Using the math in everyday life to improve student learning

The Math in Everyday Life homework assignment builds student confidence and competence in mathematics.

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Preparing middle school students for the mathematics portion of standardized tests without “teaching to the test” may sound challenging and implausible. Building students’ confidence and competence for test taking by way of mathematics homework may also sound unrealistic. However, in this age of high-stakes testing, teachers must find ways to weave test preparation into their routine instructional practices without compromising the depth or breadth of the curriculum (Turner, 2009). In this article, I share the impact a weekly mathematics homework assignment had on students’ self-confidence and self-perceived competence with test taking. Each week, fifth grade students wrote about an authentic experience they had outside school that required them to use mathematics. They described the situation for which the mathematics was necessary and communicated not only an answer to their problem but also an explanation of how they approached and solved it.

Originally, there were two explicit goals for the assignment, neither of which pertained to test preparation. The first was to develop students’ ability to recognize, appreciate, apply, and communicate about mathematics used outside the classroom. The second was for students to see themselves as competent and functional mathematicians, independent of, or perhaps in spite of, their success with school mathematics. Near the end of the school year, students reflected on the assignment in an impromptu and candid whole-group discussion. In this discussion, they unexpectedly shared the positive impact they believed the assignment had on their confidence and competence going into the period of intensive standardized testing in spring.

In this article, I situate the Math in Everyday Life (MIEL) assignment within the relevant literature and describe its implementation. I share students’ reflections about the assignment, provide examples of students’ work as it progressed over time, and offer an analysis of the outcomes of the assignment. Finally, I discuss ways MIEL can be used to enhance classroom practice and to address middle level mathematics curriculum standards.

Connecting mathematics to everyday life

It has been more than two decades since the mathematics education community was introduced to young Brazilian street merchants, who, without pencils, paper, or calculators, could solve complex, multistep computations involving currency (Carraher, Carraher, & Schleimann, 1987; Nunes, Schleimann, & Carraher, 1993). These same children, however, could not solve identical problems using strategies typically taught in school. To illustrate, consider the following scenario involving a Brazilian third grade student and an interviewer. The interviewer asked the child to solve the problem 200 – 35. First, the child rewrote the problem vertically, as per the standard school-taught algorithm. He carefully lined up the place values and began his computation with the farthest right-hand column, as per convention. He explained:

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...five, to get to zero, nothing. Three, to get to zero, nothing. Two, take away nothing, two ... 200" (Carraher, Carraher, & Schleiman, 1987, p. 95). When prompted by the interviewer to consider his solution, the child tried the problem again using a different algorithmic strategy. Again he failed. At last, the child abandoned any school-taught approach and conceptualized the problem in terms he understood: "If it were to cost thirty, then I'd give you one hundred seventy." The researcher probed with: "But it is thirty-five. Are you giving me a discount?" The child replied: "One hundred sixty-five."

The illustration of Brazilian children who fail in school but deftly make change as street merchants is indeed compelling. However, this discrepancy between school-taught and streetwise facility with mathematics is not unique to that population. Rather, it is widespread among American children, adolescents, and adults alike. In fact, the negative impact of this disparate structure between school learning and critical real-world knowledge has been studied in the context of mathematics more than in any other subject area (see Davis & Maher, 1993, 1997; Gravemeijer, 1997; Gruber, 1996; McNair, 2000). This structural discrepancy leads to a perennial question students ask teachers: When will we ever use the countless formulas and algorithms we spend hours upon hours memorizing and parroting (Heuser, 2005)? Often, students do not see the connection between the mathematics they learn in school and the mathematical demands of their everyday lives. Not seeing this connection can affect students' motivation for, interest in, and, ultimately, their success with mathematics (Hidi, Krapp, & Reninger, 1992).

