Overview of the Connected Mathematics Project

The Connected Mathematics Project (CMP) was funded by the National Science Foundation (NSF) between 1991 and 1997 to develop a complete middle school mathematics curriculum for the middle grades. The result was *Connected Mathematics*, a curriculum built around mathematical problems that help students develop understanding of important concepts and skills in number, geometry, measurement, algebra, probability, and statistics.

In 2000, with funding from NSF and input from CMP teachers and other professionals, the *Connected Mathematics* curriculum undertook a five-year revision process similar to the process used to develop *Connected Mathematics 1*. Each unit went through at least three cycles of reviews, revision, field-testing, and evaluation. Forty-nine schools, approximately 150 teachers, and 20,000 students were involved in the revisions. *Connected Mathematics* is used in all fifty states and some foreign countries.

The Goal of Connected Mathematics

The overarching goal of *Connected Mathematics* is to help students and teachers develop mathematical knowledge, understanding, and skill, as well as an awareness and appreciation of the rich connections among mathematical strands and between mathematics and other disciplines. As the CMP materials were developed, the authors synthesized multiple mathematical goals into a single standard:

*All students should be able to reason and communicate proficiently in mathematics. This includes knowledge of and skill in the use of the vocabulary, forms of representation, materials, tools, techniques, and intellectual methods of the discipline of mathematics, including the ability to define and solve problems with reason, insight, inventiveness, and technical proficiency.*

This statement makes a commitment to skill, but skill that is much more than just proficiency with computation and manipulation of symbols. Skill in CMP means that a student can use the mathematical tools, resources, procedures, knowledge, and ways of thinking that have been developed over time to make sense of new situations that he or she encounters.

*Connected Mathematics* at a Glance

Below are some key features of *Connected Mathematics*:

- *It is organized around important mathematical ideas and processes.* The mathematics in the curriculum is carefully selected and sequenced to develop a coherent, connected curriculum.

- *It is problem-centered.* Important mathematical concepts are embedded in interesting problems to promote deeper engagement and learning for students. Students develop deep understanding of key mathematical ideas, related skills, and ways of reasoning as they explore the problems, individually, in a group, or with the class.

- *It builds and connects mathematical ideas from problem to problem, investigation to investigation, unit to unit, and grade to grade.* The name of the curriculum points to the importance of students making connections among mathematical ideas. Rather than seeing mathematics as a series of unrelated experiences, students learn to recognize how ideas are connected and develop a disposition to look for connections in the mathematics they study — it has coherence.
• *It provides practice with concepts and related skills.* The in-class development problems and the homework problems give students practice distributed over time with important concepts, related skills, and algorithms.

• *It helps students grow in their ability to reason effectively* with information represented in graphic, numeric, symbolic, and verbal forms and to move flexibly among these representations.

• *It supports instruction and learning based on inquiry.* The teacher launches the problem, the students explore the problem individually or in small groups with the teacher guiding, probing, redirecting, extending as needed, and then together the class summarizes the mathematics and reasoning.

• *It is for teachers as well as students.* The *Connected Mathematics* materials were written to support teacher learning of both mathematical content and pedagogical strategies. The teacher’s guides include extensive help with mathematics, pedagogy, and assessment. Multidimensional tasks are provided in the assessment materials.

• *It is research-based.* Each *Connected Mathematics* unit was field tested, evaluated, and revised over a six-year period. Approximately 200 teachers and 45,000 students in diverse school settings across the United States participated in the development of the curriculum.

Alignment with the NCTM Standards

*Connected Mathematics* is aligned with the National Council of Teachers of Mathematics Standards for School Mathematics (NCTM 1989, 1991, 1995, 2000). Most of the mathematics curriculum frameworks for the fifty states reflect the NCTM Standards. This means that *Connected Mathematics* is a good fit over the middle grades for most states.

At the University of Washington, Adams et al. (2002) conducted a research study that compared three middle school mathematics curricula — *Connected Mathematics*, another NSF-funded program, and the Singapore curriculum — to the 2000 NCTM Principles and Standards. *Connected Mathematics* received very high scores and outscored the other two curricula compared to the Standards.

National Recognition of *Connected Mathematics*

• The American Association for the Advancement of Science (1999), in its review of twelve nationally available middle school mathematics curricula, ranked *Connected Mathematics* highest, stating that it “contains both in-depth mathematics content and excellent instructional support.”

• *Connected Mathematics* was the only middle school mathematics curriculum awarded “exemplary” status by the U.S. Department of Education’s Mathematics and Science Education Expert Panel (1999). Of the 61 elementary, middle school, and high school curricula submitted for review, only five received this exemplary status.
The Purpose of This Document

This document provides users and prospective users of Connected Mathematics with information about its effectiveness with students. The results presented are based on quantitative, qualitative, and trend data reports collected from over 10 years of classroom observation and evaluation in a variety of school settings across the country.

The results consistently show that CMP students do as well as, or better than, non-CMP students on tests of basic skills. And CMP students outperform non-CMP students on tests of problem-solving ability, conceptual understanding, and proportional reasoning.

This document also includes examples of student work demonstrating that CMP students can use basic skills to solve important mathematical problems and are able to communicate their reasoning and understanding.

The examples of student reasoning also illustrate that, by the end of grade 8, CMP students show a considerable ability to solve non-routine algebra problems and demonstrate a strong understanding of linear functions and a beginning understanding of exponential and quadratic functions.
This section summarizes key findings from various research studies on the CMP curriculum and provides bibliographical information for dissertations and research papers related to CMP. The research described here is representative of a growing body of work showing that *Connected Mathematics* is an effective middle school curriculum that is accessible to all students.

The research studies are separated into two categories: those conducted by the CMP team during the last year of field testing and those conducted by other professionals who have studied the effects of CMP in a variety of settings since its publication.

The summaries indicate the special populations involved in each study:

**Minority**: Results for minority students were reported as a subset of the general population.

**Gifted**: Results for gifted and talented students were reported as a subset of the general population.

**Low/High SES**: The districts involved had a significant percentage of low (or high) socioeconomic status (SES) students, including a significant number of students who received free or reduced-price lunch.

**Geographic Diversity**: The study included students from a variety of geographic (rural, urban, or suburban) or economic settings and/or students with a variety of racial or ethnic characteristics.

**ESL**: The districts involved included a significant number of students for whom English is a second language.

**Field Test Research Reports**

The schools included in Reports 1 and 2 were each Field Test Sites for *Connected Mathematics 1*. This classroom testing occurred over two academic years (1992-1994), allowing careful study of the effectiveness of each of the 24 units that comprise the program. The results helped shape the final version of *Connected Mathematics 1*.

**Report 1**

**Evaluation Results from the Field Testing (1994-1996)**

**Special Populations: Geographic Diversity**

During the fourth and fifth years of CMP development, Ridgeway, Zawojewski, Hoover, and Lambdin (2003) conducted a study comparing the results of CMP students and students who used traditional middle school mathematics curricula. The students were evaluated at the beginning and end of the school year using the following two tests:

- The Iowa Test of Basic Skills (ITBS), which assesses basic mathematical skills
- A test designed by the NSF-funded Balanced Assessment Project (Schoenfeld et al. 1999) to assess student attainment in mathematical reasoning, communication, connections, and problem solving

The study was conducted during the 1994–95 school year with grades 6 and 7 students and during the 1995–96 year with grade 8 students. More than 2,000 students from urban, suburban, and rural communities in a variety of geographic regions took part in the study. Approximately two-thirds of the participants used *Connected Mathematics*. 
Basic Skills: The study found that gains made by the CMP students on the ITBS were comparable to gains made by the non-CMP students and to gains made by the test-publisher’s representative sample. The graph below summarizes the results for each grade level. Note that the graph should not be interpreted as longitudinal: the data for grades 6 and 7 were gathered in the same year, so the results are from different students. However, much of the grade 8 results are from students who were part of the grade 7 sample.

Problem Solving: The study found that the CMP students at all three grade levels showed significantly greater growth than their non-CMP peers on the Balanced Assessment test. The test consisted of challenging, open-response items that required students to reason mathematically, communicate ideas, make connections, and solve problems.
The graph below shows the distribution of content on both the ITBS and the Balanced Assessment tests used in the study. At all three grade levels, the great majority of items on the ITBS involve number and operations, while the Balanced Assessment test incorporates number-and-operations items with problems involving algebra, geometry, and statistics. Therefore, the CMP students demonstrated greater growth in a variety of mathematical content areas (Ridgeway 2003).

Comparison of ITBS and BA Test Content

Note: Some test items are classified under more than one strand, so percents do not add up to 100%.
Ben-Chaim et al. (1997, 1998) conducted a study to investigate the proportional-reasoning abilities of CMP and non-CMP students. (See also Miller and Fey 2000.) In the spring of 1995, 124 grade 7 CMP students, who had also studied *Connected Mathematics* in grade 6, and 91 non-CMP students were tested to assess their understanding and skill in proportional reasoning. The items on the test were contextual problems involving rates, ratios, and scaling. In the spring of 1996, 108 of the CMP students and 39 of the non-CMP students were given the test again in grade 8.

The graph below summarizes the results of the testing in proportional reasoning. CMP students outperformed non-CMP students not only in grade 7, when proportional reasoning is the focus of several units, but also in grade 8. Moreover, CMP students showed greater growth in their achievement from grade 7 to 8.

A replication of the study was conducted to further investigate this observation. When the proportional-reasoning test was administered in 1997 and 1998 to CMP students in grade 8 who had also studied *Connected Mathematics* in grades 6 and 7, the results again revealed that the students retained much of their proportional-reasoning understanding (Ben-Chaim et al. 1998).
Of the thirteen items on the proportional-reasoning test, five were items on rates. Student answers on these items were classified as correct, incorrect, or no response. Correct answers were then categorized according to whether they were accompanied by no support work, correct support work, or incorrect support work. Incorrect answers were categorized as being accompanied by no support, support indicating partial understanding, or support indicating incorrect thinking. The table below shows that 53% of the answers provided by CMP students were supported by correct work, while only 28% of the answers provided by non-CMP students included correct support work.

<table>
<thead>
<tr>
<th>Percent of Total Grade 7 Responses on Rate Items Falling into Each of Seven Classifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Correct Answer</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Incorrect Answer</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>No Response</strong></td>
</tr>
<tr>
<td><strong>Gr 7 CMP students</strong></td>
</tr>
<tr>
<td><strong>Gr 7 Non-CMP students</strong></td>
</tr>
<tr>
<td><strong>Answer only</strong></td>
</tr>
<tr>
<td><strong>Correct support work</strong></td>
</tr>
<tr>
<td><strong>Incorrect support work</strong></td>
</tr>
<tr>
<td><strong>Answer only</strong></td>
</tr>
<tr>
<td><strong>Partial understanding</strong></td>
</tr>
<tr>
<td><strong>Incorrect thinking</strong></td>
</tr>
<tr>
<td><strong>No Response</strong></td>
</tr>
</tbody>
</table>

| **Gr 7 CMP students**                                                                       |
| **Gr 7 Non-CMP students**                                                                   |
| **Answer only**                                                                             |
| **Correct support work**                                                                    |
| **Incorrect support work**                                                                  |
| **Answer only**                                                                             |
| **Partial understanding**                                                                   |
| **Incorrect thinking**                                                                      |
| **No Response**                                                                             |
Collins (1998-1999) conducted a study as part of her doctoral research to investigate the impact of sustained professional development on student achievement in one urban district. The district adopted *Connected Mathematics 1* in the spring of 1999 and phased in implementation over three years. Thus, in year 3 of this study, CMP1 was the official middle school program for the district. The study looked at three schools in the district, identified as the CMP1 School, School A, and School B.

- In the CMP1 School, teachers participated in all the professional development provided by the district. Each grade had an average of 122 hours of professional development during 1999–2001. CMP1 was the primary curriculum at the school, with students completing nine grade 6 and 7 units each year over the three years of the cohort.

- In School A, teachers participated only in contractually mandated professional development, for an average of 22 hours per grade. In year 1 of the study, School A used a traditional text and direct instruction. In year 2, two teachers in School A piloted some CMP1 units. In year 3, School A used three to four CMP1 grade 7 units in grade 8.

- In School B, teachers participated only in contractually mandated professional development, for an average of 53 hours per grade. In years 1 and 2 of the study, School B used a traditional text and direct instruction. In year 3, School B used three to four CMP1 grade 7 units in grade 8.

Note that the professional development hours described above do not include coaching or study-group sessions.

All three schools had similar profiles as shown in this table.

### School Profiles

<table>
<thead>
<tr>
<th>Year</th>
<th>School</th>
<th>Total Enrollment</th>
<th>% White</th>
<th>% Minority</th>
<th>% Low Income</th>
<th>% FLNE (Free &amp; Reduced Lunch)</th>
<th>% LEP (Limited English Proficiency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>CMP1 School</td>
<td>434</td>
<td>26</td>
<td>74</td>
<td>70</td>
<td>53</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>School A</td>
<td>336</td>
<td>12</td>
<td>88</td>
<td>77</td>
<td>83</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>School B</td>
<td>895</td>
<td>24</td>
<td>76</td>
<td>78</td>
<td>60</td>
<td>26</td>
</tr>
<tr>
<td>2001</td>
<td>CMP1 School</td>
<td>420</td>
<td>22</td>
<td>78</td>
<td>84</td>
<td>58</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>School A</td>
<td>373</td>
<td>9</td>
<td>91</td>
<td>91</td>
<td>84</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>School B</td>
<td>928</td>
<td>25</td>
<td>75</td>
<td>65</td>
<td>60</td>
<td>26</td>
</tr>
<tr>
<td>2002</td>
<td>CMP1 School</td>
<td>411</td>
<td>24</td>
<td>76</td>
<td>86</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>School A</td>
<td>346</td>
<td>24</td>
<td>76</td>
<td>86</td>
<td>71</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>School B</td>
<td>934</td>
<td>11</td>
<td>89</td>
<td>59</td>
<td>60</td>
<td>27</td>
</tr>
</tbody>
</table>
The study compared achievement on two tests:

- The Massachusetts Comprehensive Assessment System (MCAS) is a statewide test administered yearly at the end of grade 8. Scores on the test range from 200 to 280. The MCAS was first administered in 1998.

