IDENTIFYING PROFESSIONAL DEVELOPMENT NEEDS IN MATHEMATICS

A Planning Tool for Grades 3–7

Second Edition

CENTER ON INSTRUCTION

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INTRODUCTION

Purpose

This document offers a planning tool for grades 3–7 that can be used by regional comprehensive centers, other technical assistance centers, and state departments of education to plan professional development for teachers. It is based on the *National Mathematics Advisory Panel Report* which was published in 2008. The panel synthesized its final report after reviewing 16,000 research publications and policy reports and receiving public testimony from more than 100 individuals. In addition, they reviewed written commentary from 160 organizations and individuals and analyzed survey results from 743 active teachers of algebra. The panel worked as a committee of the whole but largely worked in task groups and subcommittees. Each of the five task groups carried out a detailed analysis of the available evidence in these areas: Conceptual Knowledge and Skills, Learning Processes, Instructional Practices, Teachers and Teacher Education, and Assessment.

This tool can be useful for educators as they engage in careful planning and consideration of the "benchmarks for the critical foundations" recommended by the panel. The benchmarks can be found in Table 2 of the panel's report, "Foundations for Success: The Final Report of the National Mathematics Advisory Panel" (http://www.ed.gov/about/bdscomm/list/mathpanel/index.html.) These benchmarks are necessary for increasing student learning and important to the process of setting meaningful professional development goals.

This tool can be used as a data gathering activity to determine the sources of "performance problems" within an organization (Schnackenberg, Luik, Nisan, & Servant, 2001). Although designed primarily for use by regional and state entities, districts and schools will also find it valuable. It can be used over a period of years to determine patterns and trends in student performance. Data are analyzed to determine the strengths and weaknesses of students and subsequently set priorities for professional development activities.

How the needs assessment tool is organized

This needs assessment document is organized to assist users as they (a) align the benchmarks for the critical foundations with current academic content standards and related test items and (b) examine student performance data relative to the new benchmarks. This document contains a series of working charts, one for each grade from grades three to seven, that will help educators address both of these tasks.

In each chart, the critical foundations are listed in Column A: Benchmarks for the Critical Foundations: Fluency with Whole Numbers (Grades 3–5), Fluency with Fractions, and Geometry and Measurement. Under these broad foundations are the specific benchmarks for each grade level and two subsequent grade levels. Because mathematics instruction is sequential, the additional benchmarks are listed so that users can consider the prerequisite competencies that lead up to the required benchmarks for the following years. There is no empirical research on the placement of these benchmarks, but the panel made these recommendations for state frameworks and school districts. Column B: Related State Content Standards is a place where state content standards, indicators, or objectives that relate to the benchmark can be listed. Column C: Related Test Items is a place to name the relevant state test items or other formative test items relevant to the critical foundation. Column D: Average Percent Meeting Benchmark is a place to record student performance data using state tests, quarterly assessments, or achievement tests pertinent to the standard represented.

How to use the needs assessment tool

Download the Word version of this tool from the COI website and save it on your computer. Here is the link: http://centeroninstruction.org/files/Needs%20Assessment%20for%20Mathematics%20Professional%20Development%20Dynamic%20Tool.doc. The tables in this tool will expand as you add information. Establish professional development priorities by completing one table for each grade level (3–7) using the following steps:

- **Review each of the benchmarks.** Think and talk about the essential conceptual knowledge students will need to reach this expectation.

- **Look at the first benchmark.** Examine state content standards to determine which ones align with the benchmark for the critical foundation or identify the specific indicators or objectives related to it. If the benchmark for the critical foundation is for a grade level beyond the current grade, (e.g. third grade for a fifth grade critical foundation), determine a reasonable standard, indicator, or objective that will lead students to acquire this expectation.
- **Name the relevant test item(s)** that aligns with the first benchmark or document other test data they may have relevancy to that benchmark. Place this information in Column C: Related Test Items.
- **Examine student performance data.** In Column D, record student performance for each item listed in Column C. For each benchmark, compute an average percent if more then one item is listed in Column C.
- **Pinpoint the area of professional development** that is needed by reviewing the information in Column D. Determine the scores in column D that will indicate that professional development is needed. We recommend professional development in areas where students' average performance on the items is below 50 percent and this should be coded yellow. If the average is below 25 percent, we would consider this a serious danger signal and recommend color code of red.

Use the *Needs Assessment Tool for Mathematics Professional Development* to identify important, relevant professional development activities. Discuss whether the needs will require work with teachers to develop their content or pedagogical knowledge or what further needs analysis is necessary to make decisions about professional development.