One reason behind this discrepancy is most mathematics programs and assessments require students to consider rules and laws formulated by others, use symbols or systems determined by others, and resolve problems contrived by others (Oliver, 1999). A person's real life, however, requires that she act on authentic situations and resolve unpredictable and, often, ill-defined problems (Brown, Collins, & Duguid, 1989). In an earnest effort to combat the lack of correspondence between school mathematics and the demands for mathematics in real life, many teachers and textbook writers offer problems that reflect real-life scenarios and circumstances (e.g., Carpenter, Fennema, Franke, Levi, & Empson, 1999; The University of Chicago School Mathematics Project, 2007). However, situations that reflect the lives of students are not the same as authentic situations in real-time and that are unique to and current in students' lives (Gravemeijer, 1997; McNair, 2000). These latter, real-time situations are found in students' in situ mathematical activities—shopping, playing sports, cooking—and require spontaneous and functional applications of mathematical knowledge and skills. Accordingly, the MIEL homework assignment was designed to bring personal relevance to the mathematics middle school students practice in and outside school.

### The MIEL assignment

MIEL was implemented in a fifth grade class consisting of 17 students who attended a suburban public school in an economically diverse school district. There were ten boys and seven girls. One student was Hispanic, two were African American, and the rest were Caucasian. Seven students had individualized education plans (IEPs), all for attention deficit hyperactivity disorder (ADHD). All students had worked exclusively with a textbook-based mathematics program since first grade.

In the first week of the school year, the teacher introduced her students to MIEL. She told her students that each Monday they would hand in a unique
description of when and how they used mathematics outside school. She explained to them that they must describe the situation and do the necessary mathematics, and then explain how they did the mathematics from a conceptual rather than procedural perspective. She gave examples such as tipping a waiter in a restaurant, calculating tax and discounts when shopping, and measuring and adjusting proportions when cooking to illustrate her points. She also showed examples of mathematical explanations that were insufficiently conceptual. For example, if a student wanted to explain how she added 24 and 13, setting up a vertical algorithm and adding columns of digits would not suffice. This is because the algorithm does not explain why 24 plus 13 equals 37, it only shows how to add them together digit by digit. Rather, she expected students to explain something like: “13 is the same as 10 plus 3. So, I can add 24 plus 10, which is 34 and then I can add on the other 3. Thirty-four plus 3 is 37.”

The teacher also encouraged students to involve their parents and other family members. She told students that they would have opportunities to share their work on Mondays during math time, but the submissions would not be assigned a letter or number grade. Rather, the submissions would be recorded as “done” or “not done.” The teacher also explained that the assignment was exclusively for homework, and no class time would be provided for working on it, only for sharing it.

An analysis of MIEL

I visited with the students three times over the school year. The first time was about a month into the school year when I first talked with them about the MIEL assignment. I explained that their teacher and I were working together to learn more about their mathematical thinking and to try to make mathematics interesting and relevant to them. I visited the classroom twice more during the school year to collect students’ work and to talk with them. The final visit came late in the spring, within a week of their having taken a battery of standardized tests. During this visit, I collected the last of the students’ work, and I also took the opportunity to have an impromptu discussion with them about the MIEL assignment. During this conversation, students revealed outcomes of the assignment that neither their classroom teacher nor I had anticipated.

I asked students three main questions. The first question was intentionally very general: What did you think of the MIEL assignment? As a follow-up, I asked them if their thoughts evolved or changed throughout the year. The second question was: Has the MIEL assignment helped with taking tests? I was particularly interested in any relationship to the standardized tests they had recently taken. The final question was: Were you lucky to have the MIEL assignment, or was it just extra homework? I wanted to know how these students felt about being the only one of three fifth grade classes in the school to have this “extra” homework assignment.

What did you think of the MIEL assignment?

When considering MIEL over the course of the school year, most students who commented (14 of 17 students) focused on how the assignment opened their eyes to the mathematics they use outside school and how it made the mathematics they learned in school easier and more meaningful. For example, one student said: “It made math easier because we are more aware now that we do math every day.” Another student said: “Our everyday life math problems are not made-up experiences that everyone has to work with; they are our own experiences we are writing about.” And a third student shared: “It is making us better at math because we take what we learn in the classroom and apply it to everyday life.”