- The TerraNova Achievement Test is a norm-referenced test that has been administered in the district since 1999. This test was first administered across the district in 1999–2000.

**FINDINGS**

The bar graph below compares MCAS results for the three schools. In 2001, year 3 of the study, there was a seven-point difference between the CMP1 school and School A and a four-point difference between the CMP1 school and School B. According to the MCAS support manual published by the Massachusetts Department of Education, a difference of two points for schools with populations of 100 or more is statistically significant.

![Mean MCAS Scaled Math Scores](image)

It is interesting to note that students in the CMP1 School scored better than the other schools on the MCAS test, which covers grade 8 content, even though students had used only grade 6 and 7 CMP1 units. (Due to the gradual phase-in, they wouldn’t use grade 8 material until 2002–2003.)

The following graph shows mean TerraNova scores for a cohort of students who started grade 6 in 1999–2000 and completed grade 8 in 2001–2002. The graph indicates a steady gain for students in the CMP1 School across the three years versus a decline from year 1 to year 2 for both Schools A and B, followed by a gradual increase in year 3.
Below are some other findings from the study:

- Student MCAS scores improved two points for every ten hours of professional development.
- The more CMP1 units taught over the three years, the better students performed on both the MCAS and the TerraNova.
- In year 3, both School A and School B used some CMP1 units in grade 8. The scores in these schools showed statistically significant improvement that year.
- The percentage of special education students designated with the warning status on the MCAS each year decreased by 10% at the CMP1 School, compared to a 3% decrease for School A and a 0% decrease for School B.
- Gains in student achievement take time and reflect the number of CMP1 units taught, the way in which CMP1 is implemented, and the consistency of the implementation.
**Iowa Test of Basic Skills (ITBS), Louisiana Education Assessment Program (LEAP), and Survey Results for Lafayette Parish, Louisiana (2000)**

**Special Populations: Geographic Diversity**

**Description**
Cain (2002) conducted a formative, internal evaluation on *Connected Mathematics 1* as it is used in Lafayette Parish, Louisiana, using the Iowa Test of Basic Skills and the Louisiana Education Assessment Program. Approximately 3,500 students in this public school system were enrolled in CMP1, and the district school board planned to expand the program to include all 12 public middle schools.

**Findings**
An analysis of the Iowa Test of Basic Skills (ITBS) and the Louisiana Education Assessment Program (LEAP) mathematics data indicates the following: (1) the CMP schools significantly outperformed the non-CMP schools on both standardized tests (2) questionnaires distributed to the teachers and to a sample of the students indicated that both groups indicated that the program is helping students become better problem solvers and (3) teachers find CMP more challenging for their students, while the students note that CMP encourages more thought on their parts.

### ITBS Results for Lafayette Parish, Louisiana

<table>
<thead>
<tr>
<th></th>
<th>ITBS Average Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998-99</td>
<td>61%</td>
</tr>
<tr>
<td>1999-00</td>
<td>58%</td>
</tr>
</tbody>
</table>

### LEAP Results for Lafayette Parish, Louisiana

<table>
<thead>
<tr>
<th></th>
<th>Average Grade 8 LEAP Passing Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CMP Schools</td>
</tr>
<tr>
<td>1998-99</td>
<td>86%</td>
</tr>
<tr>
<td>1999-00</td>
<td>87%</td>
</tr>
</tbody>
</table>
### Survey Results for CMP1 Teachers of Lafayette Parish, Louisiana

<table>
<thead>
<tr>
<th>Questionnaire Items</th>
<th>Agree</th>
<th>No Opinion</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefer CMP to previous programs taught</td>
<td>93</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Increased personal understanding of math concepts as a result of CMP</td>
<td>93</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Students becoming better problem solvers as a result of CMP</td>
<td>93</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>CMP is more challenging than other programs taught</td>
<td>90</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Training was beneficial to understanding and teaching of CMP</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Survey Results for CMP1 Students of Lafayette Parish, Louisiana

<table>
<thead>
<tr>
<th>Questionnaire Items</th>
<th>Agree</th>
<th>No Opinion</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefer CMP to previous programs taught</td>
<td>65</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Calculator is used more often in CMP than in previous programs</td>
<td>53</td>
<td>20</td>
<td>27</td>
</tr>
<tr>
<td>Becoming a better problem solver as a result of CMP</td>
<td>67</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>CMP makes me think more than other programs taught</td>
<td>68</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>Activities in CMP help me to understand the math concepts</td>
<td>73</td>
<td>19</td>
<td>8</td>
</tr>
</tbody>
</table>
Post, Davis, Maeda, Cutler, Andersen, Kahan, and Harwell (2004) completed a study in which students from five school districts making use of NSF-funded, standards-based curricula (CMP1 and Math Thematics), were tested using the SAT-9 in three areas: open-ended exercises, problem-solving, and procedural competency. All students tested had used their respective curricula for three years. Within each of the districts, two comparisons were made: 1) high versus low prior achievement and 2) high versus low socio-economic status (SES). The gaps between the subgroups were measured in each of the three areas both in the initial testing (Fall 2000) and in the final testing (Spring 2002).

### Findings

Information from CMP districts in the study is presented below. The gaps between the subgroups decreased significantly in nearly all areas in CMP district A. In CMP district B, in both the achievement and SES comparisons, both high and low subgroups’ scores increased, though the gap did widen in procedures. It should be noted that District B was selected to participate in the study because the adoption of CMP had been “sabotaged by a few faculty dissenters and parents” (Post 2004).

#### CMP1 District A (High vs. Low Prior Achievement)

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Prior Achievement</th>
<th>N</th>
<th>Fall 2000 Mean</th>
<th>Gap</th>
<th>Spring 2002 Mean</th>
<th>Gap</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Ended</td>
<td>High</td>
<td>61</td>
<td>656.6</td>
<td>52.4</td>
<td>673.67</td>
<td>43.7</td>
<td>-8.7</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>32</td>
<td>604.3</td>
<td></td>
<td>630</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Solving</td>
<td>High</td>
<td>63</td>
<td>687.3</td>
<td>66.5</td>
<td>707.06</td>
<td>57.2</td>
<td>-9.3</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>35</td>
<td>620.8</td>
<td></td>
<td>649.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>High</td>
<td>62</td>
<td>684.4</td>
<td>64.4</td>
<td>687.11</td>
<td>47.5</td>
<td>-17.0</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>33</td>
<td>620.0</td>
<td></td>
<td>639.67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### CMP1 District B (High vs. Low Prior Achievement)

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Prior Achievement</th>
<th>N</th>
<th>Fall 2000 Mean</th>
<th>Gap</th>
<th>Spring 2002 Mean</th>
<th>Gap</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Ended</td>
<td>High</td>
<td>13</td>
<td>646.2</td>
<td>22.6</td>
<td>671.2</td>
<td>21.7</td>
<td>-0.9</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>14</td>
<td>623.6</td>
<td></td>
<td>649.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Solving</td>
<td>High</td>
<td>13</td>
<td>687.8</td>
<td>42.9</td>
<td>699.7</td>
<td>30</td>
<td>-12.9</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>15</td>
<td>644.9</td>
<td></td>
<td>669.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>High</td>
<td>13</td>
<td>660.4</td>
<td>24.6</td>
<td>698.3</td>
<td>39.7</td>
<td>15.1</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>15</td>
<td>635.8</td>
<td></td>
<td>658.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### CMP1 District A (High vs. Low SES)

<table>
<thead>
<tr>
<th>Subtest</th>
<th>SES</th>
<th>N</th>
<th>Mean</th>
<th>Gap</th>
<th>Mean</th>
<th>Gap</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Open Ended</strong></td>
<td>High</td>
<td>42</td>
<td>658.9</td>
<td>35.6</td>
<td>671.83</td>
<td>24.9</td>
<td>-10.7</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>59</td>
<td>623.4</td>
<td></td>
<td>646.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Problem Solving</strong></td>
<td>High</td>
<td>42</td>
<td>684.3</td>
<td>33.7</td>
<td>705.40</td>
<td>32.9</td>
<td>-0.8</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>65</td>
<td>650.6</td>
<td></td>
<td>672.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Procedures</strong></td>
<td>High</td>
<td>42</td>
<td>677.9</td>
<td>24.8</td>
<td>682.86</td>
<td>19.1</td>
<td>-5.7</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>62</td>
<td>653.0</td>
<td></td>
<td>663.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CMP1 District B (High vs. Low SES)

<table>
<thead>
<tr>
<th>Subtest</th>
<th>SES</th>
<th>N</th>
<th>Mean</th>
<th>Gap</th>
<th>Mean</th>
<th>Gap</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Open Ended</strong></td>
<td>High</td>
<td>26</td>
<td>639.1</td>
<td>20.4</td>
<td>659.5</td>
<td>10</td>
<td>-10.5</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>6</td>
<td>618.7</td>
<td></td>
<td>649.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Problem Solving</strong></td>
<td>High</td>
<td>29</td>
<td>668.6</td>
<td>19.4</td>
<td>690.4</td>
<td>19.6</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>6</td>
<td>649.2</td>
<td></td>
<td>670.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Procedures</strong></td>
<td>High</td>
<td>29</td>
<td>647.7</td>
<td>11.2</td>
<td>681.8</td>
<td>18.7</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>6</td>
<td>636.5</td>
<td></td>
<td>663.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lapan et al. (1998) examined the impact of a year-long implementation of two standards-based middle grades mathematics curricula on mathematics achievement. The study involved a control group and two treatment groups, one of which used *Connected Mathematics 1*. The second treatment group used another NSF-funded curriculum. This report contains the CMP1 data. A total of 255 grade 6 students participated. The following standardized tests of traditional mathematics achievement and mathematics problem solving were administered at the end of grade 5 to provide baseline data and again at the end of grade 6, after one year of implementation:

- Missouri Mastery and Achievement Test (MMAT)
- Stanford Achievement Test, version 9 (SAT9)
- SAT Open-Ended Mathematics Problem Solving Test (MPST)

Note that the control group took the California Achievement Test (CAT). The scores were linearly transformed to SAT9 scores.

No significant differences were found between the groups with respect to traditional mathematics achievement. However, students in the two standards-based curricula significantly outperformed the control group in mathematics problem solving. No gender differences in traditional mathematics achievement or mathematics problem solving were found. Mathematics problem-solving scores for African American students in the two standards-based curricula “were significantly higher than scores for African American students in the control group” (Lapan et al. 1998). The graphs below and on the next page compare the results for the control group with the results for the CMP treatment group. This longitudinal study will continue to follow a subset of the students through grades 7 and 8. (See Report 6/Part 2 on p. 20.)

---

**Test Results for All Students**

<table>
<thead>
<tr>
<th>Achievement test</th>
<th>Original Score</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMAT</td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>SAT9*</td>
<td></td>
<td>72</td>
</tr>
<tr>
<td>MPST</td>
<td></td>
<td>65</td>
</tr>
</tbody>
</table>

**Test Results for African American Students**

<table>
<thead>
<tr>
<th>Achievement test</th>
<th>Original Score</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMAT</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>SAT9*</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MPST</td>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>

*The control group took the California Achievement Test (CAT). The scores were linearly transformed to SAT9 scores.*
**Report 6/Part 2  University of Missouri Study (2003)**

**Special Population: High SES**

**Description**

Reys et al. (2003) compared the mathematics achievement of grade 8 students in the first three school districts in Missouri to adopt standards-based middle grades mathematics curricula to the achievement of students in similar districts who had not used standards-based materials. This population is a subset of that found in the previous report. Achievement was measured using the mathematics portion of the Missouri Assessment Program (MAP), which consists of two sections of open-ended items and one section of multiple-choice items drawn from the TerraNova assessments.

One of the three standards-based districts in the study used *Connected Mathematics 1*. In grade 6, all students in the district were enrolled in a course using *Connected Mathematics 1*. In grades 7 and 8, about 75% of the students continued to use *Connected Mathematics 1* as their primary text. The remaining 25% were enrolled in an accelerated program and used *Connected Mathematics 1* as a supplement to an algebra 1 text. This CMP1 district was matched with a comparison district based primarily on prior mathematics achievement and the percentage of students eligible for free or reduced-price lunch. All the students in the comparison district took the same mathematics course in grades 6 and 7. In grade 8, 40% took pre-algebra, while 60% took algebra 1. It should be noted that both the CMP1 district (13% free and reduced lunch) and the comparison district (11% free and reduced lunch) are affluent districts with consistently high test scores and a large percentage of students who go on to attend college.

**Findings**

CMP students received significantly higher scores on the algebra items than the comparison students, even though a much greater percentage of students in the comparison district were enrolled in an algebra 1 course (60% versus 25%). CMP students also received significantly higher scores on Data, Probability, and Statistics items. The differences in scores for the other strands and for the TerraNova portion of the test were not significant.

**Mean* 1999 MAP and TerraNova Scores**

![Mean 1999 MAP and TerraNova Scores](image)

*Test of comparisons of 1999 MAP Content Standard and TerraNova scores for CMP school and comparison school p < 0.05
Riordan and Noyce (2001) investigated the impact of standards-based mathematics programs on student achievement in Massachusetts. The study compared statewide standardized test (MCAS) scores of grade 4 students using an elementary standards-based program and grade 8 students using *Connected Mathematics 1* to scores of demographically similar students using traditional curricula.