Consider the following:

- Professional development goals should be based on **multiple data** sets including results from student work, content knowledge surveys from teachers, and teachers' expressed needs.
- **Specifics are important** when using this tool. Details help with preparation and next steps.
- Consistent use of this tool gives a regional center or state a systematic method for planning professional development. Regional centers and states should **review this document periodically**, using the data to make

ongoing decisions about professional development.

- Teams of state or district level personnel may decide to use new criteria to determine areas of support and professional development.
- You may want to use a **color coding system** to represent overall performance for a benchmark. For example, green can represent areas where average performance is adequate (e.g.,., above 50% or 60% depending on state or district expectations). Yellow can represent areas where performance is below average and some sort of professional development or curricula support is necessary (likely when performance is below 50%, but states will set their own thresholds). Red can represent severe problems (e.g., below 25 percent) for which significant professional development and/or curricula support are needed.

Summary

Effective planning is critical to ensure accountability for time and effort spent on professional development. This needs assessment tool can assist users in decision making about the professional development needed to support teachers' learning. Linking related state content standards and test items to the benchmarks for the critical foundations is time consuming and tedious work, and, therefore, should be completed only once every few years or as standards or test items change.

NEEDS ASSESSMENT TOOL FOR MATHEMATICS PROFESSIONAL DEVELOPMENT

Grades 3–7

Second Edition

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Needs assessment tool for mathematics professional development, Second edition

Grade 3

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with whole numbers: By the end of Grade 5 or 6, children should have a robust sense of number. This sense of number must include an understanding of place value and the ability to compose and decompose whole numbers. It must clearly include a grasp of the meaning of the basic operations of addition, subtraction, multiplication, and division. It must also include use of the commutative, associative, and distributive properties; computational facility; and the knowledge of how to apply the operations to problem solving. Computational facility requires the automatic recall of addition and related subtraction facts, and of multiplication and related division facts. It also requires fluency with the standard algorithms for addition, subtraction, multiplication, and division. Fluent use of the algorithms not only depends on the automatic recall of number facts but also reinforces it. A strong sense of number also includes the ability to estimate the results of computations and thereby to estimate orders of magnitude, e.g., how many people fit into a stadium or how many gallons of water are needed to fill a pool.			
1. By the end of grade 3, students should be proficient with the addition and subtraction of whole numbers. This includes developing a robust sense of place value, composing and decomposing whole numbers, and use of the commutative and associative properties. Computational facility and estimation is expected.			
2. By the end of grade 5, students should be proficient with multiplication and division of whole numbers. This includes the understanding and use of the distributive property, developing a robust sense of place value, computational facility and how the operations are interconnected.			

(continued)

Grade 3

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with fractions: Before they begin algebra course work, students should have a thorough understanding of positive as well as negative fractions. Understanding of fraction concepts begins in primary and intermediate grades. Middle school students should be able to locate positive and negative fractions on a number line; represent and compare fractions, decimals, and related percent; and estimate their size. They need to know that sums, differences, products, and quotients (with nonzero denominators) of fractions are fractions, and they need to be able to carry out these operations confidently and efficiently. They should understand why and how (finite) decimal numbers are fractions and know the meaning of percent.			
1. By the end of grade 4, students should be able to identify and represent fractions and decimals, and compare them on a number line or with other common representations of fractions and decimals. This includes understanding how changing the unit makes the fractional value of a given amount different.			
2. By the end of Grade 5, students should be proficient with comparing fractions and decimals and common percents, and with the addition and subtraction of fractions and decimals.			

(continued)

Grade 3

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Geometry and measurement: Middle grade students should be able to analyze the properties of two-and three-dimensional shapes using formulas to determine perimeter, area, volume, and surface area. They should also be able to find unknown lengths, angles, and areas. Understanding of geometry and measurement concepts begins in primary and intermediate grades.			
1. By the end of grade 5 students should be able to solve problems involving perimeter and area of triangles and all quadrilaterals having at least one pair of parallel sides (i.e., trapezoids). This includes understanding multiplication and its conceptual connections to area.			

(continued)

Grade 4

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with whole numbers: By the end of Grade 5 or 6, children should have a robust sense of number. This sense of number must include an understanding of place value and the ability to compose and decompose whole numbers. It must clearly include a grasp of the meaning of the basic operations of addition, subtraction, multiplication, and division. It must also include use of the commutative, associative, and distributive properties; computational facility; and the knowledge of how to apply the operations to problem solving. Computational facility requires the automatic recall of addition and related subtraction facts, and of multiplication and related division facts. It also requires fluency with the standard algorithms for addition, subtraction, multiplication, and division. Fluent use of the algorithms not only depends on the automatic recall of number facts but also reinforces it. A strong sense of number also includes the ability to estimate the results of computations and thereby to estimate orders of magnitude, e.g., how many people fit into a stadium or how many gallons of water are needed to fill a pool.			
1. By the end of grade 5, students should be proficient with multiplication and division of whole numbers. This includes the understanding and use of the distributive property, and developing a robust sense of place value, computational facility, and how the operations are interconnected.			

