performance only within each specific skill area.

Supplemental Information

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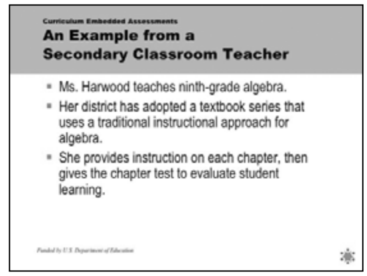
SLIDE 23

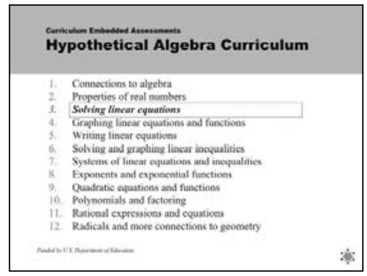


Background Information

Slides 23–25 illustrate how curriculum-embedded assessments play out in typical general education classrooms. The slides use a fictional ninth-grade algebra teacher and her annual curriculum for the illustration.

Talking Points

Let's consider how curriculum-embedded assessment might look at the secondary level. Consider Ms. Harwood's situation. This example is typical of many secondary mathematics classrooms in the country.



SLIDE 24

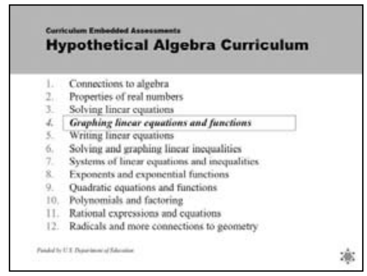
Background Information

The list of topics on this slide was drawn from the chapter titles of a commonly used Algebra 1 textbook.

Talking Points

This list reflects the chapters in Ms. Harwood's textbook. Most publishing companies provide teachers with assessments, such as chapter and unit tests or performance assessment activities, to use with the instructional materials. If Ms. Harwood is teaching Chapter 3 on solving linear equations, it is likely that she would use the test or assessment materials provided by the publisher to evaluate her students' learning on Chapter 3. This is an example of curriculum-embedded assessment.

SLIDE 25



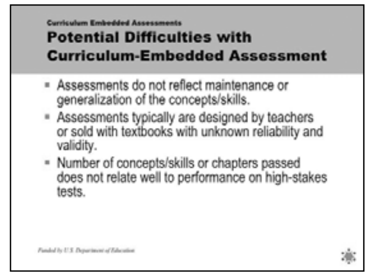
Background Information

The list of topics on this slide was drawn from the chapter titles of a commonly used Algebra 1 textbook.

Talking Points

After completing Chapter 3, Ms. Harwood would next move to Chapter 4 on graphing linear equations and functions. If she were using a curriculum-embedded approach to assessment, she would again turn to the publishers' assessment materials or perhaps to assessments she has designed herself in order to evaluate her students' learning of the content in Chapter 4. One of the critical features of curriculum-embedded assessment is that there is a close link between the instructional content and the content that is assessed. As the instructional content changes, so does the assessment content.

SLIDE 26



Background Information

The purpose of Slides 26 and 27 is to help audience members recognize the limitations of curriculum-embedded assessments. These limitations also will provide a context for considering the features of progress monitoring assessments, many of which provide a direct remedy to these limitations.

Talking Points

Although curriculum-embedded tests may yield some information about specific skills/concepts, these assessments are associated with several limitations. First, when the teacher changes the content of the assessment to a new skill (e.g., from addition with regrouping to subtraction with regrouping), maintenance of previously learned skills is not monitored. Also, generalization of learned information to other skills cannot be evaluated when the focus or content of the assessment changes to a new skill and is limited to only one type of problem or operation.

A second limitation is related to technical aspects of the tests and testing procedures. Reliability and validity are critical features of assessments that are used for decision-making purposes. However, most curriculum-embedded tests made by teachers or developed by textbook publishers have unknown reliability and validity. Another limitation relates to the misguided assumption that the greater number of skills that are assessed and judged as adequate, the better the student will do on year-end achievement tests. Of particular concern is the problem that students may progress through the sequence of chapter- or skill-based tests with adequate scores, but still not be synthesizing or generalizing this information at a level that translates into competence in mathematics as reflected on high-stakes tests.

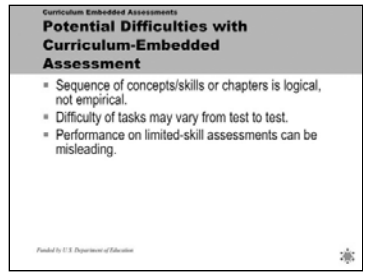
Supplemental Information

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

Supplemental References

Deno, S. L. (1985). Curriculum-based measurement: The emerging alternative. *Exceptional Children*, *52*, 210–232.

SLIDE 27



Talking Points

Several other limitations occur with curriculum-embedded assessments. Although the sequence of skills for instruction may appear logical (i.e., one skill seems easier than the next skill taught later) or teachers may be following a district-level pacing guide, the order of skills for instruction and assessment is not based on research. In other words, a different skill sequence could support better learning for particular students. Additionally, when the content changes on the new assessments, so does the difficulty level of the tests. Thus, the student's progress for one type of skill cannot be compared directly to progress made on another type of skill. Moreover, these curriculum-embedded assessments typically provide information only on limited skill sets. As a result, curriculum-embedded assessments often do not illustrate how a student actually progresses through the curriculum. Instead, these curriculum-embedded assessments show only performance on specific skills or concepts.

Supplemental Information

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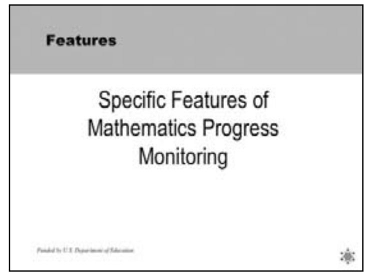
Supplemental References

Deno, S. L. (1985). Curriculum-based measurement: The emerging alternative. *Exceptional Children*, *52*, 210–232.

SLIDE 28



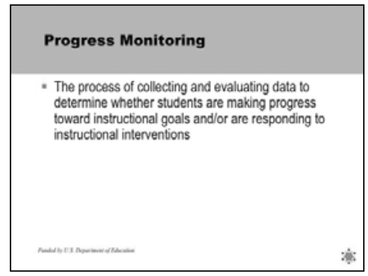
Background Information

This section, Slides 28–40, provides the definition and further description of critical features of progress monitoring systems.

Talking Points

This section covers what makes progress monitoring distinctive. Although some features are shared with other types of assessments, progress monitoring measures are developed and used in very specific ways.

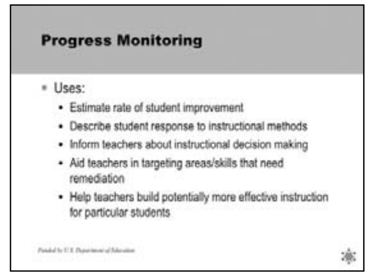
SLIDE 29



Talking Points

In progress monitoring, teachers collect data in an ongoing fashion to determine the progress students are making and whether that progress is sufficient to ultimately meet year-end goals. By judging the adequacy of student progress, teachers also are indicating whether their instructional methods are working appropriately (i.e., bringing about the desired effect) for particular students.

SLIDE 30

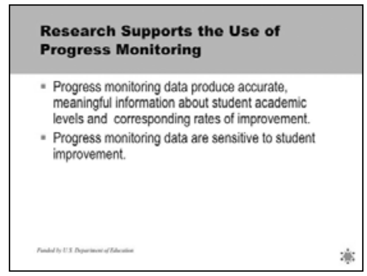


Talking Points

Teachers use progress monitoring data to determine a student's rate of improvement in response to particular instructional methods. If the rate of improvement (trend line) does not match (is less steep than) the expected rate of progress (goal line), the teacher should make instructional changes to better meet student needs.

Actual student responses (e.g., error analysis) on the progress monitoring measures may indicate where the student is having difficulty, allowing the teacher to target particular skills or concepts for remediation. By using progress monitoring data in this way—that is, testing out the effects of programmatic changes on student progress—teachers can build, formatively, more effective instructional programs over time for particular students.