The 21 participating *Connected Mathematics 1* schools were divided into two groups. Group I consisted of one school that had implemented the program for four years. Group II consisted of 20 schools that had used the program for either two or three years. Each group was matched with a comparison group based on mean scores on previous state tests, the percentage of students receiving free or reduced-price lunch, and racial and ethnic makeup.

As the graph below shows, CMP1 students in both groups performed significantly better on the 1999 MCAS than did students attending the comparison schools.

Differences in favor of *Connected Mathematics* were consistent across student subpopulations. Note that for Group I, comparisons were not made for Blacks, Asians, Hispanics, and students eligible for free and reduced-price lunch because the sample sizes for these groups were too small (i.e., fewer than 10 students per school).
The study also compared mean scores within each quartile. The results suggest that *Connected Mathematics* is effective for all students, including those at the upper and lower ends of the achievement spectrum.

In addition to the above results, the study found that CMP students outperformed comparison students in all mathematical strands and in both multiple-choice and open-response questions.
MASSACHUSETTS STUDY (2003)

SPECIAL POPULATIONS: MINORITY, LOW SES, GEOGRAPHIC DIVERSITY

In a paper presented at the 2003 AERA annual meeting, Riordan, Noyce, and Perda (2003) discussed their follow-up study of the eight Massachusetts school districts that were the focus of the study mentioned in Report 7/Part 1. The three areas of focus in the study can be summarized by the following questions: 1) How has the implementation of Connected Mathematics changed over time in these districts? 2) How has Grade 8 student performance changed over two years? 3) What happens to CMP students as they move into high school?

Due to some changes in school organization and CMP implementation (one district moved CMP to its 5th and 6th grade classes, and used Pre-Algebra and Algebra as its primary 7th and 8th grade curricula), identical comparison groups could not be used in this follow-up study. Comparisons in the study were primarily made by using the percent of students qualifying for free or reduced lunch as the independent variable.

Seven of the participating Connected Mathematics 1 school districts make up Group 1 in the study. These districts continued to use CMP as their primary curriculum in grades 6 through 8. Group 2 was made up of the seven districts in Group 1, as well as the previously mentioned district whose 5th and 6th grade students comprise the great majority of its CMP students. The comparison group was made up of demographically similar districts from across the state.

FINDINGS

Studying the changes in terms of implementation was somewhat hindered, as it was not a focus of the original study. However, because of the short time that had passed since the first study, through the use of teacher surveys it was possible to gather some valuable information regarding implementation. While all of the districts continue to use CMP as their primary curriculum, five of the eight have increased supplementation with outside materials. Additionally, four of the eight have moved some of the CMP units to earlier grade levels.

As in the first study, the statewide standardized test (MCAS) was the primary measure of comparison. The table below shows that both CMP groups had a higher percentage of advanced/proficient students as well as lower percentages of warning/failed students than the corresponding comparison groups.

<table>
<thead>
<tr>
<th>MCAS Proficiency Levels</th>
<th>% Free/Reduced Price Lunch</th>
<th>% Advanced/ Proficient</th>
<th>% Warning/ Failed</th>
<th>MCAS Scaled Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMP Group 1 N = 1,379</td>
<td>20.0</td>
<td>40.6</td>
<td>23.2</td>
<td>235.5</td>
</tr>
<tr>
<td>Comparison N = 56,148</td>
<td>19.8</td>
<td>36.9</td>
<td>27.6</td>
<td>233.9</td>
</tr>
<tr>
<td>CMP Group 2 N = 2,145</td>
<td>14.6</td>
<td>52.2</td>
<td>17.1</td>
<td>241.0</td>
</tr>
<tr>
<td>Comparison N = 51,022</td>
<td>15.5</td>
<td>39.1</td>
<td>24.8</td>
<td>235.2</td>
</tr>
</tbody>
</table>
The following table suggests that former CMP students performed at a level comparable to their statewide peers on the Grade 10 portion of the MCAS. It is worth noting that the CMP Group 2 students significantly outperformed their comparison group.

Grade 10 Student Performance: CMP Groups 1 and 2 Versus Comparison Districts

<table>
<thead>
<tr>
<th></th>
<th>MCAS Proficiency Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Free/Reduced Price Lunch</td>
</tr>
<tr>
<td>CMP Group 1 N = 1,115</td>
<td>6.2</td>
</tr>
<tr>
<td>Comparison N = 36,637</td>
<td>6.3</td>
</tr>
<tr>
<td>CMP Group 2 N = 1,821</td>
<td>5.1</td>
</tr>
<tr>
<td>Comparison N = 34,241</td>
<td>5.0</td>
</tr>
</tbody>
</table>

REPORT 8  CONNECTED MATHEMATICS 2 NATIONAL EVALUATION (IN PROGRESS)

DESCRIPTION  Preliminary work is underway on a comprehensive study of the implementation of Connected Mathematics 2. The national study, which will be coordinated by Horizon Research, Inc., will compare 25 pairs of schools. Each pair comprises a CMP2 school and an appropriately matched school that uses a more “typical” middle school mathematics curriculum.

According to the study’s proposal, the three primary research questions are as follows:

1. How does using CMP2 instead of a non-CMP2 middle school curriculum affect the tested mathematics achievement of students?
2. How does using CMP2 instead of a non-CMP2 middle school curriculum affect “achievement gaps” among demographic groups of interest?
3. How does variation of implementation fidelity of CMP2 affect student achievement?

Results of the study will be made available at www.math.msu.edu/cmp upon its completion and publication.
The reports in this section are based on data collected by states and districts that use Connected Mathematics. All the CMP districts referred to in these reports have implemented Connected Mathematics and have provided professional-development support for their teachers.

Some of the reports indicate results for special populations, including Minority, Gifted, Low SES, Geographic Diversity, and ESL. For descriptions of these populations, see page 7.

Note that three of the reports in the previous section also summarize results of studies conducted in particular states or districts. The studies described in Report 6 compared test scores for CMP and non-CMP districts in Missouri, and the study described in Report 3 and Report 7 investigated the impact of Connected Mathematics on student achievement in Massachusetts.

Reports 9-13 provide results from Connected Mathematics 2 field test schools. In Reports 12 and 13, only two schools were CMP2 field test sites. All of the CMP2 sites were using CMP1 prior to field testing CMP2.

**REPORT 9**

**TEXAS ASSESSMENT OF KNOWLEDGE AND SKILLS (TAKS) DATA FOR TEXAS CMP2 FIELD TEST SITES (2004)**

**SPECIAL POPULATIONS: MINORITY, LOW SES**

Four Texas schools served as CMP2 field-test sites. Two, Frankford and Wilson, are in the Plano Independent School District, while Bedichek and Cordova Middle Schools are from the Austin Independent School District and El Paso Independent School District, respectively. It should be noted that a small number of Bedichek teachers out of many used CMP2. The others were using CMP1.

The Texas Assessment of Knowledge and Skills (TAKS) is given each spring to all Texas students in grades 3 through 11. Each grade level test consists of at least one section assessing mathematics and one assessing reading. The grade 8 mathematics portion of the TAKS is made up of around fifty multiple-choice questions. All of the Plano middle schools have been using CMP1 for several years.

<table>
<thead>
<tr>
<th>School</th>
<th>Black</th>
<th>Hispanic</th>
<th>Low SES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordova</td>
<td>&lt;1%</td>
<td>97%</td>
<td>90%</td>
</tr>
<tr>
<td>Bedichek</td>
<td>9%</td>
<td>69%</td>
<td>63%</td>
</tr>
<tr>
<td>Frankford</td>
<td>9%</td>
<td>12%</td>
<td>13%</td>
</tr>
<tr>
<td>Wilson</td>
<td>10%</td>
<td>16%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Source: Texas Education Agency
The table below displays the percentage of students meeting or exceeding the Texas state standards from various population groups for two years during the field testing. Though it shows the change over only a two-year period, it is striking that there was growth in each of the population groups in all four schools, with one exception. Of particular note is the 16-percentage point increase in the Hispanic subgroup of Bedichek Middle School, where Hispanic students comprise nearly 70% of the population.

<table>
<thead>
<tr>
<th>Percentage of Students Meeting or Exceeding Grade 8 TAKS Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Texas Assessment of Knowledge and Skills (TAKS)</strong></td>
</tr>
<tr>
<td><strong>State</strong></td>
</tr>
<tr>
<td>Cordova</td>
</tr>
<tr>
<td>Bedichek</td>
</tr>
<tr>
<td>Frankford</td>
</tr>
<tr>
<td>Wilson</td>
</tr>
</tbody>
</table>

Source: Texas Education Agency

FINDINGS

While serving as a field-test site for *Connected Mathematics* 2, it is clear that Falmouth Middle School has seen continued success and improvement on the MEA. Since 2000, the difference in the percentage of students meeting or exceeding the state standards between Falmouth Middle School and the rest of the state has nearly doubled.
**REPORT 11**

**WISCONSIN KNOWLEDGE AND CONCEPTS EXAMINATIONS (WKCE) DATA FOR BEAVER DAM MIDDLE SCHOOL (2005)**

**SPECIAL POPULATIONS: NONE**

**DESCRIPTION**
Beaver Dam Middle School served as a field test site for *Connected Mathematics 2*. They were also using CMP1 prior to the field testing.

The Wisconsin Knowledge and Concepts Examinations (WKCE) were given annually to students in grades 4, 8, and 10. (Note: The test has gone through changes that will take place in the 2005-2006 school year. Among them are an increase in the number of grade levels to be tested.) The mathematics portion of the WKCE at each grade level consists of both multiple-choice and short answer items.

**FINDINGS**
While serving as a field-test site for *Connected Mathematics 2*, Beaver Dam Middle School has seen continued success and general improvement on the WKCE. The chart below displays this positive trend through the percent of students meeting or exceeding grade 8 expectations.

![Percentage of Students Meeting or Exceeding State WKCE Mathematics Standards](image)

Source: Wisconsin Department of Public Instruction
**REPORT 12  WASHINGTON ASSESSMENT OF STUDENT LEARNING (WASL) DATA FOR SHAHALA MIDDLE SCHOOL (2005)**

**DESCRIPTION**
Shahala Middle School, part of the Evergreen school district, served as a field test site for *Connected Mathematics 2*. Shahala was also using CMP1 prior to the field testing.

In grades 4, 7, and 10, students in the state of Washington take part in the reading, writing, and mathematics portions of the Washington Assessment of Student Learning (WASL). The mathematics portion consists of multiple-choice tasks, as well as short answer and constructed response items.

**FINDINGS**
The data below indicates that while all three subgroups (school, district, and state) each are generally improving, CMP2 field-test site Shahala Middle School continues to outperform the district and state on the grade 7 mathematics portion of the WASL. It is worth noting that between 2002 and 2005 Shahala Middle School has even widened the gap between it and both the district and state, in terms of percent of students meeting or exceeding expectations.

![Washington Assessment of Student Learning (WASL) Data for Shahala Middle School](image)

*Source: Washington Department of Public Education*
The Michigan Educational Assessment Program (MEAP) mandates that all students in Michigan take a standardized, criterion-referenced test. Until 2000, the mathematics subtest of the MEAP test was administered at grades 4, 7, and 11. Student results were reported as low, moderate, or satisfactory. From 1991 to 2000, results for grade 7 students from CMP1 field-test schools were compared to the results for all grade 7 students in Michigan. Most of the grade 7 CMP students had also studied *Connected Mathematics 1* in grade 6. Field testing for grade 6 began in the 1992–93 school year; field testing for grade 7 began in the 1993–94 school year.

The graphs below show the percentage of grade 7 students in each field-test school who received satisfactory scores on the MEAP mathematics subtest. The graph on the right shows the percentage who received low, nonpassing scores. The percentage of students in the moderate category is not shown. The black line on each graph shows the statewide results. State scores include the scores of the CMP1 schools in the report in addition to many other Michigan schools who are using CMP1.

The graphs indicate that, in general, the average performance of students at the CMP1 field-test sites has changed favorably compared to the state average. Moreover, the “low” category has been nearly eliminated for some of the CMP1 schools. This means that, in addition to increasing student performance at or above the rate of the entire state, some CMP1 schools are moving students up and out of the lowest-performance category.

**Grade 7 MEAP Results for CMP1 Field-Test Schools***

1995-2000 Demographic Data

<table>
<thead>
<tr>
<th>School</th>
<th>$ per student</th>
<th>% free lunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bloomfield Hills</td>
<td>11,931</td>
<td>1.7</td>
</tr>
<tr>
<td>Waverly</td>
<td>8,501</td>
<td>17.9</td>
</tr>
<tr>
<td>Portland</td>
<td>6,033</td>
<td>13.8</td>
</tr>
<tr>
<td>Traverse City West</td>
<td>6,084</td>
<td>20.6</td>
</tr>
<tr>
<td>Traverse City East</td>
<td>6,084</td>
<td>19.7</td>
</tr>
<tr>
<td>Sturgis**</td>
<td>6,207</td>
<td>30.5</td>
</tr>
<tr>
<td>Shepherd</td>
<td>6,370</td>
<td>28.5</td>
</tr>
<tr>
<td>Statewide</td>
<td>7,139</td>
<td>31.3</td>
</tr>
</tbody>
</table>

* Grade 6 field testing began in 1992–93. Grade 7 field testing began in 1993–94.
** No grade 6 CMP until the 1993–94 school year.

Data courtesy Michigan Department of Education
THE MICHIGAN EDUCATIONAL ASSESSMENT PROGRAM (MEAP) TEST DATA (2000-2005)

SPECIAL POPULATIONS: GEOGRAPHIC DIVERSITY, LOW SES

After the 2000 MEAP test, changes were made to the test structure and assessment criteria. Beginning in 2002, the test was administered in grade 8. The new test reports results based on four levels of performance. Levels 1 and 2 refer, respectively, to students who have exceeded and met grade level expectations, while students at the remaining two levels have shown minimal evidence of their ability to perform at grade level (Level 3) or have performed at a very low level (Level 4).