It is making us better at math because we take what we learn in the classroom and apply it to everyday life.

Has the MIEL assignment helped with taking tests?

As I listened to students’ general reactions to MIEL, I was impressed with the confidence they conveyed. Moreover, I had recently been in a fourth grade classroom in the same district and listened to students comment on how relieved they were that the annual testing period was over. Thus, in the context of MIEL, I asked the fifth grade students how they felt going into the testing period and how they thought they had done on the mathematics portion of it.
Two main themes emerged from responses to these questions. The first had to do with how well-prepared students felt for the unpredictable nature of test questions and the anxiety that typically surrounds that unpredictability. One boy shared that MIEL prepared him “for stuff, because you don’t know what math you’re going to write about every week. There’s unpredictability, like test questions, you don’t know what they’re going to ask.” Another girl insightfully commented: “We all learn math from the book, yet we all encounter math problems in different ways. I can do a problem in my life how I see it.”

The second theme dealt with the way students felt their confidence and competence answering extended response questions improved. One student said that the MIEL assignment helped her with the math extended responses “because for math in our everyday lives, we have to write the steps that we take to solve the problem.” Another said that at first he “wrote a few sentences” to describe the math he did in his everyday life. He went on to say that “now we are writing longer answers.”

**Were you lucky to have the MIEL assignment, or was it just extra homework?**

Most students seemed to feel pretty good about the impact MIEL had on the mathematics they practiced in school (including on tests) and outside school. Consequently, I wondered how students felt about doing the assignment as additional mathematics homework that the other fifth grade classes were not assigned. By asking this question, I shifted the focus from the impact of the assignment to the work itself. I wondered if students could appreciate the extra work the assignment required in view of having discussed its positive impact.

Despite the fact that MIEL was extra homework, most students saw it as giving them an advantage over their peers when it came to class work, testing, and succeeding with mathematics-related tasks and opportunities outside school. One student explained: “It was better for us and gave us an advantage because we know more and use math more instead of just doing it for an hour every day.” He also explained: “I don’t feel lucky to have extra homework, but on a math test or in the long-run, it makes me feel lucky.” One girl said that it was “not always the most fun, but it does put us at an advantage because it gets us thinking more about math, and we don’t just forget math exists when we leave the classroom.”

**Students’ work and test results**

The above discussions I had with students came before I had the chance to look through their work and well before I had access to any test scores. Thus, the conversations turned out to be critical because students’ insights gave me some direction as I planned for analysis. Specifically, I looked through students’ work for evidence of how MIEL prepared them for taking tests in the context of improved confidence and competence with extended response items and with the unpredictability of test questions. I also looked at Measure of Academic Progress (MAP) test results at three points in time. A MAP test is an electronically administered standardized test published by the Northwest Evaluation Association (NWEA) and given to students in many school districts in the fall, winter, and spring of their school year.

Results showed that mean scores on the MAP tests did not significantly improve from fall (RIT mean score of 225.48) to winter (229.40) but did improve significantly from winter to spring (234.73) and from fall to spring. It is, of course, impossible to attribute this growth in test scores solely to the MIEL assignment because of the breadth of learning opportunities available to students throughout the year. Therefore, I turned my attention to conducting a qualitative analysis of students’ homework.

To analyze students’ work relative to confidence and competence with extended response items, I looked for progress in the clarity of students’ work and how well they described both their MIEL problems and the mathematics required to solve them. To evaluate how well prepared students were for the unpredictability of test items, I looked for increasingly complex mathematics and problem-solving strategies. I inferred that the more proficient and comfortable students became with identifying and solving a variety of complex mathematics problems outside school, the less daunted they would be when encountering unfamiliar test questions.

Two independent raters looked through all student work and coded each piece as “poor,” “satisfactory,” or “excellent” with respect to its clarity and as “basic” or “advanced” with respect to complexity. Then, the compilation of each student’s work was reviewed and coded as “improved” or “not improved” in complexity and clarity. To be coded as improved in clarity, students had to progress from minimal descriptions of a problem-solving strategy or calculation to consistently
elaborate descriptions of a problem-solving process or computational approach. Students whose work was categorized as not improved either began with very clear and comprehensive writing, or their explanations never evolved.