SLIDE 31



Talking Points

Research confirms that progress monitoring data produce meaningful information about overall student performance in an academic area and can show students' rate of improvement in the curriculum over time. These scores also are sensitive to student change in terms of either improvement or deterioration.

Supplemental Information

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

Supplemental References

Many of the experimental-contrast design studies addressing the use of progress monitoring data for enhancing student learning and improving teachers' instructional decision have been conducted by Lynn and Doug Fuchs and their colleagues at Peabody College of Vanderbilt University. Several key references addressing this question in mathematics are included here:

Fuchs, L. S., Fuchs, D., & Hamlett, C. L. (1989). Effects of alternative goal structures within curriculum-based measurement. *Exceptional Children*, *55*, 429–438.

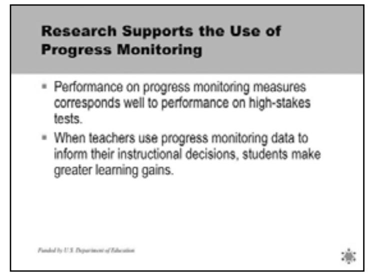
Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Stecker, P. M. (1990). The role of skills analysis in curriculum-based measurement in math. *School Psychology Review*, *19*(1), 6–22.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Stecker, P. M. (1991). Effects of curriculum-based measurement and consultation on teacher planning and student achievement in mathematics operations. *American Educational Research Journal*, *28*, 617–641.

Stecker, P. M., & Fuchs, L. S. (2000). Effecting superior achievement using curriculum-based measurement: The importance of individual progress monitoring. *Learning Disabilities Research and Practice*, *15*(3), 128–134.

Stecker, P. M., Fuchs, L. S., & Fuchs, D. (2005). Using curriculum-based measurement to improve student achievement: Review of research. *Psychology in the Schools*, *42*, 795–819.

SLIDE 32



Talking Points

Studies demonstrate that student scores on progress monitoring measures correlate well with student performance on other types of academic measures, such as standardized, norm-referenced tests and states' high-stakes measures. Progress monitoring systems have been emphasized in recent years because research shows greater overall achievement gains among students whose teachers use such systems compared to teachers who use their own evaluation and instructional planning methods.

Supplemental Information

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Many of the experimental-contrast design studies in this field have been conducted by Lynn and Doug Fuchs and their colleagues at Peabody College of Vanderbilt University. Several key references addressing this question in mathematics are included here:

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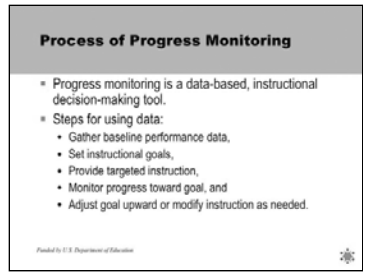
Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Stecker, P. M. (1991). Effects of curriculum-based measurement and consultation on teacher planning and student achievement in mathematics operations. *American Educational Research Journal*, *28*, 617–641.

Stecker, P. M., & Fuchs, L. S. (2000). Effecting superior achievement using curriculum-based measurement: The importance of individual progress monitoring. *Learning Disabilities Research and Practice*, *15*(3), 128–134.

Stecker, P. M., Fuchs, L. S., & Fuchs, D. (2005). Using curriculum-based measurement to improve student achievement: Review of research. *Psychology in the Schools*, *42*, 795–819.

SLIDE 33



Background Information

This slide and the next one illustrate the overall set of procedures for conducting progress monitoring.

Talking Points

Teachers use progress monitoring as a systematic way to make instructional decisions based on student data.

First, the teacher evaluates the student's current performance on the progress monitoring measures. This baseline information may be used to target an ambitious but realistic goal for the end of the year. The teacher provides instruction and continues to monitor student progress on a frequent basis.

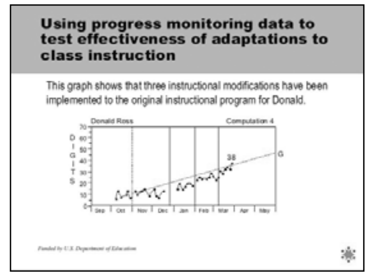
At periodic intervals, the teacher evaluates whether student progress appears adequate to meet the established goal by the end of the year. The teacher poses this question: "If the student's progress continues in this same manner for the rest of the year, is it likely that he or she will achieve the year-end goal?" If student progress appears insufficient, the teacher responds by making one or more instructional modifications. If the student is actually doing better than anticipated (i.e., trend of student data is steeper than the goal line), the teacher would raise the level of the goal. Teachers should not leave low expectations in place when the student appears to be making progress faster than expected

Supplemental Information

The teacher should never adjust the goal downward. Research indicates that students tend to work harder and achieve more when teachers set ambitious goals, whether or not students actually meet those particular goals.

When the student's rate of progress mirrors the rate established by the goal line, the teacher may keep the same instructional program in place and continue to collect progress monitoring data, allowing him or her to continue evaluating the adequacy of student progress and make instructional modifications or raise goals as needed.

SLIDE 34



Background Information

This graph depicts the progress monitoring process across the year for one student.

Talking Points

This graph illustrates the use of progress monitoring to develop an effective instructional program. Here, the teacher has administered the same type of progress monitoring tool to Donald throughout the year to determine his rate of improvement. In October, the teacher used baseline performance (an average of six scores collected during the month) to set an end-of-year goal. The red line connects average baseline performance with the year-end goal and shows the rate of progress Donald needs to make throughout the year to attain his goal. Donald's teacher continues to assess his performance with similar measures to monitor Donald's responsive to her instruction. She then compares Donald's actual rate of progress to the red goal line to see if he is moving along adequately toward the long-term goal.

Look at Donald's progress during November and December. He seemed to have changed little during November and December. Consequently, his teacher modified instruction in January to try to better meet Donald's needs. This instructional intervention is shown on the graph by the solid vertical line at the end of December.

Although Donald's performance level increased during January (reasoned to be a result of the instructional modification), the slope of his improvement in January did not match his goal line (i.e., the anticipated slope of improvement required to meet the end-of-year goal). Donald's teacher adjusted instruction again in February in an effort to boost Donald's achievement.

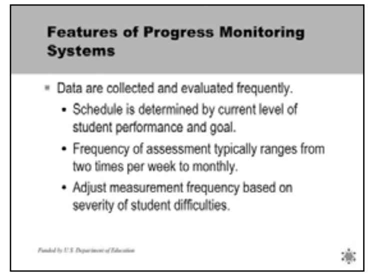
Donald's performance improved somewhat in February, but it started to stabilize (or even deteriorate) in early March. The teacher made yet another instructional adjustment in March. How would you describe Donald's progress during March? Do you think he is likely to meet his end-of-year goal?

Supplemental Information

The dotted vertical line on the graph shows the end of data collection for baseline. Donald's average performance during baseline is marked on the dotted vertical line. Donald's teacher used this average (often a mean or median score) as the beginning point for drawing the goal line. Teachers use baseline information as one piece of information for establishing an appropriately ambitious goal. Information about goal setting can be found in the materials provided by the National Center on Student Progress Monitoring (see below).

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

SLIDE 35

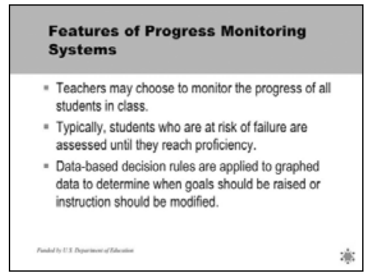


Talking Points

Progress monitoring measures must be administered often enough to provide sufficient data for judging student progress. The testing schedule is determined by student need. Progress monitoring is especially critical for low-achieving students; teachers may opt to administer measures more frequently to these students (once or twice weekly). If students seem to be doing well, a teacher might check their progress only monthly. To meet the definition of true progress monitoring, however, data must be collected at least once a month.

If teachers are collecting data once or twice a week, they will have sufficient data every month or two to draw conclusions about the overall effectiveness of their instructional program and still have enough time to implement instructional modifications as needed.