Of the schools included in this report, Portland Middle School, Traverse City East Junior High School, and Traverse City West Junior School have each served as field test sites for CMP2. The others in the report have remained CMP users. Recent demographic information for the schools in this report is included below, as well.

The changes in the MEAP test make it difficult to compare the 2002 results with results from previous years. The graph below indicates that, on the 2002 MEAP test, six of the seven CMP2 field-test sites had a greater percentage of students who received satisfactory scores (Levels 1 and 2) than did the state.

### 2005 Demographic Information

<table>
<thead>
<tr>
<th>School</th>
<th>% Free and Reduced Lunch</th>
<th>White</th>
<th>Hispanic</th>
<th>N.A.</th>
<th>Asian</th>
<th>African American</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shepherd</td>
<td>29.8</td>
<td>94</td>
<td>1</td>
<td>3</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Sturgis</td>
<td>47</td>
<td>78</td>
<td>19</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Portland</td>
<td>15</td>
<td>99</td>
<td>&lt;1</td>
<td>-</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Traverse City East</td>
<td>26</td>
<td>95</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Traverse City West</td>
<td>28</td>
<td>94</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Waverly</td>
<td>29</td>
<td>57</td>
<td>9</td>
<td>&lt;1</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>Bloomfield Hills</td>
<td>3</td>
<td>85</td>
<td>&lt;1</td>
<td>-</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Statewide</td>
<td>31</td>
<td>72</td>
<td>4</td>
<td>&lt;1</td>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>

Note: N.A. = Native American; Asian = Asian or Pacific Islander
Source: Michigan Department of Education

### FINDINGS

The changes in the MEAP test make it difficult to compare the 2002 results with results from previous years. The graph below indicates that, on the 2002 MEAP test, six of the seven CMP2 field-test sites had a greater percentage of students who received satisfactory scores (Levels 1 and 2) than did the state.
REPORT 14  FLORIDA COMPREHENSIVE ASSESSMENT TEST (FCAT) FOR DUVAL COUNTY PUBLIC SCHOOLS (2005)

SPECIAL POPULATIONS: GEOGRAPHIC DIVERSITY

DESCRIPTION The Duval County Public Schools (FL) have been in the process of phasing in CMP1 over the last three years. The following scores display some information based on the results of Duval County students on the mathematics portion of the Florida Comprehensive Assessment Test (FCAT).

FINDINGS Duval County’s students performed significantly higher in 2005 than in both 2004 and 2003 as demonstrated by the percent that scored at or above “grade level” (achievement level 3) on the mathematics FCAT. This improved performance was seen across all grades, except for grade 6 where the performance remained steady, from 2003 to 2005. Further evidence of improvement can be seen in the significant decline in the percent of students who performed at the lowest level of achievement (achievement level 1 which is defined as “below basic”). These findings are particularly notable when following the 2003 sixth-grade cohort’s performance as seventh and then eighth graders, in which the scores rose from 38 (6th grade) to 40 (7th grade) to 54 (8th grade). The sixth-grade class of 2003 was the first to use Connected Mathematics 1, which was then phased in during the subsequent school years.

FCAT Results for Duval County, Florida

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Percent Scoring Three or Above</th>
<th>Percent Scoring at Level One</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003</td>
<td>2004</td>
</tr>
<tr>
<td>6</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>7</td>
<td>38*</td>
<td>40</td>
</tr>
<tr>
<td>8</td>
<td>49*</td>
<td>50*</td>
</tr>
</tbody>
</table>

*Not yet using CMP1
Source: Florida Department of Education
**Wisconsin Knowledge and Concepts Examinations (WKCE) Data for Fritsche Middle School (2005)**

**Special Populations: Geographic Diversity, Low SES**

**Description**

The Wisconsin Knowledge and Concepts Examinations (WKCE) were given annually to students in grades 4, 8, and 10. (Note: The test has gone through changes that will take place in the 2005-2006 school year. Among them are an increase in the number of grade levels to be tested.) The mathematics portion of the WKCE at each grade level consists of both multiple-choice and short answer items.

<table>
<thead>
<tr>
<th>Test Year</th>
<th>2000-01</th>
<th>2001-02</th>
<th>2002-03</th>
<th>2003-04</th>
<th>2004-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>27%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Free or Reduced Lunch</td>
<td>67%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: NCES

**Findings**

Fritsche Middle School is part of the Milwaukee public school district. It has a large minority and low SES population. Fritsche students have made great progress in terms of their performance on the Grade 8 Mathematics WKCE. Not only have they continued to outperform their district peers, they have made substantial gains in terms of drawing closer to the state percentage of students meeting or exceeding grade 8 standards.

Data courtesy Fritsche Middle School and Wisconsin Department of Public Instruction
GRADE 7 BENCHMARK DATA FOR EVERETT PUBLIC SCHOOLS, EVERETT, WASHINGTON (2005)

DESCRIPTION

Everett (WA) Public Schools have found continued success through use of CMP1 in their five middle schools. This success is measured, in part, by Washington’s state assessment program. In grades 4, 7, and 10, students in the state of Washington take part in the reading, writing, and mathematics portions of the Washington Assessment of Student Learning (WASL). The mathematics portion consists of multiple-choice tasks, as well as short answer and constructed response items. This report includes results for all five middle schools in Everett Public Schools. The table below gives demographic data for the schools.

Demographic Breakdown for Middle Schools of Everett Public Schools, Washington

<table>
<thead>
<tr>
<th>Schools</th>
<th>African-American</th>
<th>Pacific Islander</th>
<th>Caucasian</th>
<th>Hispanic</th>
<th>Native American/Alaskan Native</th>
<th>Percent Eligible for Free/Reduced Lunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eisenhower</td>
<td>6.0</td>
<td>11.2</td>
<td>74.5</td>
<td>6.6</td>
<td>1.7</td>
<td>35</td>
</tr>
<tr>
<td>Evergreen</td>
<td>5.8</td>
<td>7.3</td>
<td>76.6</td>
<td>8.9</td>
<td>1.4</td>
<td>42</td>
</tr>
<tr>
<td>Gateway</td>
<td>4.0</td>
<td>12.5</td>
<td>77.8</td>
<td>4.7</td>
<td>1.0</td>
<td>19</td>
</tr>
<tr>
<td>Heatherwood</td>
<td>3.0</td>
<td>17.2</td>
<td>73.5</td>
<td>4.9</td>
<td>1.4</td>
<td>15</td>
</tr>
<tr>
<td>North</td>
<td>5.0</td>
<td>8.2</td>
<td>69.9</td>
<td>13.1</td>
<td>3.8</td>
<td>58</td>
</tr>
<tr>
<td>District</td>
<td>4.4</td>
<td>11.6</td>
<td>74.3</td>
<td>8.1</td>
<td>1.6</td>
<td>31</td>
</tr>
</tbody>
</table>

Data courtesy of Everett Public Schools and the Washington State Office of the Superintendent of Public Instruction

FINDINGS

The graph below compares the performance of CMP students from the Everett Public Schools (WA) on the WASL with all students taking the seventh grade portion of the WASL during those years.
The graph below compares the performance in each of the 8 content areas assessed on the Seventh Grade Mathematics WASL. These results cover both multiple choice and open-ended test items. The percentages indicate the percentage of students meeting or exceeding the standard in each of the content areas.

Data courtesy of Everett Public Schools and the Washington State Office of the Superintendent of Public Instruction
MEAP DATA FOR ANN ARBOR, MICHIGAN (1996-1999)

SPECIAL POPULATIONS: MINORITY

DESCRIPTION

The Ann Arbor Public School District adopted and began phasing in Connected Mathematics 1 during the 1996–97 school year. Change in student achievement since CMP1 implementation was measured using results from the mathematics subtest of the Michigan Educational Assessment Program (MEAP) test. See Report 17/Part 2 for more information.

FINDINGS

The Ann Arbor district has reported steady improvement in student mathematics achievement. Districtwide, the percentage of students scoring at the satisfactory level in grade 7 increased from 68% in 1996–97, the first year of CMP1 implementation, to 75% during the 1998–99 school year. The tables below show results for the district as a whole and for three middle schools involved in the report.

### MEAP Results for All Students

<table>
<thead>
<tr>
<th></th>
<th>Percent Receiving Satisfactory Scores</th>
<th>Percent Receiving Low Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clague</td>
<td>70</td>
<td>81</td>
</tr>
<tr>
<td>Scarlett</td>
<td>45</td>
<td>63</td>
</tr>
<tr>
<td>Slauson</td>
<td>75</td>
<td>84</td>
</tr>
</tbody>
</table>

The greatest gains were made by African American students, whose satisfactory achievement level increased from 22% to 39%. In addition, the percentage of African American students receiving low scores has decreased in each of these three schools and for the district overall.

### MEAP Results for African American Students

<table>
<thead>
<tr>
<th></th>
<th>Percent Receiving Satisfactory Scores</th>
<th>Percent Receiving Low Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clague</td>
<td>10</td>
<td>42</td>
</tr>
<tr>
<td>Scarlett</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>Slauson</td>
<td>25</td>
<td>39</td>
</tr>
</tbody>
</table>

Data courtesy Ann Arbor Public Schools
REPORT 17/PART 2  MEAP DATA FOR ANN ARBOR, MICHIGAN (2002-2005)

SPECIAL POPULATIONS: MINORITY

DESCRIPTION

In 2002, the MEAP test was restructured and moved to grade 8. (See Report 17/Part 1 for more information.)

This report includes results for all five middle schools in the Ann Arbor Public School District. (Note: Three of the schools—Clague, Slauson, and Scarlett—were described in Part 1.) The table below gives demographic data for the schools.

<table>
<thead>
<tr>
<th>School</th>
<th>African American</th>
<th>Asian/Pacific Islander</th>
<th>Caucasian</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clague</td>
<td>12.2</td>
<td>25.5</td>
<td>51.7</td>
<td>10.6</td>
</tr>
<tr>
<td>Forsythe</td>
<td>11.5</td>
<td>6.2</td>
<td>71.9</td>
<td>10.4</td>
</tr>
<tr>
<td>Scarlett</td>
<td>33.8</td>
<td>9.4</td>
<td>36.4</td>
<td>20.4</td>
</tr>
<tr>
<td>Slauson</td>
<td>14.2</td>
<td>11.2</td>
<td>62.8</td>
<td>11.7</td>
</tr>
<tr>
<td>Tappan</td>
<td>14.9</td>
<td>14.4</td>
<td>57.0</td>
<td>13.7</td>
</tr>
<tr>
<td>Total</td>
<td>16.5</td>
<td>13.7</td>
<td>56.7</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Note: “Other” includes Native American, Hispanic, Middle Eastern, Other, and Multi-ethnic.

FINDINGS

As mentioned in Report 17/Part 1, changes in the MEAP test make it difficult to compare results prior to 2002 with any since 2002. The graph below shows the progress made by the students at each of the Ann Arbor Public Schools’ middle schools, as well as at the district and state levels. The values given represent the percent of eighth grade students meeting or exceeding the state standards.

Data courtesy Ann Arbor Public Schools
THE TEXAS ASSESSMENT OF ACADEMIC SKILLS (TAAS) FOR PLANO, TEXAS (1998-1999)

DESCRIPTION

SPECIAL POPULATIONS: MINORITY, GIFTED, LOW SES

The Plano Independent School District (a largely affluent district) piloted CMP1 in some of their middle schools. They compared the achievement of CMP and non-CMP middle school students in the district using scores on the mathematics subtest of the Texas Assessment of Academic Skills (TAAS). Growth was measured from grade 5, before students began using Connected Mathematics 1, to grade 8. Of the 2,336 students tested, 892 used Connected Mathematics 1 in grades 6 through 8.

FINDINGS

The graph below shows the growth in the Texas Learning Index (TLI) for CMP1 and Non-CMP students. (The TLI allows TAAS results to be compared across years and grade levels, even though the difficulty and number of questions may vary. So, for example, a TLI score of 80 on the 1996 grade 5 math test is equivalent to a TLI score of 80 on the 1999 grade 8 math test. A TLI score does not indicate the percent of items answered correctly.) A TLI growth of zero indicates that students are progressing at grade level expectations.

As a group, the CMP1 students’ scores increased more than those of the non-CMP students. Moreover, economically disadvantaged, Hispanic, and African American students in the CMP group showed more growth than both the CMP1 group as a whole and the corresponding students in the non-CMP group. The CMP1 students classified as gifted and talented increased their already high scores slightly, making greater gains than the non-CMP gifted and talented students.

See Report 9 for further information on the Texas schools that served as field test sites for Connected Mathematics 2.
THE TEXAS ASSESSMENT OF ACADEMIC SKILLS (TAAS) FOR PLANO, TEXAS (1998-2001)

SPECIAL POPULATIONS: MINORITY, GIFTED, LOW SES

In the 1999–2000 school year, all the middle schools in the Plano Independent School District began using *Connected Mathematics*. This report summarizes the growth in mathematics scores from the Grade 5 TAAS in 1998 to the Grade 8 TAAS in 2001. Note that the TAAS test has been transitioning to reflect the Texas Essential Knowledge and Skills (TEKS) and, as a result, the difficulty level of test items has increased on recent tests.

**DESCRIPTION**

This table shows the growth in TLI scores from grade 5 to grade 8. (See Part 1 of this report for a description of the TLI.) The entire district and each subgroup made gains on the mathematics subtest of the TAAS. Note that groups that began with the lowest average scores showed the greatest increases.