Students whose work improved in complexity went from completing no computations or very basic computations involving addition or subtraction to completing advanced, multifaceted mathematical tasks, such as those requiring multi-digit multiplication and division or calculations with percentages and rational numbers. Students whose complexity did not improve were either using advanced mathematics from the beginning or did not progress beyond basic addition and subtraction.

Seventy-one percent of students improved in their clarity of explanations from September to May, and 29% showed no improvement. This number closely corresponds to the 76% of students who improved overall on the mathematics portion of the MAP test from fall to spring. In terms of increased complexity of problems and application of mathematics, 65% of students improved from September to May, and 35% showed no improvement.

Representative case studies of how two students, Leah and Adam, progressed with either clarity or complexity on the MIEL assignment over time are discussed below and summarized in Figures 1 and 2.

Leah

Leah’s MIEL assignments improved substantially in both complexity and clarity. She went from scoring at the 58th percentile on the MAP test in the fall to scoring in the 82nd percentile in the spring. Figure 1 shows examples of how the clarity of her work improved and how she went from simply recording addends for a simple addition problem in September to describing how to calculate the number of years ago something occurred using a base ten counting system.

Figure 1 Leah’s progress in “clarity” with the MIEL

“This week for everyday math I was trying to figure out how many minutes it would take to do my homework. It was 11:00 a.m. and I estimated I could do my math in 15 mins. I start at 11:15 and it takes me 5 mins. on #1 so that was 5 min. It took me 2 minnets to do #2, 5 min to do #3 and 2 min to do after it took me 9 more small I did my HW in 14 min.

“This weekend I was watching the movie Sound of Music. My parents said it wasn’t in 1965. They wanted me to find out how many years the movie had been around for. So first, I counted by tens to get to 2010. So I subtracted 1965 by 2010 to get 45 years. So overall the Sound of Music was 45 years old. The question asked how old they were when it was filmed which was a trick question because they weren’t born yet so, they were 0 years old.”
Adam

Adam’s MIEL assignments improved substantially in complexity from September to May. He also went from scoring at the 66th percentile on the mathematics portion of the fall MAP test to scoring at the 91st percentile in the spring (see Figure 2). Adam's early submissions involved performing and explaining simple calculations, such as adding up the number of minutes he spent practicing his French horn in a week. By April, Adam was using conventional algorithms and mathematical symbols. For example, he used the notation for a repeating decimal in his quotient when calculating his speed in feet per minute for a mile-long race. He also demonstrated his ability to interpret the results of a standard algorithm by explaining that his quotient of 512.615 is “about 512.62 feet per minute” and went on to consider that speed in the context of his ability to run “his fastest” mile.

Using the MIEL assignment to enhance classroom practice

Turner (2009) suggested that teachers should integrate test preparation into their regular instructional practices.

Figure 2 Adam’s progression in “complexity” with the MIEL
without narrowing the curricular focus or compromising program standards. He went on to describe the importance of preparing students for high-stakes testing by “teaching to the curriculum” as distinct from “teaching to the test.” The latter connotes the practice of giving students actual high-stakes items as practice without a broader curricular context or instructional motive. On the other hand, teaching to the curriculum refers to planning instruction that aligns mandated curriculum with the knowledge and skills students need to succeed on tests.

There are many ways that MIEL can be integrated into classroom practice as a tool for test preparation and formative assessment. For instance, MIEL can help teachers plan instruction in ways that directly reflect the process and content standards found in state or locally mandated curricula and in the parent document *Principles and Standards for School Mathematics* (National Council for Teachers of Mathematics [NCTM], 2000). In this document, there are five content standards and four process standards. The first process standard is “problem solving.” According to NCTM (2000), the ultimate goal of engaging with problem solving is for students to develop ways of thinking that “build confidence in unfamiliar situations that will serve them well outside the mathematics classroom” (p. 52). The MIEL assignment seems to embody this in its mission and outcome. Moreover, when children share their MIEL scenarios orally and in writing, they are engaging in meaningful communication, which is another NCTM process standard. When students are challenged to communicate the process and results of their reasoning, they learn to be clear and convincing, and they learn to reflect on and revise their thinking in ways that help them learn and make connections to new mathematical concepts, which is a third NCTM process standard.