SLIDE 36



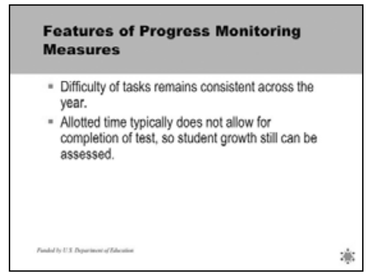
Talking Points

Although teachers might be most concerned about their low-achieving students, they may monitor the progress of all students. Typically, low-achieving students are monitored until they reach levels of proficiency. Teachers evaluate student performance patterns using data-based decision rules. These rules indicate when goals should be raised or when instruction should be modified.

Supplemental Information

Specific data-based rules can be found in the mathematics training materials (Summer Institutes) on the National Center for Student Progress Monitoring website: http://www.studentprogress.org.

SLIDE 37



Talking Points

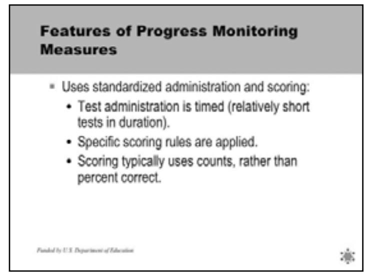
Progress monitoring measures are developed in very specific ways. For example, alternate forms of the measures are created so that students do not memorize problems from test to test. However, the difficulty level of the measures should not change throughout the year. Each measure represents the proficient or desired performance expected by the end of the year. With progress monitoring measures, students are taking shortened versions of the year-end test. By keeping the difficulty level constant, teachers can compare student scores on the graph to reveal improvement or deterioration in achievement.

The amount of time allocated to take the test should also remain constant. Otherwise, scores cannot be compared. The time allotment should not allow students to finish the test. This permits teachers to capture growth for comparatively high-achieving students. Task completion is not a goal of progress monitoring. The focus should stay on capturing student change and growth.

Supplemental Information

Task difficulty could vary throughout the year as long as the measures are equated and anchored to a common scale or metric.

SLIDE 38



Talking Points

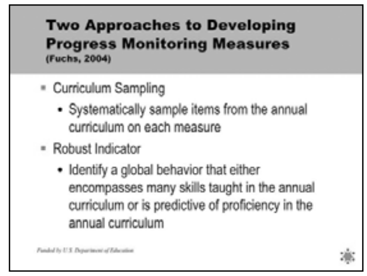
Because progress monitoring graphs involve comparisons of a student's scores over time, test conditions need to remain constant, including the difficulty of the tests and the time allotted for taking them. Tests are relatively short, so teachers can give them frequently without sacrificing a lot of instructional time. Teachers determine scores using standardized procedures and specified scoring rules.

Raw scores, or counts, are the primary data for graphing rather than percent correct. Teachers should not use progress monitoring data for student grades (e.g., as percentage of items completed correctly). Rather, progress monitoring helps teachers evaluate overall student response to the instructional program, as indicated by the adequacy of student progress.

Supplemental Information

The time allocated for test-taking should remain constant for tests given within a grade level. However, the amount of time may differ by grade level, depending on the types of skills and concepts being assessed. In mathematics, measures typically range from 2–15 minutes, with most measures taking 2–8 minutes.

SLIDE 39



Background Information

The information in this slide is drawn from Fuchs' (2004) article, "The Past, Present, and Future of Curriculum-Based Measurement Research" (see reference below). This article is an excellent resource on basic approaches to the development of CBM measures and stages of research to establish those measures as viable for progress monitoring. Presenters are strongly encouraged to read this article carefully.

Talking Points

In a 2004 article in *School Psychology Review*, Lynn Fuchs described two approaches to creating progress monitoring measures. These approaches are particularly relevant to mathematics.

The first approach, curriculum sampling, systematically draws items from the annual curriculum in proportions that reflect their comparative instructional emphasis. For example, curriculum-sampled progress monitoring measures in the early elementary grades would have more problems involving addition and subtraction of whole numbers. Those in the later elementary grades would have whole number problems and problems with fractions, decimals, and percents. Each progress monitoring measure samples from the entire year's instructional curriculum. At the beginning of the school year, students may not be able to answer a large portion of the problems, but, as instruction progresses, they are expected to become more proficient.

Progress monitoring measures using robust indicators consist of more global behaviors that either require students to integrate the range of skills taught in the annual curriculum or are highly correlated with other indicators of proficiency in the annual curriculum.

Supplemental Information

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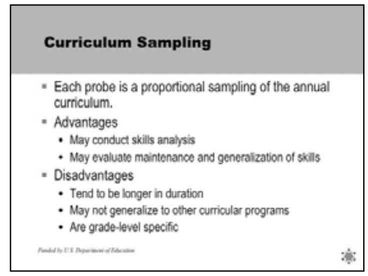
Supplemental References

Fuchs, L. S. (2004). The past, present, and future of curriculum-based measurement research. *School Psychology Review*, *33*, 188–192.

SLIDE 40



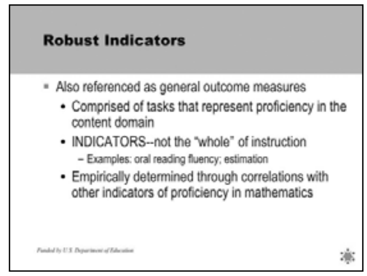
Talking Points

As mentioned, a curriculum-sampled mathematics progress monitoring measure draws from the entire annual instructional curriculum. Teachers need to alert students that there may be questions on the measure that they haven't learned yet.

These data are still useful, though, for conducting skills analyses and determining strengths and weaknesses for individuals and groups of students. Teachers will need to continually keep in mind which concepts have not yet been taught. Also, each measure provides data on the degree to which students are maintaining and generalizing skills and concepts taught earlier in the academic year.

Curriculum sampling has some disadvantages. First, because these measures represent the annual curriculum, they are often longer and take away more time from instruction. Second, because each measure draws from a specific curriculum, it may not generalize to other curricular programs. Research has not yet clearly answered the question of generalizability among curriculum-sampled measures. Finally, because instruction changes with each grade level, different measures must be created specifically for each grade level's curricular emphases, calling for a greater commitment to and investment in measure development.

SLIDE 41



Talking Points

Robust indicators are also referred to as general outcome measures in the literature. As mentioned earlier, these assessments (or probes) do not span the full range of problem types included in a curriculum. The concept of indicators is particularly important with this approach. These measures do not represent the whole instructional curriculum but they serve as indirect indicators of proficiency in this whole.

A classic example of a robust indicator in reading is oral reading fluency. This simple measure (the number of words read correctly from a passage of text in one minute) clearly does not reflect the entire range of skills and concepts included in any reading curriculum. However, students' performance on this measure highly correlates with overall proficiency in reading, including, decoding, fluency, and comprehension. An example from mathematics is estimation, a robust indicator used at the middle school grades.

The process for developing robust indicators differs from creating measures using curriculum sampling, where measures are developed through a careful analysis of the skills and concepts from the entire annual curriculum. In the development of robust indicators, an empirical process determines which potential tasks produce sufficiently strong correlations with other indicators of mathematics proficiency.

Supplemental Information

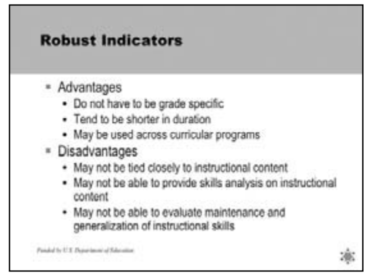
Foegen (2000) and Foegen & Deno (2001) have published research on the use of estimation as a progress monitoring measure for middle school that represents the robust indicator approach. Other examples of robust indicators in mathematics would include basic facts in single or mixed operations.

Supplemental References

Foegen, A. (2000). Technical adequacy of general outcome measures for middle school mathematics. *Diagnostique*, *25*(3), 175–203.

Foegen, A., & Deno, S. L. (2001). Identifying growth indicators for low-achieving students in middle school mathematics. *Journal of Special Education*, *35*, 4–16.