<table>
<thead>
<tr>
<th>Group</th>
<th>Grade 5 1998</th>
<th>Grade 8 2001</th>
<th>Gain</th>
<th>Group Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>84.56</td>
<td>88.02</td>
<td>3.46</td>
<td>2271</td>
</tr>
<tr>
<td>Male</td>
<td>84.67</td>
<td>88.15</td>
<td>3.48</td>
<td>1159</td>
</tr>
<tr>
<td>Female</td>
<td>84.45</td>
<td>87.88</td>
<td>3.43</td>
<td>1112</td>
</tr>
<tr>
<td>Ec. Dis.</td>
<td>80.62</td>
<td>84.67</td>
<td>4.05</td>
<td>98</td>
</tr>
<tr>
<td>At Risk</td>
<td>75.34</td>
<td>81.35</td>
<td>6.01</td>
<td>194</td>
</tr>
<tr>
<td>Afr. Amer.</td>
<td>79.87</td>
<td>84.71</td>
<td>4.84</td>
<td>106</td>
</tr>
<tr>
<td>Hispanic</td>
<td>81.56</td>
<td>85.48</td>
<td>3.93</td>
<td>99</td>
</tr>
<tr>
<td>PACE*</td>
<td>89.95</td>
<td>91.01</td>
<td>1.06</td>
<td>339</td>
</tr>
<tr>
<td>Special Ed.</td>
<td>75.67</td>
<td>82.47</td>
<td>6.8</td>
<td>87</td>
</tr>
<tr>
<td>Honors Math</td>
<td>89.47</td>
<td>90.82</td>
<td>1.35</td>
<td>768</td>
</tr>
<tr>
<td>Regular Math</td>
<td>82.38</td>
<td>86.83</td>
<td>4.44</td>
<td>1455</td>
</tr>
<tr>
<td>Sp. Math**</td>
<td>68.76</td>
<td>77.17</td>
<td>8.41</td>
<td>41</td>
</tr>
</tbody>
</table>


Students who answer 95% of the items on the TAAS mathematics subtest correctly receive “Academic Recognition” status. The following chart shows how the percentage of students receiving Academic Recognition changed from grade 3 to grade 5, from grade 5 to grade 8, and from grade 8 to grade 10. Most of the gains are negative, which reflects the impact of the greater number of higher-level questions on the 2001 test. However, the relatively small change from grade 5 to grade 8 suggests that *Connected Mathematics* better prepares students for higher-level problem solving than the traditional programs used at the elementary and high school levels.

**Special Populations: Geographic Diversity, Low SES**

The Arkansas Statewide Systemic Initiative (ASSI) conducted a statewide evaluation of the CMP1 curriculum from 1995 to 1997. The study evaluated one year of implementation of the grade 6 curriculum in eight Arkansas school districts (O’Neal and Robinson-Singer 1998). Districts participating in the study included a wide range of socioeconomic levels, from poor to relatively affluent. The Stanford Achievement Test was used in 1995 to acquire baseline data. The test was given again in the fall of 1997, after a year of CMP1 implementation.

The data presented on the following page are matched longitudinal data, including results only from students present for both years of testing. The study found that mathematics scores of CMP1 students showed positive and statistically significant growth that exceeded that of their non-CMP1 peers across the state. And, of the participating districts, all but one showed gains in test scores. Evidence presented in the study also shows that CMP1 was viewed favorably by teachers and had a positive impact on teachers’ classroom practices.

Districts B and G were the poorest in the study (measured by the percentage of students receiving free or reduced-price lunches). Although these districts composed only a small portion of the study, the CMP students in district G showed gains on the Stanford test that not only outpaced the gains by all the students in Arkansas, but also slightly exceeded the gains made by the entire sample of CMP students. The ASSI study concluded that CMP1 showed excellent promise even after only one year of evaluation.

### TAAS Academic Recognition for Plano ISD

<table>
<thead>
<tr>
<th>Group</th>
<th>Gr. 3 1999</th>
<th>Gr. 5 2001</th>
<th>Gain</th>
<th># in Group</th>
<th>Gr. 5 1998</th>
<th>Gr. 8 2001</th>
<th>Gain</th>
<th># in Group</th>
<th>Gr. 8 1999</th>
<th>Gr. 10 2001</th>
<th>Gain</th>
<th># in Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>33.00%</td>
<td>27.00%</td>
<td>-6.13%</td>
<td>2709</td>
<td>28.00%</td>
<td>31.00%</td>
<td>2.00%</td>
<td>2271</td>
<td>42.00%</td>
<td>21.00%</td>
<td>-18.70%</td>
<td>2578</td>
</tr>
<tr>
<td>Male</td>
<td>35.00%</td>
<td>29.00%</td>
<td>-6.58%</td>
<td>1384</td>
<td>9.00%</td>
<td>33.00%</td>
<td>4.00%</td>
<td>1159</td>
<td>43.00%</td>
<td>27.00%</td>
<td>-16.40%</td>
<td>1323</td>
</tr>
<tr>
<td>Female</td>
<td>30.00%</td>
<td>25.00%</td>
<td>-5.66%</td>
<td>1325</td>
<td>27.00%</td>
<td>28.00%</td>
<td>1.00%</td>
<td>1112</td>
<td>40.00%</td>
<td>19.00%</td>
<td>-21.11%</td>
<td>1255</td>
</tr>
<tr>
<td>Ec. Dis.</td>
<td>12.00%</td>
<td>10.00%</td>
<td>-1.85%</td>
<td>162</td>
<td>10.00%</td>
<td>9.00%</td>
<td>-1.00%</td>
<td>98</td>
<td>16.00%</td>
<td>5.00%</td>
<td>-10.67%</td>
<td>75</td>
</tr>
<tr>
<td>At Risk</td>
<td>7.00%</td>
<td>6.00%</td>
<td>-1.36%</td>
<td>295</td>
<td>5.00%</td>
<td>3.00%</td>
<td>-2.00%</td>
<td>194</td>
<td>8.00%</td>
<td>2.00%</td>
<td>-5.90%</td>
<td>288</td>
</tr>
<tr>
<td>Afr. Amer.</td>
<td>13.00%</td>
<td>7.00%</td>
<td>-5.04%</td>
<td>175</td>
<td>12.00%</td>
<td>10.00%</td>
<td>-2.00%</td>
<td>106</td>
<td>15.00%</td>
<td>6.00%</td>
<td>-9.35%</td>
<td>139</td>
</tr>
<tr>
<td>Hispanic</td>
<td>15.00%</td>
<td>13.00%</td>
<td>-2.55%</td>
<td>157</td>
<td>15.00%</td>
<td>12.00%</td>
<td>-3.00%</td>
<td>99</td>
<td>17.00%</td>
<td>4.00%</td>
<td>-12.32%</td>
<td>138</td>
</tr>
<tr>
<td>PACE*</td>
<td>72.00%</td>
<td>65.00%</td>
<td>-6.97%</td>
<td>488</td>
<td>64.00%</td>
<td>71.00%</td>
<td>7.00%</td>
<td>339</td>
<td>80.00%</td>
<td>60.00%</td>
<td>-20.52%</td>
<td>307</td>
</tr>
<tr>
<td>Special Ed.</td>
<td>9.00%</td>
<td>5.00%</td>
<td>-4.65%</td>
<td>129</td>
<td>3.00%</td>
<td>2.00%</td>
<td>-1.00%</td>
<td>87</td>
<td>7.00%</td>
<td>4.00%</td>
<td>-2.92%</td>
<td>137</td>
</tr>
<tr>
<td>Honors Math</td>
<td>58.00%</td>
<td>63.00%</td>
<td>5.00%</td>
<td>588</td>
<td>63.00%</td>
<td>57.00%</td>
<td>-6.00%</td>
<td>768</td>
<td>79.00%</td>
<td>57.00%</td>
<td>-22.60%</td>
<td>730</td>
</tr>
<tr>
<td>Regular Math</td>
<td>13.00%</td>
<td>14.00%</td>
<td>1.00%</td>
<td>1455</td>
<td>30.00%</td>
<td>10.00%</td>
<td>-19.46%</td>
<td>1593</td>
<td>30.00%</td>
<td>10.00%</td>
<td>-19.46%</td>
<td>1593</td>
</tr>
<tr>
<td>Sp. Math**</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>41</td>
<td>3.00%</td>
<td>0.00%</td>
<td>-2.70%</td>
<td>74</td>
<td>3.00%</td>
<td>0.00%</td>
<td>-2.70%</td>
<td>74</td>
</tr>
</tbody>
</table>

*Plano ISD’s Gifted and Talented Program
**A group of algebra classes for newly arrived, non-English speakers and other special students

Data courtesy Plano Independent School District
Students from five of the school districts involved in the previous study (Report 19) continued to use *Connected Mathematics 1* throughout grades 7 and 8. Since that study, Arkansas has begun an assessment plan requiring all schools to administer criterion-referenced exams—known as Benchmark Exams—in grades 4, 6, and 8. The exams consist of 39 or 40 multiple-choice items, worth 1 raw score point each, and 5 open-response items, worth 8 raw score points each. Students are classified into four categories according to their performance on the Benchmark Exam.

- **Advanced**: Students demonstrate a performance beyond proficiency for their grade level.
- **Proficient**: Students are well prepared to proceed to the next level.
- **Basic**: Students are performing below grade level but are approaching preparedness for the next level.
- **Below Basic**: Students are functioning well below grade level and need remediation.

The Benchmark Exam was administered to all grade 8 students for the first time in 1999.
The graph below compares the performance of students in the CMP1 schools with the performance of all grade 8 students in Arkansas. The CMP1 results are for all students who were enrolled in the CMP1 schools at the time of the test. The state data also include the CMP1 schools.

On the 2001 grade 8 Benchmark Exam, the CMP1 schools outperformed the state on 33 of the 40 multiple-choice items and on all the open-response items. The graph below compares the performance on the open-response items. Note that there is one item for each of the five content strands: number sense, properties, and operations; geometry; measurement; data analysis, probability, and statistics; and algebra and functions.
Since 1998, more Arkansas middle schools have implemented *Connected Mathematics 1*. In 2002, Arkansas began administering the Benchmark exam in both grade 6 and grade 8.

The grade 6 data are given for 10 CMP1 schools. At these ten schools combined, 36.4% of students receive free or reduced-price lunch and 13.5% are minorities. The grade 8 data are given for six CMP1 schools, including the five CMP1 schools described in Report 20. At these six schools combined, 32.85% of students receive free or reduced-price lunch and 8.8% are minorities.

The graphs below show 2002 Grade 6 Benchmark Exam results for all CMP1 schools, the best-performing CMP1 school, and the state. The state data includes the CMP1 data. The CMP1 schools performed better than the state on 38 of the 39 multiple-choice items and as well as the state on 1 item. The CMP1 schools outperformed the state on all the open-response items. (Note: Of the five open-response questions on the test, one was on measurement; two were on data, statistics, and probability; and two were on patterns, algebra, and function. There were no questions from the number or geometry strands.)

The graphs on the following page show 2002 Grade 8 Benchmark Exam results for all CMP1 schools, the best-performing CMP1 school, and the state. The CMP1 schools performed better than the state on 31 of 40 multiple-choice items and as well as the state on two of the items. The CMP1 schools outperformed the state on all the open-response items.
REPORT 22  EVALUATION STUDY FROM MINNEAPOLIS (1997)

SPECIAL POPULATIONS: GEOGRAPHIC DIVERSITY

DESCRIPTION
During the 1996–97 school year, nine middle schools in Minneapolis began using Connected Mathematics (Winking, Bartel, and Ford 1998). Five of the schools fully implemented the curriculum, while the other four partially implemented it (that is, they routinely used other mathematics curricula in addition to Connected Mathematics, or the teachers did not receive professional development). A total of forty teachers participated in the study. After one year, the study evaluated academic performance in mathematics as well as changes in the attitudes of students and teachers about teaching and learning mathematics.

FINDINGS
The graphs on the next page compare the performance of students at CMP1 schools with the performance of students in “matching” non-CMP schools. Schools were matched according to three characteristics: ethnicity, socioeconomic status, and school type (open, magnet, K–8, etc.). (Note: Suitable matches could not be found for two of the schools in the study, and one of the schools included grade 6 only. Thus, results are shown for six of the nine schools in the study only.)

The first graph shows that grade 7 CMP1 students in the full-implementation schools scored significantly better than their non-CMP peers on the CAT/5 Math Concepts Sub-test. The second graph indicates that most grade 8 students in the full-implementation CMP1 schools performed significantly better than their non-CMP peers on the mathematics portion of the Minnesota Basic Standards Tests (MBST).
The study also found that, after using *Connected Mathematics*, students were less likely to make negative comments about mathematics.

**Special Populations: None**

**Description**
During the 1996–99 school years, the Maine Mathematics and Science Alliance (MMSA) provided professional development for several school districts to assist them in implementing *Connected Mathematics 1* over a three-year period. MMSA has compiled student performance data using the Maine Educational Assessment (MEA). This assessment is given to students at grades 4, 8, and 11.

**Findings**
This graph summarizes the change in student performance for CMP1 schools and for the state, starting the year before implementation (1995–96).

Since the 1998–99 school year, Maine students have been given a redesigned, standards-based MEA. Based on the results, students are classified into one of the following categories: Exceeds the Standards, Meets the Standards, Partially Meets the Standards, and Does Not Meet the Standards.

The graph below shows student performance on the new MEA for a sample of schools that have had teams of teachers participating in CMP1 summer institutes and that have implemented CMP1 for at least two years. These results are compared to the state results. The results from CMP1 students exceeding or meeting the standards were 2 to 5 percentage points above the state average. Note that the CMP1 data are included in the state data.
AP Test Results for Traverse City, Michigan (2002)

Special Populations: Geographic Diversity

Description
Several years ago, the Traverse City Public School District began phasing in the implementation of NSF-funded, standards-based curricula across grade levels. The district chose *Investigations in Number, Data, and Space* as the elementary curriculum, *Connected Mathematics 1* as the middle school curriculum, and *Contemporary Mathematics in Context* as the high school curriculum. Two of the district’s goals were to improve Advanced Placement (AP) calculus scores and to institute an AP statistics course.