Another way the MIEL assignment can support a standards-based curriculum is by using students’ submissions as guideposts for planning. Students’ weekly submissions can represent a type of journal from which teachers can gain insight into how students are processing and applying mathematics beyond textbook exercises and tests (Burns, 2004). Teachers can use the information they gather about each student to individualize instruction or to form groups of students with similar learning needs. This approach may help teachers prepare students for tests by making them aware of the standards they have met and those they have not yet mastered.

For example, as a fifth grader, Hannah was expected to “develop fluency in adding, subtracting, multiplying, and dividing whole numbers,” according to the Numbers and Operations strand of the NCTM standards. For one of her MIEL assignments, she wanted to know how much her babysitter earned per hour if she earned $75 for 6 hours. To solve the problem, Hannah “divided $75 by 6 and got 12 with remainder of 3.” From this, she determined that the babysitter “got paid $12 an hour, [but she] didn’t know what the remainder of 3 was, so [she] just put the extra 3 as cents and got $12.03 per hour.” Hannah was clearly not prepared for test questions involving division with remainders, and her teacher could now intervene and provide her and others with more opportunities to learn and apply concepts related to division.

The MIEL assignment can also be modified to address certain areas of concern or to focus students’ attention on a particular standard or topic for test preparation. For instance, a teacher might ask students to identify ways they use a particular skill, such as measurement, in their everyday lives. This approach to MIEL was used periodically with the present group of students. The teacher generally did this when she ran short of instructional time in a given week or was unsure of students’ understanding about a particular concept. She found these particular submissions to be more “forced” and “formal,” but she also found them to be valuable assessment tools for planning purposes.

**Conclusion**

That children must connect with a curriculum for effective learning to take place is not a new proposition. Dewey asserted this more than a century ago (Dewey, 1902), and it continues to be an ongoing point of emphasis for those committed to bettering school-based learning and instruction (e.g., Brown, Collins, & Duguid, 1989; McNair, 2000). Moreover, curricular relevance and student-centeredness are key components of effective education for young adolescents (National Middle School Association, 2010). The present work contributes to this conversation by extending the implications of effective child-centered curricular planning to include the realm of mathematics learning and test preparation.
Preparing children for tests is a significant part of most modern mathematics programs, and teachers must find ways to prepare their students beyond “teaching to the test.” The MIEL assignment discussed here offers a way to maintain the integrity of a conceptually-driven, child-centered, standards-based curriculum while effectively preparing students emotionally and academically for impending tests. It is important to emphasize that the assignment itself was clearly not the only factor contributing to students’ test preparation and, ultimately, to their improved test scores. Yet, given students’ feedback about the assignment and the analysis of their work, MIEL did appear to play a significant role in students’ confidence and success with test taking. In particular, MIEL provided a regular and meaningful venue for students to apply and practice their mathematical knowledge and skills as well as their problem-solving and communication processes.

Finally, many students clearly communicated that they believed the MIEL assignment improved their mathematical abilities and their overall confidence when performing mathematics tasks, communicating about mathematics, and taking tests involving mathematics. These findings are consistent with other research confirming a positive correlation between students’ confidence and their test scores (Smith, 2002). It is possible that MIEL had little to do with improving students’ mathematical competence and that regular instruction aligned with district standards was sufficient. However, by students’ own accounts, the MIEL assignment prepared them for test taking, and, thus, it cannot be discounted as a contributing factor and one worth considering as a regular feature integrated into teachers’ instructional practices.

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**Extensions**

Have you ever asked your students when or if they use the math they learn in school outside of school? What can/do their responses tell you about the extent to which they perceive the math curriculum they are experiencing as relevant?

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