SLIDE 42



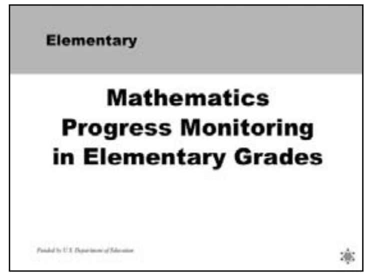
Talking Points

The advantages of robust indicators tend to mirror the disadvantages of curriculum sampled progress monitoring measures. Because robust indicators are not tied to a specific curriculum program nor to a particular grade level, they can be used across both curricular programs and grade levels. In addition, they also tend to take less time to administer because there is less variability in the problem types.

Similarly, the advantages of curriculum sampling measures become the disadvantages of robust indicators. Robust indicators may not have a clear link to the instructional content. In addition, because these measures do not sample the range of instructional skills and concepts, they are less useful to teachers in providing skills analysis information that can directly guide instructional changes. And, robust indicators have less value in assessing students' maintenance and generalization of the skills they have learned throughout the year.

Along with considering the advantages and disadvantages of the two types of approaches, schools should consider what measures are available for the grade in which they want to progress monitor, the reliability and validity evidence for the measures, and other important practical issues such as cost and ease of use.

SLIDE 43



Background Information

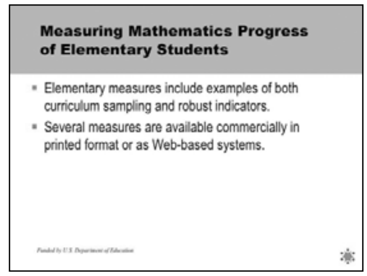
Most of the work in progress monitoring in mathematics has been done at the elementary level. A couple of progress monitoring systems have extended computation and problem solving into the middle school levels. The following slides provide examples of progress monitoring programs used primarily in the elementary grades.

Talking Points

Several commonly used programs for monitoring mathematics progress in the elementary years are highlighted next.

Many of the examples provided in the coming sections have been taken from commercially available products. Those products do not necessarily represent the policy of the U.S. Department of Education, and you should not assume endorsement by the Federal Government or the Center on Instruction.

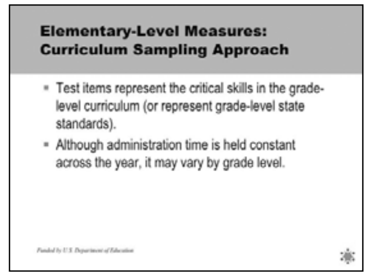
SLIDE 44



Talking Points

Curriculum-based measures in mathematics have been used successfully to monitor the progress of students in the elementary grades since the 1980s. Both types of measures, curriculum sampling and robust indicators, have proven successful at this level. Today, several commercially prepared Web-based systems incorporate progress monitoring in mathematics.

SLIDE 45



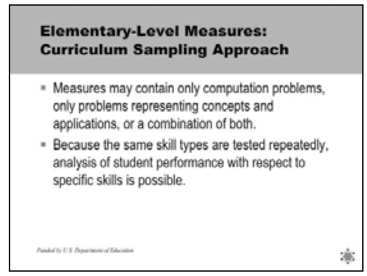
Talking Points

With curriculum sampling, items that represent the critical skills for the year-long curriculum and/or grade-level standards are included on the actual progress measures. Alternate forms test the same types of skills, although the actual numerals in the problems change. Allocated time for test taking stays constant across the year for a particular grade level, but time may vary for different grade levels.

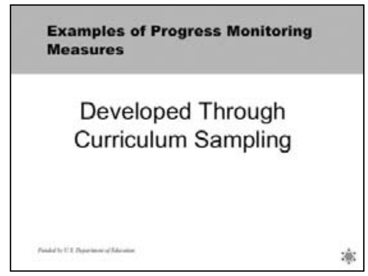
SLIDE 46

Talking Points

Some forms of progress monitoring systems contain items for computation only or for concepts and applications only. Some forms combine computation and problem solving. Whichever method is used, the types of problems remain constant across the year. Because these same skills are tested repeatedly, teachers can analyze student performance with respect to particular problem types. The teacher can develop a skills profile to help him in instructional planning.



SLIDE 47



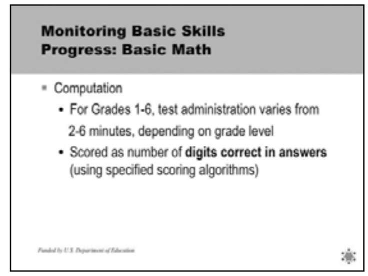
Background Information

Slides 47–55 illustrate several progress monitoring programs that use curriculum sampling.

Talking Points

Several examples of progress monitoring systems using the curriculum sampling method for test development are highlighted next.

SLIDE 48



Background Information

Some practitioners may have been taught to score the number of correct digits in all the intermediate steps of solving a problem instead of just the number of correct digits in the answer. Data for normative growth and benchmark information found in mathematics materials (Summer Institutes) of the National Center on Student Progress Monitoring (http://www.studentprogress.org) are based on scoring correct digits in answers.

Talking Points

A book of blackline masters of 30 alternate probes for each grade level 1–6 is available. These measures were developed by sampling computational skills deemed necessary for grade-level promotion in the Tennessee statewide curriculum in the late 1980s–1990s.

Depending on the specific grade level, allotted time for test administration is 2–6 minutes, and specific scoring rules are applied for evaluating student answers. The number of correct digits in answers is the datum used for graphing progress.

Supplemental Information

Blackline masters of 30 alternate probes for each grade level 1–6 are available from http://www.proedinc.com. These measures have been used in a variety of classroom-based research projects. This work has demonstrated the measures' technical adequacy, typical student growth rates, and usefulness for teachers' instructional planning and subsequent contribution to enhanced student achievement.

Supplemental References

Fuchs, L. S., Hamlett, C. L. & Fuchs, D. (1998). *Monitoring basic skills progress: Basic math computation* (2nd ed.). Austin, TX: PRO-ED. Available: http://proedinc.com.

Quite a few studies have incorporated these measures in their research procedures. The following experimental-contrast studies examined the use of progress monitoring on student achievement. Additional studies can be found in the reference list at the end of this manual.

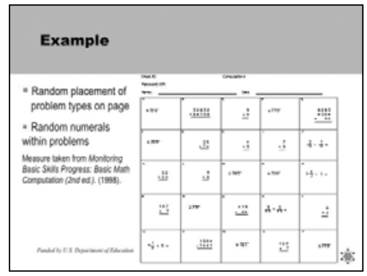
Fuchs, L. S., Fuchs, D., & Hamlett, C. L. (1989). Effects of alternative goal structures within curriculum-based measurement. *Exceptional Children*, *55*, 429–438.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Stecker, P. M. (1990). The role of skills analysis in curriculum-based measurement in math. *School Psychology Review*, *19*(1), 6–22.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Stecker, P. M. (1991). Effects of curriculum-based measurement and consultation on teacher planning and student achievement in mathematics operations. *American Educational Research Journal*, *28*, 617–641.

Stecker, P. M., & Fuchs, L. S. (2000). Effecting superior achievement using curriculum-based measurement: The importance of individual progress monitoring. *Learning Disabilities Research and Practice*, *15*(3), 128–134.

SLIDE 49



Background Information

These probes were developed as part of the first computerized mathematics progress monitoring system when Apple II computers were popular in schools. The computer program is no longer available. However, 30 alternate probes for each grade level (1–6) are provided in one book of blackline masters for computation, which is available for purchase through PRO-ED. A more current hybrid of this type of system (i.e., containing some similar features but also a number of clearly distinctive features) is the Web-based system Yearly Progress ProTM by CTB/McGraw-Hill.

Talking Points

This test is one of 30 alternate forms for fourth-grade computation provided by the Monitoring Basic Skills Progress system. Depending on grade level, test administration time varies from 2–6 minutes. Recommended allotted time for this probe is 3 minutes. Problems are placed randomly on the page, but the same problem types are tested on each form. Each alternate form contains 25 problems. Problems are scored in terms of the number of correct digits in answers.

Supplemental Information

Numerals are randomly generated within problems to the extent that the particular skill allows. For example, if the skill were addition with no regrouping for two, 2 x 2 digit numbers and the first number was 64, then the ones place in the second number could vary only from 0–5 and the tens place could vary only from 1–3.