Findings
The graphs below show Traverse City’s results for the Advanced Placement AB calculus, BC calculus, and statistics exams. Note that 2001 was the first year the AP students had completed grades 6, 7, and 8 of *Connected Mathematics 1* and an accelerated version of *Contemporary Mathematics in Context*. The percentage of students who passed the exams increased dramatically that year. Notice also that the number of students taking the exams has increased. For example, from 1999 to 2001, the number of students taking the AP statistics exam doubled.
It is also interesting to note that 2001 was the first year that both the AP calculus and AP statistics scores were above the AP international percentage results.

**Test Results for Portland, Oregon (1999-2003)**

**Special Populations: Geographic Diversity, Minority**

*Description* 
In the 1999–2000 school year, the Portland Public School District implemented *Connected Mathematics 1*. The district uses results from the Portland Achievement Level Tests (PALT) to measure student achievement in grades 6 and 7. In grade 8, the Oregon Statewide Assessment is used to measure student achievement. The statewide test includes both a problem solving assessment and a multiple-choice assessment. Grade 8 students in Portland Public Schools began taking the state test in 1999. The 1999 data represent baseline data.

*Findings* 
On the PALT tests, the percentage of students in the Meeting Standards and Exceeding Standards categories increased every year from 1999–2002. In grade 7, the percentages increased from 58% in 1999 to 69% in 2002.

The graph below shows that the percentage of grade 8 students in the Portland Public School District (PPS) meeting or exceeding standards on the problem-solving portion of the state test increased steadily during the first two years after CMP1 implementation. In 2002, there was a general decrease in scores for both Portland and the state, but Portland’s scores were still greater than the scores statewide. In all four years, the percentage of PPS students meeting or exceeding the standards was greater than the statewide percentage. Note that the state scores include the Portland scores.

![Graph showing the percentage of grade 8 students meeting or exceeding standards on the problem-solving portion of the state test from 1999 to 2003. The graph shows a steady increase in the percentage of students meeting or exceeding standards from 1999 to 2001, with a decrease in 2002 but still higher than the state percentage.](image)

The following graph shows that, since implementation of *Connected Mathematics 1*, the grade 8 students in PPS have improved on the multiple-choice portion of the test and have outperformed the state every year from 1999 to 2002.
The graph below shows the results for grade 8 PPS students from different ethnicity groups on the multiple-choice portion of the statewide test. Some groups have shown an increase in achievement.

Data courtesy Portland Public Schools and Oregon State Department of Education
Performance of the Michigan Invitational Group in the TIMSS Benchmarking Study (1999)

Special Populations: Geographic Diversity

Description
The 1999 Third International Mathematics and Science Study (TIMSS 1999) measured trends in the mathematics and science achievement of grade 8 students in 38 countries. In addition, 13 states and 14 districts or consortia of districts participated in the TIMSS 1999 Benchmarking Study (also known as the TIMSS-R Benchmarking Study). This study provided participants with an opportunity to evaluate their mathematics and science programs in an international context. The TIMSS-R assessments were given to random samples of students from each group, using the same guidelines established for the 38 participating countries.

Michigan was represented in the TIMMS-R Benchmarking Study both as a state and as the Michigan Invitational Group (MIG). The MIG consisted of 21 school districts that were selected to represent the diversity within Michigan and to meet five criteria for implementation. Eighteen of the districts in the MIG reported using standards-based curricula. About half of these eighteen districts reported using Connected Mathematics 1.

Findings
The graph on the following page ranks the participating groups that scored above the international average and compares their scores to the international average of 487. Scores for the 22 groups scoring below the international average are not shown. The Michigan Invitational Group (MIG) came in fourth among the U.S. groups.

In the top performing U.S. groups, all the U.S. groups are high affluent districts except MIG. MIG represents Michigan’s high SES, low SES, minority, urban, and suburban populations.

The TIMSS benchmarking study also collected data on teaching practices. In the MIG schools, 41% of the students had teachers who emphasized reasoning and problem solving, ranking them fourth overall on this measure. (In the highest-ranking group, Japan, 49% of students had teachers who emphasized problem solving.)
Nevin Platt Middle School, which has approximately 615 students, is one of 17 middle schools in the Boulder Valley School District. The school began using *Connected Mathematics 1* in 1998. The Colorado State Assessment Program (CSAP) is administered to grade 8 students every spring. Based on their scores, students are classified as Advanced, Proficient, Partially Proficient, or Unsatisfactory. Beginning in 2001, the grade 8 students tested at Nevin Platt had been using *Connected Mathematics* for three years. CSAP scores at Nevin Platt Middle School have steadily increased since the implementation of *Connected Mathematics 1*. The school consistently outscores the district and the state. Since 2003, the grade 8 scores at Nevin Platt have been third highest out of the 17 schools in the district. (The two highest-scoring schools are charter schools.) The graph below compares the results for Nevin Platt to the results for the Boulder Valley School District and for the state. Note that the Nevin Platt scores are included in the district and state scores.

### FINDINGS

Data courtesy Colorado State Department of Education, Nevin Platt Middle School, and Boulder Valley School District

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The Austin Collaborative for Mathematics Education (ACME), funded by the National Science Foundation, was a districtwide initiative to improve mathematics education in elementary and middle school classrooms in the Austin Independent School District (AISD) from 1997 to 2002. The initiative provided professional development to teachers as they implemented new standards-based mathematics programs. The district used *Investigations in Number, Data, and Space* in grades K–5 and *Connected Mathematics 1* in grades 6–8.
An independent evaluation of ACME was completed in 1999–2000. Student performance data on the Texas Assessment of Academic Skills (TAAS) were collected over three school years. In addition, data on the effectiveness of the professional development program were assessed through principal and teacher questionnaires, classroom observations, professional development observations, and teacher interviews.

The study found that the percentage of students passing the mathematics subtest of the TAAS rose from 1998–1999 to 1999–2000. The passing rate also increased for most subpopulations, with African American, Hispanic, and economically disadvantaged students making greater gains than white students.

Note: The data for the 1997–98 school year did not include Grade 6, 7, and 8 students in special education.
The study also looked at how the level of implementation of standards-based instruction was related to TAAS mathematics passing rates and basic mathematics knowledge as assessed by the Iowa Test of Basic Skills (ITBS.) Classrooms with the strongest implementation of the curricula had the highest passing rates on both measures. These classrooms also had the highest passing rates on each of the 13 TAAS mathematics objectives. Note that the sample for this study included randomly selected classrooms from grades K–8.

Note: Chi-square tests were statistically significant ($p < .01$), indicating that the number of students passing TAAS mathematics and passing each of the 13 objectives varied significantly by the quality of teacher implementation.
The Austin Independent School District analyzed student performance data on the spring 2001 TAAS mathematics test as it related to the level of implementation of Connected Mathematics 1. This data is different from the data in Part 1 in that it includes only Connected Mathematics 1 classrooms, no elementary classrooms.

The graph below shows that classrooms with the strongest implementation of CMP1 had the highest passing rates on the TAAS.
The graph below shows results for various subpopulations. For African American students, white and other students, and economically disadvantaged students, classrooms with strong or moderate implementation had the highest passing rates. For Hispanic students, there was no significant difference in achievement for the different levels of implementation.

In addition, classrooms with strong implementation scored higher on 9 out of 13 objectives than students in classrooms with weak or moderate implementation.
Note: The differences between the implementation levels were statistically significant for every objective. Chi-squares were significant (p < .05).

Information for this report courtesy Michelle L. Batchelder, Ph.D., Evaluation Analyst, Office of Program Evaluation, Austin Independent School District.
RESULTS FROM THE MADISON SCHOOL DISTRICT, PHOENIX, ARIZONA (1996-2001)

SPECIAL POPULATIONS: MINORITY, LOW SES

Madison School District is a K–8 district in Phoenix, Arizona that began implementation of Connected Mathematics 1 in 1996-97. The district has a high mobility rate, a substantial number of students qualifying for free or reduced-price lunch, and a large minority population. In 2001, Meadows had a 24% mobility rate and a 14% free or reduced-price lunch population, and Park had a 58% mobility rate and a 73% free and reduced-price lunch population. The table on the next page shows minority data for the three middle schools in the district.

Beginning in 1998, all students in the Madison School District used the standards-based program Investigations in Number, Data, and Space for grades K–5 and Connected Mathematics 1 for grades 6–8. In 1998–1999, the district received a National Science Foundation grant, TREASURmath, to provide professional development for grade K–8 teachers to assist them in implementing the new curricula.

After completing Grade 8, Madison students go to Phoenix Union High School District (PUHSD). All incoming freshman take a placement exam to determine which math course they will take.

FINDINGS

The tables in this section show placement-test results for 1995–1996, the year prior to CMP1 implementation, and for 2000–2001.

The table below shows that the percentage of students placing into algebra increased for all three schools. The greatest increase occurred at Park, which has the highest mobility rate in the district and the greatest percentage of students receiving free or reduced-price lunch.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Number of Students</td>
<td>Percent Qualified</td>
</tr>
<tr>
<td>Meadows</td>
<td>155</td>
<td>86%</td>
</tr>
<tr>
<td>Number One</td>
<td>192</td>
<td>65%</td>
</tr>
<tr>
<td>Park</td>
<td>86</td>
<td>31%</td>
</tr>
</tbody>
</table>

Some of the grade 8 students who place into algebra score well enough to qualify for honors algebra. The next table shows that the percentage of students who qualified for algebra and who also qualified for honors algebra increased at all three schools. Note the particularly impressive gains at Park.
Students who receive a score of 30 or above on the placement exam qualify for geometry, and those who receive a score of 40 or above qualify for honors geometry. The mean score was over 40 at all three schools: 73.5 for Meadows, 73.8 for Number One, and 64.1 for Park.

The table below shows that the percentage of students who qualified for honors algebra and who also qualified for honors geometry increased at all three schools. (It should be noted that Park has a smaller population and a smaller number of students qualifying for honors algebra and honors geometry than the other two schools, and thus the findings should be interpreted carefully.)

### Grade 8 Students Qualifying for Algebra who also Qualify for Honors Algebra

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>Number of Students</td>
<td>Percent Qualified</td>
</tr>
<tr>
<td>Meadows</td>
<td>65</td>
<td>54%</td>
</tr>
<tr>
<td>Number One</td>
<td>79</td>
<td>28%</td>
</tr>
<tr>
<td>Park</td>
<td>8</td>
<td>9%</td>
</tr>
</tbody>
</table>

Arizona’s Instrument to Measure Standards (AIMS) is a statewide test administered in grades 3, 5, and 8. The test was first given in the Madison School District in 1999–2000. The next graph shows the results on the mathematics portion of the test for Madison and for the state.
In addition to the results described above, results on the Stanford 9 Achievement Test for mathematics have also improved. In 1998–1999, prior to the implementation of TREASUREmath, Stanford 9 scores for Madison were in the 55th to 67th percentile rank (depending upon the grade level). After two years of intensive professional development, 2000–2001 test scores on the same norm-referenced test ranged from the 62nd percentile to the 73rd percentile (again depending upon grade level). Since the 1998–1999 school year, Stanford 9 test scores for all grades have increased, including the scores for cohort groups of students across the years.

AIMS and Stanford 9 results courtesy Madison School District
This section presents a brief description of qualitative reports of student learning. The first set of studies summarized and cited involves learning within the content strands of number, geometry, measurement, statistics, and probability. The second set reports on algebraic understanding.

**Number, Geometry, Measurement, Statistics, and Probability**

- Chapin (2003) shares how a similarity problem from the CMP unit “Stretching and Shrinking” has been used to help a group of seventh grade students formalize their own conceptual methods of solving proportional reasoning problems.
- Friel (1998) and Friel and O’Connor (1999) provide evidence showing that *Connected Mathematics*’ carefully sequenced development of conceptual and procedural understanding of mean, median, and mode helps students to develop sophisticated ways of comparing and analyzing data sets using box plots and outliers.
- Keiser (1997a, 1997b, 2000), in a study of grade 6 CMP students’ understanding of geometry, found that *Connected Mathematics* has the potential to promote development of deep understanding of geometric definitions and concepts.
- Krebs (2003) reports on a study of five pairs of CMP students that focused on their algebraic understanding. The study indicated that all five pairs: (1) possessed some strategies to formalize generalizations, (2) made connections among tabular, symbolic, and graphical representations, and (3) made connections between tasks and other problems they had studied.
- Lappan and Bouck (1998) show that *Connected Mathematics* not only affords students opportunities to develop algorithms for adding and subtracting fractions, but also helps them refine problem-solving skills and the ability to distinguish between reasonable and unreasonable solutions to problems involving fractions.
- Rubenstein et al. (1993) show how the angle sense developed in *Connected Mathematics* helps students make connections to rational numbers, coordinates, number theory, patterns and functions, and additional concepts in geometry.

**Algebra**

- Herbel-Eisenmann (2002) analyzes the role of language in developing understanding of slope in two grade 8 CMP classrooms. Through a series of problems, students move from “contextual language” to “bridging language” and finally to “official mathematical language.” Herbel-Eisenmann concludes that allowing students to develop their own ways of communicating ideas about slope before introducing formal language is more natural and helps make algebraic ideas more understandable for every student.
• Krebs (1999) found that grade 8 students who have studied *Connected Mathematics* for three years exhibit a deep understanding of how to generalize functions symbolically from patterns of data.