(continued)

Grade 4

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with fractions: Before they begin algebra course work, middle school students should know that sums, differences, products, and quotients (with nonzero denominators) of fractions are fractions, and they need to be able to carry out these operations confidently and efficiently. They should understand why and how (finite) decimal numbers are fractions and know the meaning of percent. Beyond computational facility with specific numbers, the subject of fractions, when properly taught, introduces students to the use of symbolic notation and the concept of generality, both being integral parts of algebra.			
1. By the end of grade 4, students should be able to identify and represent fractions and decimals, and compare them on a number line or with other common representations of fractions and decimals. This includes understanding how division and fractions are related and the part/whole nature of fractions.			
2. By the end of Grade 5, students should be proficient with comparing fractions and decimals and common percent, and with the addition and subtraction of fractions and decimals. This includes the part/whole nature of fractions verses the part/part or part/whole nature of ratios.			
3. By the end of grade 6, students should be proficient with multiplication and division of fractions and decimals. This includes understanding generalizations such as the multiplication of rational numbers less than one but greater than 0 produces a smaller product.			
4. By the end of grade 6, students should be proficient with all operations involving positive and negative integers.			

(continued)

Grade 4

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Geometry and measurement: Middle grade students should be able to analyze the properties of two-and three-dimensional shapes using formulas to determine perimeter, area, volume, and surface area. They should also be able to find unknown lengths, angles, and areas. Understanding of geometry and measurement concepts begins in primary intermediate grades.			
1. By the end of grade 5, students should be able to solve problems involving perimeter and area of triangles and all quadrilaterals having at least one pair of parallel sides (i.e., trapezoids, rhombus). This includes visualizing how a composite shape decomposes into others shapes.			
2. By the end of grade 6, students should be able to analyze the properties of two-dimensional shapes and solve problems involving perimeter and area, and analyze the properties of three-dimensional shapes and solve problems involving surface area and volume.			

(continued)

Grade 5

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with whole numbers: By the end of Grade 5 or 6, children should have a robust sense of number. This sense of number must include an understanding of place value and the ability to compose and decompose whole numbers. It must clearly include a grasp of the meaning of the basic operations of addition, subtraction, multiplication, and division. It must also include use of the commutative, associative, and distributive properties; computational facility; and the knowledge of how to apply the operations to problem solving. Computational facility requires the automatic recall of addition and related subtraction facts, and of multiplication and related division facts. It also requires fluency with the standard algorithms for addition, subtraction, multiplication, and division. Fluent use of the algorithms not only depends on the automatic recall of number facts but also reinforces it. A strong sense of number also includes the ability to estimate the results of computations and thereby to estimate orders of magnitude, e.g., how many people fit into a stadium or how many gallons of water are needed to fill a pool.			
1. By the end of grade 5, students should be proficient with multiplication and division of whole numbers. This includes the understanding and use of the distributive property, and developing a robust sense of decimal place value, computational facility, and how the operations are interconnected.			

(continued)

Grade 5

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with fractions: Before they begin algebra course work, middle school students should have a thorough understanding of positive as well as negative fractions. They should be able to locate positive and negative fractions on a number line; represent and compare fractions, decimals, and related percent; and estimate their size. They need to know that sums, differences, products, and quotients (with nonzero denominators) of fractions are fractions, and they need to be able to carry out these operations confidently and efficiently. They should understand why and how (finite) decimal numbers are fractions and know the meaning of percent. They should encounter fractions in problems in the many contexts in which they arise naturally, for example, to describe rates, proportionality, and probability. Beyond computational facility with specific numbers, the subject of fractions, when properly taught, introduces students to the use of symbolic notation and the concept of generality, both being integral parts of algebra.			
1. By the end of Grade 5, students should be proficient with comparing common fractions and decimals and common percent, and with the addition and subtraction of fractions and decimals. This includes the part/whole nature of fractions verses the part/part or part/whole nature of ratios.			
2. By the end of grade 6, students should be proficient with multiplication and division of fractions and decimals. This includes understanding generalizations such as the multiplication of two rational numbers less than one but greater than 0 produces a smaller product.			
3. By the end of grade 6, students should be proficient with all operations involving positive and negative integers.			

(continued)

Grade 5

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
4. By the end of grade 7, students should be proficient with all operations involving positive and negative fractions.			
5. By the end of grade 7, students should be able to solve problems involving percent, ratio, and rate and extend this work to proportionality. This includes understanding that fractions and percents are one type of part/whole ratio where as rates are not part/whole.			