This and other slides in this presentation were adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

Supplemental References

Fuchs, L. S., Hamlett, C. L. & Fuchs, D. (1998). *Monitoring basic skills progress: Basic math computation* (2nd ed.). Austin, TX: PRO-ED. Available: http://proedinc.com.

Quite a few studies have incorporated these measures in their research procedures. The following experimental-contrast studies examined the use of progress monitoring on student achievement. Additional studies can be found in the reference list at the end of this manual.

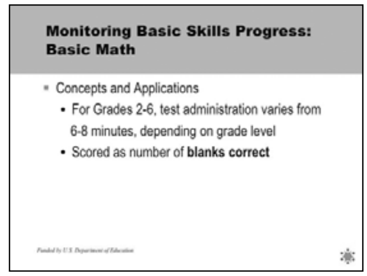
Fuchs, L. S., Fuchs, D., & Hamlett, C. L. (1989). Effects of alternative goal structures within curriculum-based measurement. *Exceptional Children*, *55*, 429–438.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Stecker, P. M. (1990). The role of skills analysis in curriculum-based measurement in math. *School Psychology Review*, *19*(1), 6–22.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Stecker, P. M. (1991). Effects of curriculum-based measurement and consultation on teacher planning and student achievement in mathematics operations. *American Educational Research Journal*, *28*, 617–641.

Stecker, P. M., & Fuchs, L. S. (2000). Effecting superior achievement using curriculum-based measurement: The importance of individual progress monitoring. *Learning Disabilities Research and Practice*, *15*(3), 128–134.

SLIDE 50



Background Information

Data for normative growth and benchmark information found in mathematics materials (Summer Institutes) of the National Center on Student Progress Monitoring (http://www.studentprogress.org) are based on the number of correct blanks completed.

Talking Points

A book of blackline masters of 30 alternate probes for each grade level 2–6 is available for purchase. These progress monitoring measures were developed by sampling concepts and applications skills deemed necessary for grade-level promotion in the Tennessee statewide curriculum in the late 1980s–1990s.

Depending on the specific grade level, allotted time for test administration is 6–8 minutes. Specific scoring rules are applied when evaluating student answers. Some problems require several parts, so each answer blank completed within the problem is scored as right or wrong. The number of correct blanks completed is the datum used for graphing student progress.

(Note: an example of this measure appears on the next slide.)

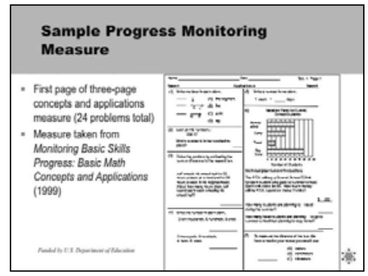
Supplemental Information

Blackline masters of 30 alternate probes for each grade level 2–6 are available for concepts and applications from http://www.proedinc.com.

Supplemental References

Fuchs, L. S., Hamlett, C. L. & Fuchs, D. (1999). *Monitoring basic skills progress: Basic math concepts and applications.* Austin, TX: PRO-ED. Available: http://proedinc.com.

SLIDE 51



Background Information

These probes were developed as part of the first computerized mathematics progress monitoring system when Apple II computers were popular in schools. The program is no longer available for purchase. However, 30 alternate probes for each grade level (2–6) are provided in one book of blackline masters for concepts and applications, which is available for purchase through PRO-ED. Although the concepts and applications blackline masters can be purchased separately from the computation blackline masters, both sets of probes were developed using the same principles and methodology. A more current hybrid of this type of system (i.e., containing some similar features but also a number of clearly distinctive features) is the Web-based system Yearly Progress ProTM by CTB/McGraw-Hill.

Talking Points

This slide shows the first page of a three-page test at the fourth-grade level in concepts and applications. With Monitoring Basic Skills Progress, computation probes are given separately from concepts and applications. Six minutes are allocated for work on this three-page concepts and applications test.

Depending on grade level, test-taking times vary from 6–8 minutes. The concepts and applications problems on each probe require computational skills for figuring many of the answers, but the level of computational skill required for problem completion is no more difficult than the problem types included on the fourth-grade level computation probes. Concepts and applications probes are scored in terms of number of correct blanks (or response opportunities) completed correctly. For example, problem 1 contains three answer blanks, so a student could earn up to three points on Problem 1. However, only one point could be earned on Problem 2, because it contains only one answer blank. The same types of concepts and applications problems are tested on alternate forms, and the number of problems remains the same on each grade level.

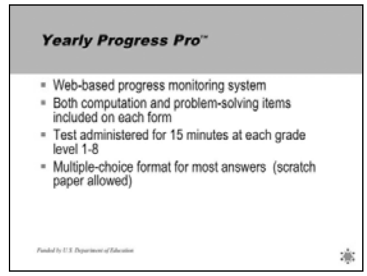
Supplemental Information

A number of slides, including this one, have been adapted from the mathematics training (Summer Institutes) provided by the National Center on Student Progress Monitoring: http://www.studentprogress.org. Individuals may go to the website to learn more specific information about progress monitoring procedures.

Supplemental References

Fuchs, L. S., Hamlett, C. L. & Fuchs, D. (1999). *Monitoring basic skills progress: Basic math concepts and applications.* Austin, TX: PRO-ED. Available: http://proedinc.com.

SLIDE 52



Talking Points

Yearly Progress ProTM is a Web-based version of progress monitoring in mathematics. Tests are taken at the computer for 15 minutes, although students may have paper and a pencil for figuring answers. Students select the correct choice for most of the items, although some problems require typing the numerals for the answers. Both computational and problem-solving items are included in the 30 problems at each grade level 1–8.

(Note: these features continue on the next slide.)

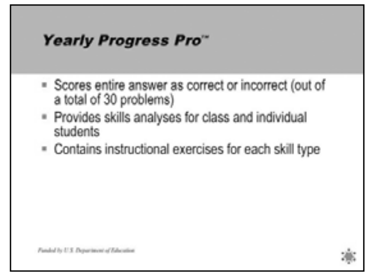
Supplemental Information

An audio option allows students to hear the problems being read aloud. This option may be important for students who have weak reading skills.

Supplemental References

Information about this Web-based program can be found at http://www.mhdigitallearning.com.

SLIDE 53



Background Information

Although developed using similar methods to Monitoring Basic Skills Progress, data for normative growth and benchmark information found in the mathematics materials (Summer Institutes) of the National Center on Student Progress Monitoring (www.studentprogress.org) may not apply to Yearly Progress ProTM measures. Yearly Progress ProTM measures require entire problems to be scored as correct or incorrect, regardless of the number of digits correct in answers or the number of steps in the problem.

Talking Points

Problems are scored as correct or incorrect with graphed scores reflecting the percentage of 30 items answered correctly. Skills analyses are available at both the class and student level. In addition, instructional exercises are provided by the system for each of the problem types tested. Therefore, teachers may assign particular instructional exercises to students who appear to need additional practice.

Supplemental Information

School or district administrators also may have access to the program and can look at student progress by class or grade.

Supplemental References

Information about this Web-based program can be found at www.mhdigitallearning.com.

SLIDE 54

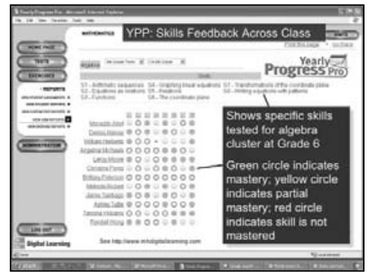
Talking Points

Instructional exercises are provided for each skill. Teachers may assign exercises that include screens with demonstration, guided practice (including corrective feedback), and independent practice (5-problem quiz). This slide shows one screen of an instructional exercise for a geometry skill, but it also illustrates the format for item presentation on the progress monitoring probes. Each problem is presented one at a time on the progress monitoring measures. Students may move forward or backward through the probe.

Supplemental References

Information about this Web-based program can be found at www.mhdigitallearning.com.