• Lambdin, Lynch, and McDaniel (2000) use problems from the CMP unit *Variables and Patterns* to explore rates of change and the shapes of graphs with grade 6 students. The classroom activities were selected to illustrate one aspect of the algebra standard in the *Principles and Standards for School Mathematics* (NCTM 2000).


• Phillips and Lappan (1998) examine how the development of algebraic thinking, skill, and understanding can be successfully initiated and fostered throughout a student’s mathematics education. Examples of CMP students’ algebraic experiences are presented showing that “more students can be successful with algebra if given an opportunity to engage in, and make sense of, interesting mathematical situations.”

• Phillips et al. (1998) discuss the development of exponential functions in *Connected Mathematics* and document students’ reasoning with and understanding of exponential functions.

• Smith, Herbel-Eisenmann, and Star (1999) found that among eight classes of grade 8, third-year CMP students, spanning four schools and three school districts in Michigan, most students exhibited a strong understanding of algebraic concepts and procedures. In particular, they demonstrated a strong understanding of linear relationships and a beginning understanding of quadratic and exponential relationships.

• Smith, Phillips, and Herbel-Eisenmann (1998) and Smith and Phillips (2000) found that a class of grade 8 CMP students showed significant understanding in algebra. The students’ algebraic understanding included a strong grasp of linear relationships, the ability to distinguish linear from non-linear relationships, effective use of graphing calculators, and the ability to make connections between symbolic expressions and problem contexts.

• Wasman (2000) investigates the algebraic reasoning of seventh and eighth graders who have studied from the CMP materials. Students demonstrated flexibility in their thinking and ability to describe linear relationships in a variety of representations. Wasman also found the students that participated in the study approached problems in a sense-making way, choosing a variety of different strategies (informal and formal), all of which led to correct solutions and reflected strong conceptual understanding of algebraic ideas.


**Professional Development and Implementation**

A number of studies on *Connected Mathematics* address the professional development of CMP teachers. This collection of reports also discusses the impact of the curriculum on implementation issues and on teacher knowledge of content and pedagogy.

• Bouck, Keusch, and Fitzgerald (1996) show that good curriculum, alternative pedagogy, coaching, and time are four major factors needed to provide intellectual and emotional support for teachers as they work toward changing their practices.

• Collins (2000) writes of her own experiences in tutoring a neighbor’s son in 6th grade mathematics. Collins, a CMP teacher, used the same CMP lessons from her own classroom to
tutor her 6th grade neighbor and shares her successes with and fondness for the use of CMP in her classroom and her neighborhood.

- Kladder, Peitz, and Faulkner (1998) discuss how *Connected Mathematics* has the potential to eliminate tracking without compromising the integrity of the mathematical content. Student work shows different ways in which students may approach the same problem.

- Lambdin and Keiser (1996) explore how time constraints in the classroom can impact teaching with *Connected Mathematics* and suggest that some schools consider longer class periods and constructive use of time in order to most effectively implement the curriculum.

- Lambdin and Lappan (1997) reflect on six years of development of the CMP curriculum in order to “discuss and debate some of the most salient dilemmas and issues” identified during the development and implementation of the curriculum. The dilemmas and issues are described and analyzed with respect to characteristics of the reform movement.

- Lambdin and Preston (1995) show that teaching with *Connected Mathematics* can elicit different reactions from teachers and provide teachers with varying degrees of professional challenge.


- Lappan (1997) examines the vision of teacher decision-making that is portrayed in the NCTM Professional Teaching Standards: choosing worthwhile mathematical tasks, orchestrating and monitoring classroom discourse, creating an environment for learning, and analyzing one’s practice.

- Lowe (2004), a middle school principal, outlines suggestions for schools considering adoption of the CMP curriculum.

- Lubienski (2000) describes CMP, with special attention paid to the role of teachers and researchers in the implementation of CMP. Also discussed is how seventh graders with different SES backgrounds react to a problem-solving approach to learning mathematics.

- Preston and Lambdin (1997) explore how using *Connected Mathematics* over time impacts teachers’ professional development in challenging and positive ways.

- Raymond (2004) reports on NCTM President Cathy Seeley’s visit to a CMP middle school in Austin, TX. Ms. Seeley’s interactions with staff and students, as well as the CMP curriculum itself, are highlighted.

- Reinhart (2000) discusses how improving the communication about mathematical ideas creates new opportunities for students to increase learning.

- Rickard (1995a, 1995b, 1996, 1998) profiles a middle school mathematics teacher and her approach in the use of a unit on perimeter and area. He shows that *Connected Mathematics* can be used to yield rich opportunities for problem solving and making mathematical connections, but that the outcome may be changed by a teacher’s beliefs, how a teacher’s beliefs interact with problem-solving contexts, and how that interaction influences a teacher’s use of the curriculum.

- Schneider (1998), in a study conducted by the Texas Statewide Systemic Initiative, investigates the implementation of the CMP curriculum and suggests that all mathematics teachers in a school should use *Connected Mathematics* in order to provide students with continuity between and across grades. Furthermore, she suggests that ongoing professional development for teachers and administrative, parental, and community support are essential.

- Sjoberg, et al. (2004) discuss the significance of improving writing prompts, as well as the development and use of such prompts, as a means of improving student reflection. The use of CMP, how it encourages meaningful reflection, and implications for classroom practice are additional points touched upon.
This section presents examples of work done by CMP students. The examples illustrate the rich mathematical problems and contexts students in *Connected Mathematics 1* routinely encounter, and demonstrate how the students typically explain their reasoning and organize their findings.

The problems shown are drawn from *Connected Mathematics 1* units, research and evaluation studies on the CMP curriculum, and assessments developed by the Balanced Assessment Project (Schoenfeld et al. 1999) to evaluate students’ achievement in mathematical problem solving—including the ability to connect, communicate, and reason with mathematical concepts and procedures. Most of the samples are taken from heterogeneous classes.

**Example 1 Orange Juice Problem**

This problem appears in the grade 7 CMP unit *Comparing and Scaling*, which focuses on rates, ratios, and proportional reasoning. In previous units, students have developed skill in and understanding of rational numbers. The samples, taken from six groups of students, illustrate a variety of strategies. Each group used a part-to-part or part-to-whole analysis to determine which mixes have the highest and lowest proportions of orange juice concentrate. The groups used several types of representations to convey their reasoning. The work also demonstrates the students’ number skill and flexibility in using and moving among fractions, decimals, and percents.

**Example 2 Goat Problem**

This problem is a Balanced Assessment test item (Schoenfeld et al. 1999) administered to students in grades 6, 7, and 8 during the development phase of the curriculum. The examples shown are typical of the responses collected. The work for each grade is from different students, so the examples should not be interpreted as showing the longitudinal development of one student. Strategies employed include constructing diagrams and estimating, counting, and using formulas to determine the area of a circle. The formula for the area of the circle is developed in grade 6, but these examples show that students continue to understand and use the formula over the three grades. For more information on the goat problem, see Zawojewski, Robinson, and Hoover (1999). See Report 1 for details of the field study test.

**Example 3 Nonagon and Decagon Problem**

This problem is a Balanced Assessment test item (Schoenfeld et al. 1999) administered to grade 6 students during the development phase of the curriculum. The problem involves the concepts of angle, perimeter, and area, and requires students to use both direct measurement and estimation strategies. This example illustrates how students are routinely expected to explain their reasoning and demonstrates that students understand the differences between measures of length and area.
Example 4 Carnival Game Problem

This problem is a Balanced Assessment test item administered to grade 6 students during the development phase of the curriculum. The work shows that the student is able to develop solutions, explain reasoning, and make valid comparisons using both theoretical and experimental probabilities. Embedded in the student’s reasoning is the ability to use fractions to analyze and compare data in probabilistic situations.

Example 5 Pumping Water Problem

This problem was developed by the Michigan Algebra Initiative Project* and administered to grade 8 students at the end of the 1997–98 school year. The example shows that the student is able to use a linear-equation model to answer questions about a situation. The student is also able to write an equivalent expression and explain its meaning within the context of the problem. The student demonstrates a clear understanding of the underlying pattern of change for a linear function.

Example 6 Gasoline Problem

This problem is from the Michigan Algebra Initiative Project* and was administered to grade 8 students. The sample exemplifies the type of reasoning used by CMP students. This student used patterns in data tables to determine that the demand for gas grows exponentially while the supply of gas grows linearly. The student then used the patterns to make and explain a prediction for when demand would exceed supply.

Example 7 Pool Problem

This problem appears in the grade 8 CMP unit Say It with Symbols, which focuses on equivalent expressions and solving linear and quadratic equations. This example illustrates the variety of expressions one group wrote to represent a situation and shows how they used diagrams to demonstrate that the expressions are equivalent.

* In 1997–98 the Michigan Algebra Initiative was funded by the Michigan Eisenhower Higher Education Division to study grade 8 students’ algebraic reasoning and understanding. This problem is taken from a set of problems designed to evaluate students’ knowledge at the end of the year. The project was directed by John Smith and Elizabeth Phillips at Michigan State University.
**Example 8 Equivalent Expressions Problem**

This problem is an assessment item provided in the grade 8 CMP unit *Say It with Symbols*. The teacher used the question to assess his students’ intuitive understanding of equivalence before developing the distributive property. The examples illustrate the variety of strategies students used to determine that $12x - 2x + 10$ is not equivalent to the other expressions. Some students substituted values for the variable and compared the results. Others looked at the underlying linear pattern each expression represents—comparing the slopes of the associated lines, tables of values, or patterns of change.

**Example 9 Toothpick Problem**

This problem is a Balanced Assessment test item (Schoenfeld et al. 1999) administered to grade 8 students at the end of the 1998–1999 school year. These examples show that students can use linear and quadratic equations to generalize geometric patterns. In doing so, the students explicitly discuss the fact that the growth pattern for the perimeter is linear and the growth pattern for the total number of toothpicks is quadratic.
Orange Juice Problem

Every year, the seventh grade students at Langston Hughes School go on an outdoor-education camping trip. During the week-long trip, the students study nature and participate in recreational activities. Everyone pitches in to help with the cooking and cleanup.

Arvind and Mariah are in charge of making orange juice for all the campers. They make the juice by mixing water and orange juice concentrate. To find the mix that tastes best, Arvind and Mariah decided to test some recipes on a few of their friends.

**Problem 3.1**

Arvind and Mariah tested four juice mixes.

<table>
<thead>
<tr>
<th>Mix</th>
<th>Concentrate</th>
<th>Cold Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix A</td>
<td>2 cups</td>
<td>3 cups</td>
</tr>
<tr>
<td>Mix B</td>
<td>1 cup</td>
<td>4 cups</td>
</tr>
<tr>
<td>Mix C</td>
<td>4 cups</td>
<td>8 cups</td>
</tr>
<tr>
<td>Mix D</td>
<td>3 cups</td>
<td>5 cups</td>
</tr>
</tbody>
</table>

**A.** Which recipe will make juice that is the most "orangey"? Explain your answer.

**B.** Which recipe will make juice that is the least "orangey"? Explain your answer.

**C.** Assume that each camper will get $\frac{1}{2}$ cup of juice. For each recipe, how much concentrate and how much water are needed to make juice for 240 campers? Explain your answer.

**Explanation**

- **Mix A** has the least concentrate and the most cold water. It is the least "orangey".
- **Mix B** has the most concentrate and the least cold water. It is the most "orangey".

**Solution**

- **Mix A**: Concentrate $= 2$ cups, Cold Water $= 3$ cups
- **Mix B**: Concentrate $= 1$ cup, Cold Water $= 4$ cups
- **Mix C**: Concentrate $= 4$ cups, Cold Water $= 8$ cups
- **Mix D**: Concentrate $= 3$ cups, Cold Water $= 5$ cups

To make juice for 240 campers:

- **Mix A**: $\frac{1}{2} \times 240 = 120$ cups total
  - Concentrate: $120 \div 120 = 1$ cup
  - Cold Water: $120 \div 2 = 60$ cups
- **Mix B**: $\frac{1}{2} \times 240 = 120$ cups total
  - Concentrate: $120 \div 120 = 1$ cup
  - Cold Water: $120 \div 4 = 30$ cups
- **Mix C**: $\frac{1}{2} \times 240 = 120$ cups total
  - Concentrate: $120 \div 120 = 1$ cup
  - Cold Water: $120 \div 8 = 15$ cups
- **Mix D**: $\frac{1}{2} \times 240 = 120$ cups total
  - Concentrate: $120 \div 120 = 1$ cup
  - Cold Water: $120 \div 5 = 24$ cups

**Team 1**

- Mix A
- Mix B
- Mix C
- Mix D

**Mixture (A)** would have the most taste.
**Mixture (B)** would have the least taste.
**Orange Juice Problem—Full Example 1, continued**

A. Mix "A" is the most concentrate because it has the least amount of water added, which is 1.5 cups of water.

B. Mix "B" is the least concentrate because it has 4 cups of water to 1 cup of concentrate.

**Mix A**

\[
\frac{3}{2} : \frac{1}{2} \text{ water}
\]

**Mix C**

\[
\frac{4}{8} : \frac{2}{8} \frac{1}{2} \text{ water}
\]

**Mix B**

\[
\frac{1}{4} \text{ water}
\]

**Mix D**

\[
\frac{3}{5} \frac{1}{2} \text{ water}
\]

---

**Team 3**

Mix A: 2+3=5 cups of juice \(\times 3=15\) cups 6 concentrate + 9 water 6/15 concentrate 3/15 concentrate

Mix C: 9+6=15 cups of juice \(\times 3=45\) cups of concentrate 9/15 concentrate 3/15 concentrate

A mix "K" uses the concentrate because it had the most percent concentrate (60%).

B. Mix "K" uses the least concentrate because it had the least.

**Team 10**

Mix A is most orange, because...

Mix B is the least orange, because...