(continued)

Grade 5

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Geometry and measurement: Middle school students should be able to analyze the properties of two-and three-dimensional shapes using formulas to determine perimeter, area, volume, and surface area. They should also be able to find unknown lengths, angles, and areas.			
1. By the end of grade 5, students should be able to solve problems involving perimeter and area of triangles and all quadrilaterals having at least one pair of parallel sides (i.e., trapezoids, rhombus). This includes visualizing how a composite shape decomposes into others shapes.			
2. By the end of grade 6, students should be able to analyze the properties of two-dimensional shapes and solve problems involving perimeter and area, and analyze the properties of three-dimensional shapes and solve problems involving surface area and volume.			
3. By the end of grade 7, students should be familiar with the relationship between similar triangles and the concept of the slope of a line.			

(continued)

Grade 6

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with fractions: Before they begin algebra course work, middle school students should have a thorough understanding of positive as well as negative fractions. They should be able to locate positive and negative fractions on a number line; represent and compare fractions, decimals, and related percent; and estimate their size. They need to know that sums, differences, products, and quotients (with nonzero denominators) of fractions are fractions, and they need to be able to carry out these operations confidently and efficiently. They should understand why and how (finite) decimal numbers are fractions and know the meaning of percent. They should encounter fractions in problems in the many contexts in which they arise naturally, for example, to describe rates, proportionality, and probability. Beyond computational facility with specific numbers, the subject of fractions, when properly taught, introduces students to the use of symbolic notation and the concept of generality, both being integral parts of algebra.			
1. By the end of grade 6, students should be proficient with multiplication and division of fractions and decimals. This includes understanding generalizations such as the multiplication of rational numbers less than one but greater than 0 produces a smaller product.			
2. By the end of grade 6, students should be proficient with all operations involving positive and negative integers.			
3. By the end of grade 7, students should be proficient with all operations involving positive and negative fractions.			
4. By the end of grade 7, students should be able to solve problems involving percent, ratio, and rate and extend this work to proportionality. This includes understanding that fractions and percents are one type of part/whole ratio where as rates are not part/whole. Students should also recognize the invariant and covariant nature of both equivalent fractions and proportions.			

(continued)

Grade 6

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Geometry and measurement: Middle grade experience with similar triangles is most directly relevant for the study of algebra. Sound treatments of the slope of a straight line and of linear functions depend logically on the properties of similar triangles. Furthermore, students should be able to analyze the properties of two-and three-dimensional shapes using formulas to determine perimeter, area, volume, and surface area. They should also be able to find unknown lengths, angles, and areas.			
1. By the end of grade 6, students should be able to analyze the properties of two-dimensional shapes and solve problems involving perimeter and area, and analyze the properties of three-dimensional shapes and solve problems involving surface area and volume.			
2. By the end of grade 7, students should be familiar with the relationship between similar triangles and the concept of the slope of a line.			

(continued)

Grade 7

A. Benchmarks for the critical foundations [color code based on column D]	B. Related state content standards	C. Related test items and percent of students with correct answers for each relevant	D. Average percent meeting benchmark
		e.g. Item 1, 80% e.g. Item 11, 40% e.g. Item 70, 60%	e.g. 60%
Fluency with fractions: Before they begin algebra course work, middle school students should have a thorough understanding of positive as well as negative fractions. They should be able to locate positive and negative fractions on a number line; represent and compare fractions, decimals, and related percent; and estimate their size. They need to know that sums, differences, products, and quotients (with nonzero denominators) of fractions are fractions, and they need to be able to carry out these operations confidently and efficiently. They should understand why and how (finite) decimal numbers are fractions and know the meaning of percent. They should encounter fractions in problems in the many contexts in which they arise naturally, for example, to describe rates, proportionality, and probability. Beyond computational facility with specific numbers, the subject of fractions, when properly taught, introduces students to the use of symbolic notation and the concept of generality, both being integral parts of algebra.			
1. By the end of grade 7, students should be proficient with all operations involving positive and negative fractions.			
2. By the end of grade 7, students should be able to solve problems involving percent, ratio, and rate and extend this work to proportionality. This includes understanding that fractions and percents are one type of part/whole ratio where as rates are not part/whole. Students should also recognize the invariant and covariant nature of both equivalent fractions and proportions.			
Geometry and measurement: Middle grade experience with similar triangles is most directly relevant for the study of algebra. Sound treatments of the slope of a straight line and of linear functions depend logically on the properties of similar triangles. Furthermore, students should be able to analyze the properties of two-and three-dimensional shapes using formulas to determine perimeter, area, volume, and surface area. They should also be able to find unknown lengths, angles, and areas.			
1. By the end of grade 7, students should be familiar with the relationship between similar triangles and the concept of the slope of a line.			

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