SLIDE 55



Talking Points

This screen illustrates the type of information in Yearly Progress ProTM. A different screen shows all the clusters tested at this grade level, but this screen illustrates the analysis for the eight skills in the sixth-grade algebra cluster. Level of mastery (red = not mastered; yellow = partially mastered; green = mastered) is shown for each skill for every student in this class.

Supplemental Information

Each alternate form tests the same set of clusters (e.g., algebra) each time, although the specific skills within each cluster may vary somewhat from test form to test form. Items are presented similarly to what might be seen on standardized, norm-referenced assessments or high-stakes tests. Mastery information for skills analysis is based on the last three items on recent tests for each of the skills in the cluster.

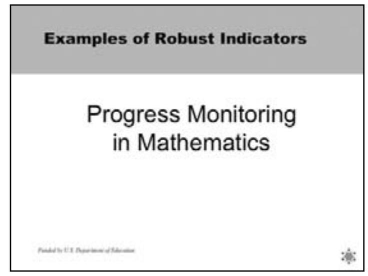
Supplemental References

Information about this Web-based program can be found at www.mhdigitallearning.com.

SLIDE 56

Background Information

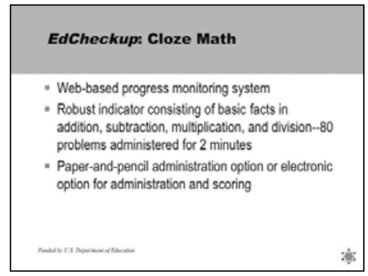
Slides 56–60 illustrate two progress monitoring programs that use robust indicators.



Talking Points

Robust indicators are skills that correlate well with overall proficiency in the subject area. Several monitoring systems include a type of robust indicator as the method for assessing student progress.

SLIDE 57



Talking Points

Edcheckup is a Web-based system that uses the robust indicator approach. Cloze Math provides a basic facts probe, in which a mixed set of 80 problems of addition, subtraction, multiplication, and division facts are presented on two pages. Empty boxes appear in any position within the problem. For example, in an addition problem, a student may need to give the answer for the sum or for an addend. Students have 2 minutes to fill in the boxes.

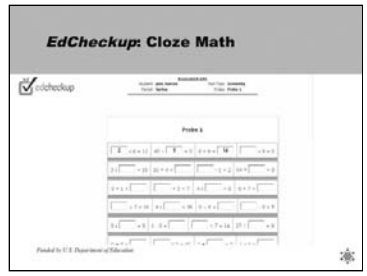
Students may take a paper-pencil test, for which teachers score the measures and enter student scores into the program. The electronic scoring feature may be selected instead, in which students see the probe and type in answers at the computer. When 2 minutes have elapsed, the program scores the answers, provides the score for the student, and saves the score in the system for the teacher. Cloze Math is designed to be used for students in Grades 2–6. Graphs of student progress are provided as well as other types of feedback for the teacher or school administrator.

(Note: an example of this measure appears on the next slide.)

Supplemental References

Information about this Web-based program can be found at www.edcheckup.com.

SLIDE 58



Talking Points

This slide shows the top portion of an electronic math cloze probe in progress. The student already has typed in some of the answers. The test will disappear after 2 minutes and then will save and display the student's score.

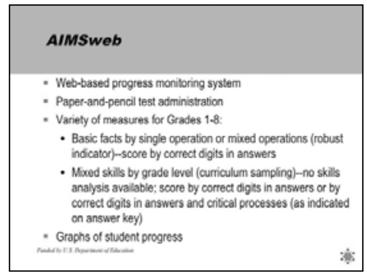
Supplemental Information

The math cloze probes are designed for use with students in Grades 2–6. Edcheckup future plans include the incorporation of a Quantity Math measure for students in kindergarten through second grade. With this measure, students select the larger of two numbers presented.

Supplemental References

Information about this Web-based program can be found at http://www.edcheckup.com.

SLIDE 59



Talking Points

AIMSweb is another Web-based progress monitoring system. Measures are downloaded and printed for students to take as paper-pencil tests. A variety of mathematics measures is provided, but all options include computational skills only. AIMSweb provides probes that have been developed both through the robust indicator approach and through the curriculum sampling approach.

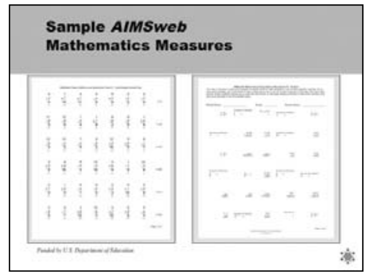
With the robust indicator approach, 2-minute basic facts probes may be selected for single operations or for a mixture of operations (i.e., mixed facts of addition and subtraction, mixed facts of multiplication and division, or mixed facts across all four operations). With the curriculum sampling approach, mixed skills including computation beyond basic facts are included as 2-minute probes for Grades 1–3 and as 4-minute probes for Grades 4–8. Like the other Web-based systems discussed here, graphs of student progress are provided as well as other types of feedback for the teacher and/or school administrator.

(Note: examples of this measure appear on the next slide.)

Supplemental References

Information about this Web-based program can be found at www.aimsweb.com.

SLIDE 60



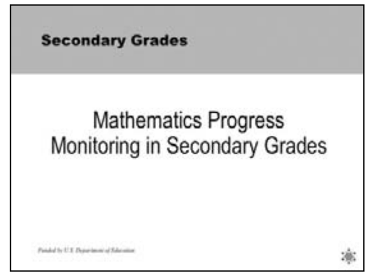
Talking Points

These AIMSweb measures illustrate the use of robust indicators and curriculum sampling. Presented here are examples of mixed basic facts for addition and subtraction on the left and eighth grade mixed computation measure on the right.

Supplemental References

Information about this Web-based program can be found at www.aimsweb.com.

SLIDE 61



Background Information

Although some tools exist for mathematics progress monitoring in the secondary grades, the research evidence and the range of tools is limited to a small body of literature conducted by Helwig and his colleagues and Foegen and her colleagues. Yearly Progress Pro has mathematics measures available for students through Grade 8; research is currently underway to establish the technical characteristics of these measures.

Research work is also underway by Foegen and her colleagues to develop progress monitoring tools in algebra. These measures are included in this presentation to illustrate the types of tools that might be valuable for secondary mathematics teachers. Examples of the measures and technical reports with the research conducted to date on the measures are available on the Project AAIMS website (www.ci.hs.iastate.edu/aaims).

This next section of slides (Slides 61–73) provides examples of current work to develop mathematics progress monitoring measures for secondary mathematics, specifically in algebra.

Talking Points

In this section of the presentation, we take a closer look at some examples of measures developed to measure secondary students' progress in mathematics.

Supplemental References

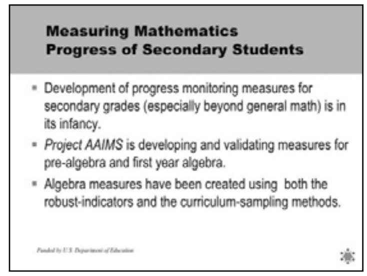
Foegen, A. (2000). Technical adequacy of general outcome measures for middle school mathematics. *Diagnostique*, *25*(3), 175–203.

Foegen, A., & Deno, S. L. (2001). Identifying growth indicators for low-achieving students in middle school mathematics. *Journal of Special Education*, *35*, 4–16.

Helwig, R., Anderson, L., & Tindal, G. (2002). Using a concept-grounded, curriculum-based measure in mathematics to predict statewide test scores for middle school students with LD. *Journal of Special Education*, *36*, 102–112.

Helwig, R., & Tindal, G. (2002). Using general outcome measures in mathematics to measure adequate yearly progress as mandated by Title I. *Assessment for Effective Intervention*, *28*(1), 9–18.

SLIDE 62



Background Information

This section of the slides highlights the work of Project AAIMS (Algebra Assessment and Instruction: Meeting Standards), a federally funded research project directed by Anne Foegen at Iowa State University. Project AAIMS was funded for a three-year period from January 2004 through December 2006. The Project AAIMS website (www.ci.hs.iastate.edu/aaims) includes descriptions of activities, samples of the algebra probes, copies of technical reports, and links to peer-reviewed studies.