Mix C is neither, because...

Mix D is neither, because...

---

**ORANGE JUICE PROBLEM—FULL EXAMPLE 1, CONTINUED**

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**CMP RESEARCH AND EVALUATION SUMMARY | 67**
The Jacobsens keep their goat on a 3-meter chain connected to a metal hook in the ground.

a) They chained the goat to the metal hook in the center of their big yard. What area of grass can the goat reach to eat? Sketch a picture and show your work.

b) Sometimes they chain the goat to the corner of a shed that is 5 meters by 4 meters. The 3-meter chain is attached to the base of the wall at ground level. What is the area of grass that the goat can reach? Show and explain your work.

c) What if the chain was attached at ground level to the center of the 4-meter wall? Would the amount of grass it can reach be greater? Justify your answer.
Nonagon and Decagon Problem

Designers are experimenting with new tile shapes for walls and floors.

- The tile here is in the shape of a regular nonagon.
- The regular nonagon has nine equal sides and angles.

a) What is the measure of the angle marked in the figure? (Use a measuring tool.)

b) Estimate the area of the nonagon: $25\text{ in.}^2$
Describe how you estimated the area.

\[\text{What I did was first I counted the whole squares then I tried to price the rest together to make some squares.}\]

\[\text{I took a ruler and measured the sides then I added them up.}\]

c) Estimate the perimeter of the nonagon: $18\text{ in.}$
Describe how you got your answer.

d) Will nonagons make good tiles that fit together with no gaps? Use the geometric properties of the nonagon to explain or illustrate why.

\[\text{No, because as you can see it leaves gaps!}\]

Designers have developed another tile like this one:
- The tile here is in the shape of a regular decagon.
- A regular decagon has ten equal sides and angles.
- The sides of this decagon are the same length as those of the nonagon.

e) Without measuring, decide whether the angle marked in this decagon is larger or smaller than the angle marked in the nonagon. Explain why this is so.

\[\text{I think it is bigger because in order to fit in another side you would have to spread out the angles to make room.}\]

f) Decide whether the perimeter of the decagon is greater, smaller or the same as the nonagon. Explain how you know.

\[\text{Greater because you said the side lengths are the same and since it has one more side the perimeter will be greater.}\]

\[\text{It is bigger because I did the same thing as I did with the other one and I counted 30.}\]

g) Is the area of the decagon greater, smaller or the same as the nonagon on the previous page? Explain your reasoning.
Carnival Game Problem

1. Luisa is designing a game for a carnival. She has prepared two bags with marbles.

   Bag A contains 3 marbles—
   one red, one blue and one green.

   Bag B contains 2 marbles—
   one red and one blue.

   TO PLAY THE GAME: Draw one marble from each bag. If the marbles match, the person wins a prize.

   a) What is the probability of winning the game? Show your work.

      
      \[ \text{possibilities} \]
      \[ \text{win} - \text{B} - \text{R} \]
      \[ \text{G} - \text{R} \]
      \[ \text{G} - \text{B} \]
      \[ \text{R} - \text{B} \]

      \[ \frac{2}{6} \text{ or } \frac{1}{3} \text{ of the possibilities} \]

   b) This is what happened on the first 30 games:

      \[ \text{WIN} \]
      \[ \text{NO WIN} \]
      \[ \text{[Match]} \]
      \[ \text{[No Match]} \]

      How do the game results in this table and the probability you found in the first question compare? Explain any differences.

      %60 of the people won.
      %60 is almost equivalent to %60.
      It looks like 1 extra person got lucky.

   c) Luisa has decided to offer each customer a choice of two games: the bag game described above and this spinner game.

      Luisa made a spinner with nine equal sections. To play the game, a player spins the spinner. If the spinner lands on a GOLD section, then the person gets a prize.

      Does the player have a better chance of winning with the bag game or the spinner game? Explain your reasoning.

      bag game = \( \frac{1}{3} \)
      spin game = \( \frac{1}{6} \)

      The spinner game because \( \frac{1}{6} \) is bigger than \( \frac{1}{3} \).
d) Luisa created five more spinner games for the carnival.

![Pie charts showing spinner outcomes]

(a) ![Pie chart](image)(b) ![Pie chart](image)(c) ![Pie chart](image)(d) ![Pie chart](image)(e) ![Pie chart](image)

Luisa spun one of the spinners 100 times. She recorded her results in a chart.

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>BLUE</th>
<th>RED</th>
</tr>
</thead>
<tbody>
<tr>
<td># OF TIMES</td>
<td>86</td>
<td>14</td>
</tr>
</tbody>
</table>

Which spinner is most likely the one she used? Explain your reasoning.

B. First I narrowed it down to the ones where blue has more than red. Then I had 2 choices, A or B. I chose B because on B it looks like 86% is blue and 14% is red. On the other one red is shown as taking up 4/3 of the circle which is more than 14.
Pumping Water Problem

Suppose you turn a pump on and let it run to empty the water out of a pool. The amount of water in the pool ($W$, measured in gallons) at any time ($T$, measured in hours) is given by the following equation:

$$W = -350(T - 4)$$

Answer each question below and explain how you used the equation to do so.

A. How many gallons of water are being pumped out each hour?

B. How much water was in the pool when the pumping started?

C. How long will it take for the pump to empty the pool completely?

D. Write an equation that is equivalent to $W = -350(T - 4)$. What does this second equation tell you about the situation?

$$-350X + 1400 \text{ or } -350X + 1400$$

This second equation tells how much water was in the pool in the beginning (the 1400), and the $-350X$ is how much water is pumped out of the pool each hour (350 gallons are pumped out of the pool each hour) for the $T$ hours.

E. Describe what the graph of the relationship between $W$ and $T$ looks like.

The graph will have a straight line that goes this way.

[Graph sketch]
Gasoline Problem

The tables below show the amount of gasoline used by (demand) and the amount of gasoline available (supply) to drivers of cars and trucks in the U.S. for the years 1993-1997.

### Demand for gasoline

<table>
<thead>
<tr>
<th>Year</th>
<th>Gas (billions of gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>50</td>
</tr>
<tr>
<td>1994</td>
<td>60</td>
</tr>
<tr>
<td>1995</td>
<td>72</td>
</tr>
<tr>
<td>1996</td>
<td>86.4</td>
</tr>
<tr>
<td>1997</td>
<td>103.7</td>
</tr>
</tbody>
</table>

### Supply of gasoline available

<table>
<thead>
<tr>
<th>Year</th>
<th>Gas (billions of gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>200</td>
</tr>
<tr>
<td>1994</td>
<td>230</td>
</tr>
<tr>
<td>1995</td>
<td>260</td>
</tr>
<tr>
<td>1996</td>
<td>290</td>
</tr>
<tr>
<td>1997</td>
<td>320</td>
</tr>
</tbody>
</table>

A. Describe the pattern of change for demand.

In the year column they go up by one year each time and in the gas column they multiplied by 1.2 to get the next number. If you graphed the table it would be exponential. This is because the “y” column (gas) is increasing by multiplication not addition.

B. Describe the pattern of change for supply.

In the year column it is increasing by 1 year each time and the gas column is increasing by 30 each time. If you graphed this table you would see that it is linear because in the “y” column (gas) you are increasing by addition.

C. In what year will the demand be greater than supply? Explain your reasoning.

If you keep multiplying the gas column in the demand table by 1.2 and adding 30 each time to the gas column in the supply table and adding a year each time you will find that in year 2007 the demand is 142.1 billion and the supply is 67.0 billion.
Pool Problem

Hot tubs and in-ground swimming pools are sometimes surrounded by borders of tiles. This drawing shows a square hot tub with sides of length $s$ feet. This tub is surrounded by a border of square tiles. Each border tile measures 1 foot on each side.

A. Let $N$ represent the total number of border tiles. How many 1-foot square tiles will be needed for the border of a square pool that has edge length $s$ feet?
B. See if you can come up with more than one way to express the pattern relating $s$ and $N$. Explain your reasoning.
C. Find a way to convince your classmates that the expressions are equivalent.

The work below comes from one group in a CMP classroom.
Equivalent Expressions Problem

Three of the following expressions are equivalent. For the expression which is not equivalent to the others explain how you can predict that it will not be equivalent by examining the expression.

\[
a) \quad 2x - 12x + 10 \quad b) \quad 12x - 2x + 10 \quad c) \quad 10 - 10x \quad d) \quad 10(1 - x)
\]

Samples of Students' Reasons for Selecting b) \(12x - 2x + 10\)

- You can predict this because taking \(2x\) from \(12x\) is totally different than taking \(12x\) from \(2x\).
- Because \(c\) and \(d\) are the same and \(a\) and \(b\) are not the same because it flip flops the first two numbers around and it messes the answer up.
- I put a number for \(x\) and the expression that didn't equal the same number as the other ones is not equal.
- You can predict because if you give the expression a value, like 2, and then solve it, the answer will be different.
- You can put in a value for \(x\) and then work them out in your head and see which one is different.
- This expression increases and the others decrease.
- They are all linear, but the rest all have negative slopes.
- Not equivalent to the others because the table of \(a\), \(d\), and \(e\) decrease by negative numbers. B's table increases by 10.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>-10</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>-20</td>
<td>40</td>
</tr>
</tbody>
</table>

- Because as \(x\) gets bigger \(10x\) becomes larger so you begin to go in the negative, go down instead of up.

NOTE: The teacher gave this problem prior to the development of the distributive property. He used this problem to assess his students' intuitive understandings about equivalence. This problem then led to the development of understanding of the distributive property and its use in showing equivalence, including both linear and quadratic expressions.
Toothpick Problem

The figures shown below are made with toothpicks. Look for patterns in the number of toothpicks in the perimeter of each figure and the total number of toothpicks needed to make each figure.

1. Use a pattern from the above figures to determine the perimeter of Figure 5. Show or explain how you figured this out.

   I counted the perimeters for figures 1-4. I observe that each figure's perimeter increased by four toothpicks. Figure four had 18 perimeter, so in order to get this answer, I added 4 more than 18. So I believe that Figure 5's perimeter is 22 based on the same I have received - 18 + 4 = 22 toothpicks for Figure 5.

2. Use a pattern from the above figures to determine the total number of toothpicks needed to make Figure 5. Show or explain how you figured this out.

   I counted the total toothpicks in Figures 1-4. In each figure increasing to the next, the difference between each figure increased by 2 starting at 6. So in Figure 5, I would add 12 to the 40 of Figure four to get 40 + 12 = 52 toothpicks total for Figure 5.

3. Write a formula that you could use to find the perimeter of any figure N. Explain how you found your formula.

   \[ p = s + 5 + 5s \]

   \[ s = \text{side length} \]

   \[ p = \text{perimeter} \]

   \[ y = 4x \] in the 4 figures we find that the perimeter started at 4 by 4, and then they go up by 4.
4. Write a formula that you could use to find the total number of toothpicks needed to make any figure N. Explain how you found your formula.

\[ T = N(N+3) \]

It fits a pattern: when you divide the total toothpicks by the figure number you can reach by just doing the sum of all numbers you multiply the number of toothpicks by the figure number.

\[ y = x(x+3) \]

It started with (1,4) so at first (since we know it was quadratic) we started out with \( x(x+4) \) but it was 1 ahead so we tried \( x(x+3) \) and it worked.

\[ x^2 + 3x \] because if you work backwards it’s 0,0 and if you add 3 it just works.

\[ \begin{array}{c|c}
 x & y \\
 0 & 0 \\
 1 & 4 \\
 4 & 28 \\
\end{array} \]

\[ (x+4) - x \] because I put a 2 in for \( x \).

A formula to find the number of toothpicks is \( y = x(x+3) \). I know this because the difference between each figure goes 4, 6, 8, 10... so I went backwards and found a pattern. There would be 0 toothpicks or like \( (0,0) \) an x-intercept, then if you keep subtracting from \( (x, x) \) and \( (2, -3) \) where you start adding again after getting to a difference of zero. I saw if there was a figure -3 then it would also take 0 toothpicks to make. So I knew one x in the equation would add 3 since you use the opposite sign of the number to find the x-intercepts. As you add 3 to one x and the other is just plain so \( y = x(x+3) \).
5. Is the pattern of growth of the perimeter linear, quadratic, or exponential? Give reasons for your decision.

Linear. The equation shows that the data goes up at a constant rate. The graph is a straight line (that's what a linear function looks like).

It is linear because in the equation all you are doing is multiplying one variable by a number or the coefficient, there is just a coefficient available in the equation.

Linear, because the numbers go up by 4 every time and it's constant.

6. Is the pattern of growth of the total number of toothpicks linear, quadratic, or exponential? Give reasons for your decision.

Quadratic. The graph is a parabola which is what you get with a quadratic relationship.

Quadratic because the pattern of change or the " interval " between the two is increases by a certain #(x) each time.

Total toothpicks

<table>
<thead>
<tr>
<th>Total toothpicks</th>
<th>Aquire toothpicks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4, 7, 10, 13, 16,</td>
</tr>
<tr>
<td>2</td>
<td>10, 18, 26, 34,</td>
</tr>
<tr>
<td>3</td>
<td>18, 26, 34, 42,</td>
</tr>
<tr>
<td>4</td>
<td>26, 34, 42, 50,</td>
</tr>
</tbody>
</table>

Quadratic because it has a second difference of 2 each time it increases.


American Association for the Advancement of Science: Project 2061. 1999. Middle grades mathematics textbooks: A benchmarks-based evaluation: Evaluation report prepared by the American Association for the Advancement of Science. Washington, D.C.


Winking, D., A. Bartel, and B. Ford. 1998. The Connected Mathematics Project: Helping Minneapolis middle school students 'beat the odds'. Year one evaluation report. Report submitted to the National Science Foundation as part of the Connecting Teaching, Learning, and Assessment Project.