Talking Points

Although many options exist for mathematics progress monitoring tools at the elementary level, very little research and development work has been completed for the secondary grades. The middle school measures developed to date focus on general mathematics and are often extensions of existing elementary measures.

This section highlights the work of Project AAIMS (Algebra Assessment and Instruction: Meeting Standards), a grant project funded by the U.S. Department of Education, Office of Special Education Programs. This project developed and validated progress monitoring measures for use in pre-algebra and first year algebra. Four of the potential measures investigated in Project AAIMS are described next. These measures include some that have been developed using curriculum sampling and others that represent the robust indicators approach to development.

More information about Project AAIMS can be found on the project's website www.ci.hs.iastate.edu/aaims.

Supplemental References

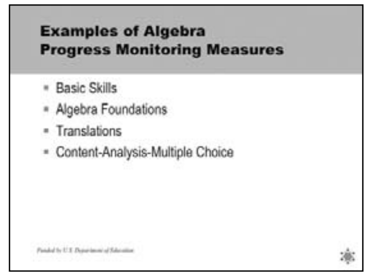
Foegen, A. (2008). Algebra progress monitoring and interventions for students with learning disabilities. *Learning Disability Quarterly*, *31*, 65–78.

Foegen, A., Olson, J. R., & Impecoven-Lind, L. (in press). Developing progress monitoring measures for secondary mathematics: An illustration in algebra. *Assessment for Effective Intervention* *33*(4).

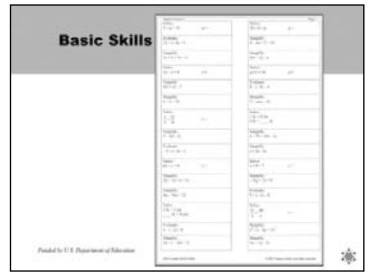
SLIDE 63

Talking Points

These four types of algebra progress monitoring measures are shown next. For each measure, we first will look at a sample of the measure and then discuss development, administration, and scoring procedures.



SLIDE 64



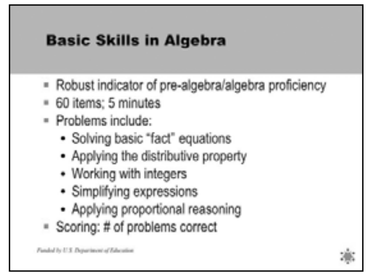
Talking Points

This slide shows the first of two similar pages of the Basic Skills probe that has been developed by Project AAIMS.

Supplemental Information

A full copy of a Basic Skills probe can be downloaded from the Resources page of the Project AAIMS website, www.ci.hs.iastate.edu/aaims.

SLIDE 65

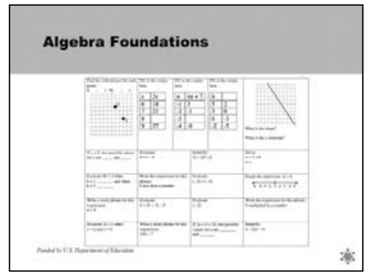


Talking Points

The Basic Skills probes were developed using the robust indicators approach. These probes are appropriate for use in pre-algebra or first year algebra courses. Each probe consists of 60 items that represent five different types of skills (see second bullet). The problems were selected to represent basic skills in algebra that students with a basic level of proficiency in first-year algebra should be able to perform with reasonable fluency.

The problems also include skills that, according to teacher observations, represent barriers to students becoming proficient in algebra, including applications of the distributive property and computations involving integers. Students work on the Basic Skills probes for 5 minutes. Scores are determined by counting the number of problems completed correctly.

SLIDE 66



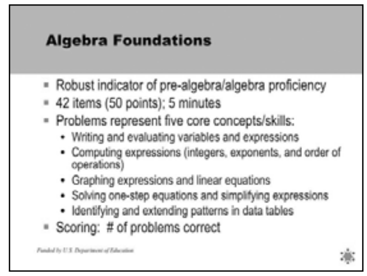
Talking Points

This slide shows the first of two pages of an Algebra Foundations probe.

Supplemental Information

A full copy of an Algebra Foundations probe can be downloaded from the Resources page of the Project AAIMS website, www.ci.hs.iastate.edu/aaims.

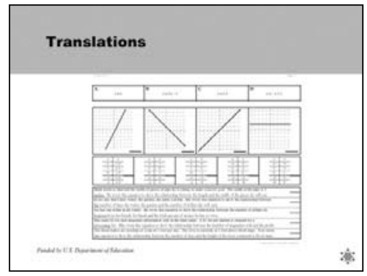
SLIDE 67



Talking Points

The Algebra Foundations probes also were developed using the robust indicators approach. Like the previous measure, they are appropriate for use in pre-algebra and first-year algebra courses. The Algebra Foundations probes were developed to reflect core concepts and skills that are essential to understanding algebra. This probe's concepts and skills align more closely with the content of a pre-algebra course than a first-year algebra course. Five core concepts and skills were used to create the problems included in the probe (see third bullet). Students work on this probe for 5 minutes. Their scores are determined by counting the number of correct responses; 50 possible correct responses are included in each probe.

SLIDE 68



Talking Points

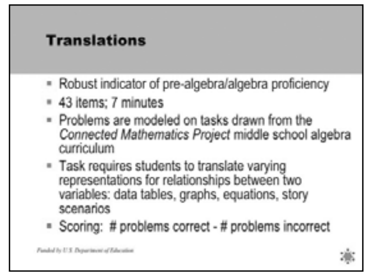
This is the first of three pages of a Translations probe. On the subsequent pages, the format of the information presented in the top row (the A, B, C, D options) varies. On the second page, the first row consists of data tables; on the third, the first row contains graphs.

Students complete this probe by determining "matches" between different representations of the same relationship between two variables. For example, Equation A (y = x) is represented in graphic form in the third graph in the second row, so the student would write an "A" in the blank next to that graph. Similarly, the first data table (in the third row) shows that each of the listed values of x is associated with a y value of 1.5. This data table would match to Equation C, y = 1.5.

Supplemental Information

A full copy of a Translations probe can be downloaded from the Resources page of the Project AAIMS website, www.ci.hs.iastate.edu/aaims.

SLIDE 69



Background Information

This task was adapted from a problem type incorporated in the Connected Mathematics Project (CMP) curriculum, a National Science Foundation-funded middle school curriculum developed at Michigan State University. More information about this curriculum is available on the CMP website, which can be found below.

Talking Points

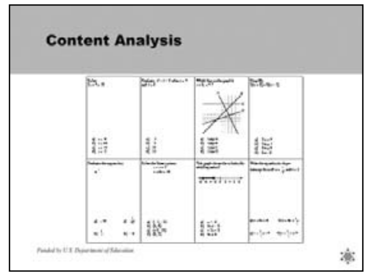
The Translations measure is also a robust indicator, but it represents a very different type of task. The Translations probe has very little emphasis on symbol manipulation and more emphasis on conceptual understanding of the relationships between two variables and the different modes with which these relationships can be represented or modeled. Project AAIMS staff created this probe by adapting a type of problem in the Connected Mathematics Project (CMP) curriculum for middle school students that involved matching different representations of the same relationship between two variables.

In this task, students translate among four different representations: equations, data tables, graphs, and story scenarios. There are 43 problems on this probe; students have 7 minutes to work. Because this probe involves a multiple-choice format, the scoring scheme takes into account the possibility that student responses are based on guessing. A student's final score is computed by subtracting the number of incorrect responses from the total number of problems correct. Students are instructed that they should not make wild guesses when responding to this probe and that a penalty is applied to their score for guessing.

Supplemental References

The Connected Mathematics Project website is located at http://connectedmath.msu.edu.

SLIDE 70



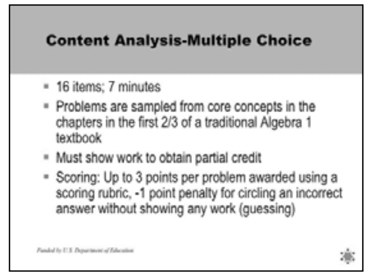
Talking Points

This final example of an algebra progress monitoring measure is a Content Analysis-Multiple Choice probe. The slide shows the first of two pages of this measure. The problems were created by sampling key ideas from the first two-thirds of a traditional Algebra 1 textbook. As with the other examples of progress monitoring measures, the problems are placed in random order. This strategy contrasts with typical curriculum-embedded assessments, which usually place problems on an assessment in order of their difficulty or in the same order in which they were presented in the instructional curriculum.

Supplemental Information

A full copy of a Content Analysis-Multiple Choice probe can be downloaded from the Resources page of the Project AAIMS website, www.ci.hs.iastate.edu/aaims.

SLIDE 71



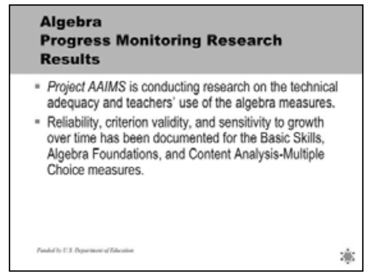
Talking Points

Of the algebra progress monitoring measures highlighted so far, this is the only one that was developed using curriculum sampling. All three of the districts participating in Project AAIMS were using the same textbook series (a traditional Algebra 1 text), so this probe was designed to provide a closer match to the teachers' instructional materials.

The probe consists of 16 problems. Students have 7 minutes to complete as many problems as possible. The problems were drawn from the first two-thirds of the textbook and are presented in a multiple-choice format. Students are instructed to show their work in order to earn partial credit.

Each problem is worth up to 3 points. Students earn full credit by circling the correct answer from among the four choices or by writing the correct answer as part of their written work. A scoring rubric is used to assign 2, 1, or 0 points to problems for which students have made an attempt at the solution, but were not able to correctly solve the problem. If a student circles an incorrect answer and does not show any written work, the response is considered a guess and the student loses 1 point as a penalty for guessing.

SLIDE 72



Background Information

The next two slides provide a brief summary of the research results on the algebra progress monitoring measures at the time when this presentation was developed. The most current information about the measures will be available from the Project AAIMS website.

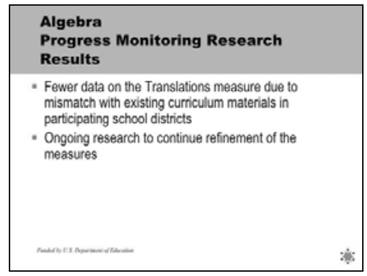
Talking Points

Project AAIMS staff have conducted a series of research studies on the algebra progress monitoring measures. The results obtained to date have demonstrated that three of the measures (Basic Skills, Algebra Foundations, and Content Analysis-Multiple Choice) have adequate levels of reliability, criterion validity, and sensitivity to growth.

Supplemental Information

Complete information about the research conducted on the algebra progress monitoring measures can be obtained through the Technical Reports link on the Research page of the Project AAIMS website, www.ci.hs.iastate.edu/aaims. As published studies become available, they will be listed under the Publications link on the Research page.

SLIDE 73



Background Information

This slide and the previous one provide a brief summary of the research results on the algebra progress monitoring measures at the time of development of this presentation. The most current information about the measures will be available from the Project AAIMS website.

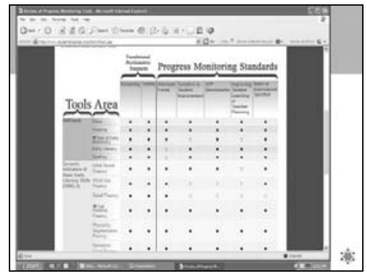
Talking Points

Less research has been conducted on the Translations measure because it did not align well with the traditional instructional materials being used in the districts participating in Project AAIMS. Research is continuing to refine the algebra measures and to examine the degree to which teachers' use of the data can improve student achievement.

Supplemental Information

More complete information about the research conducted on the algebra progress monitoring measures can be obtained through the Technical Reports link on the Research page of the Project AAIMS website, www.ci.hs.iastate.edu/aaims. As published studies become available, they will be listed under the Publications link on the Research page.

SLIDE 74



Background Information

This slide illustrates summary information on a range of progress monitoring tools across content areas. Practitioners should consider the extent of research support available for a particular set of progress monitoring tools as they make selection decisions.

Talking Points

This slide shows a portion of a screen from the National Center on Student Progress Monitoring under the "Tools" section, highlighting results from annual reviews of progress monitoring products that have been submitted to the Center's Technical Review Committee. Vendors voluntarily submit their product information for review.

This chart shows the standards and ratings obtained for each of the progress monitoring systems submitted for review. Adequate technical features as well as adherence to acceptable standards of progress monitoring procedures are important considerations when selecting progress monitoring tools.

Supplemental Information

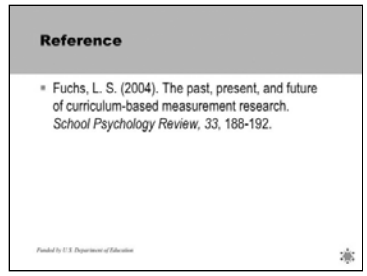
The standards that are evaluated for each measure include: reliability, validity, sufficiency of alternate forms, sensitivity to student improvement, provision of adequate yearly progress (AYP) benchmarks, improvement of student learning or teacher planning, and specification of rates of improvement.

Supplemental References

This tools chart can be found at the National Center on Student Progress Monitoring website, www.studentprogress.org under "Tools" at www.studentprogress.org/chart/chart.asp.

The National Center on Response to Intervention's website also contains information on student progress monitoring. www.rti4success.org.

SLIDE 75



Background Information

This source was cited on slide 39. It identifies curriculum sampling and robust indicators as two approaches to the development of progress monitoring measures. It also described three stages of research necessary to establish progress monitoring measures.

Stage 1 research examines the technical adequacy of the measures as static indicators of student performance at one point in time. Stage 2 research examines the technical characteristics of slopes derived from repeated measurement of student performance as indicators of student rogress. Stage 3 research examines teachers' use of progress monitoring data to effect improved student achievement.

Talking Points

This article by Lynn Fuchs includes a description of the two approaches to developing progress monitoring measures: curriculum sampling and robust indicators. It also describes three stages of research necessary to establish the viability of progress monitoring measures.

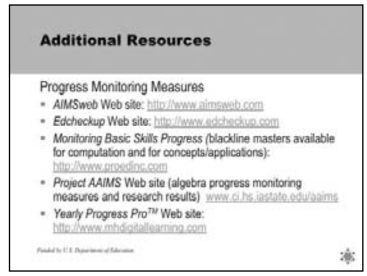
Supplemental References

Although the article by Fuchs (2004) was cited specifically within this PowerPoint presentation, a long list of articles related to progress monitoring, most of which include mathematics, is available at the end of the Presenter's Manual that accompanies this PowerPoint presentation.

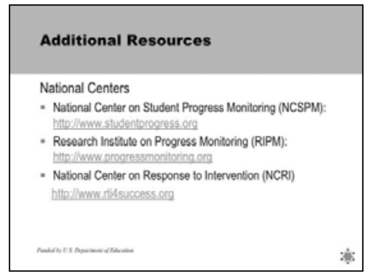
SLIDE 76

Talking Points

More information about the measures briefly described in this presentation can be found at these websites.



SLIDE 77



Talking Points

Presenters who are interested in training materials for mathematics progress monitoring at the elementary level may wish to consult the resources for training available through the U.S. Department of Education's National Center for Student Progress Monitoring: www.studentprogress.org. This website includes all training materials (i.e., PowerPoint presentations, manuals, and handouts) that accompanied recent Summer Institutes of half-day or day-long workshops. Workshops on progress monitoring in mathematics can be downloaded for Summer Institutes conducted in 2005, 2006, and 2007. Web articles on progress monitoring as well as presentation materials for national conferences also can be located here.

The U.S. Department of Education's Research Institute for Progress Monitoring (www.progressmonitoring.org) contains a great deal of information about progress monitoring research, including a searchable database of research articles related to curriculum-based measurement. Investigators affiliated with this national center continue to conduct research in progress monitoring, especially in areas that have been largely underrepresented, including examination of measures for older students and for students with cognitive disabilities.

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